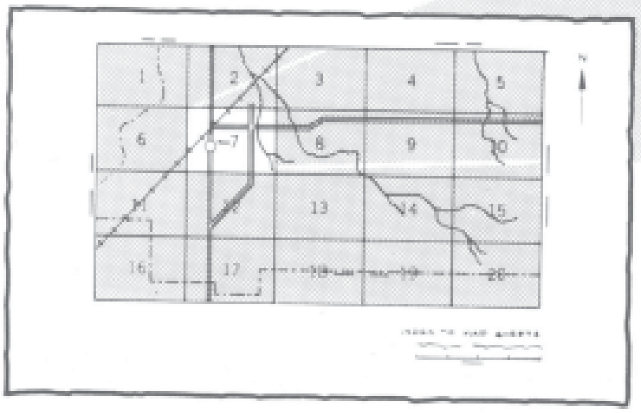
Soil Survey Of

Cottonwood County, Minnesota

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

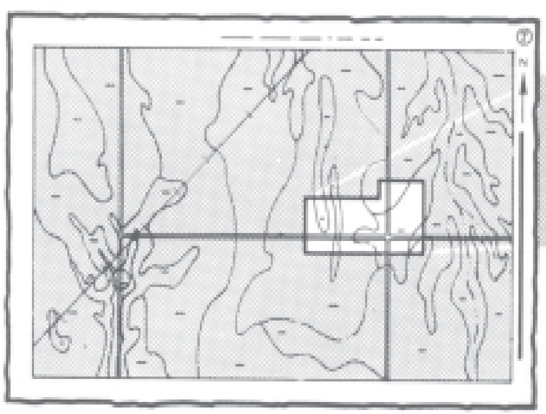
HOW TO USE

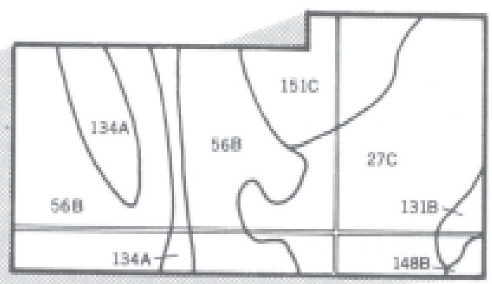
1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).



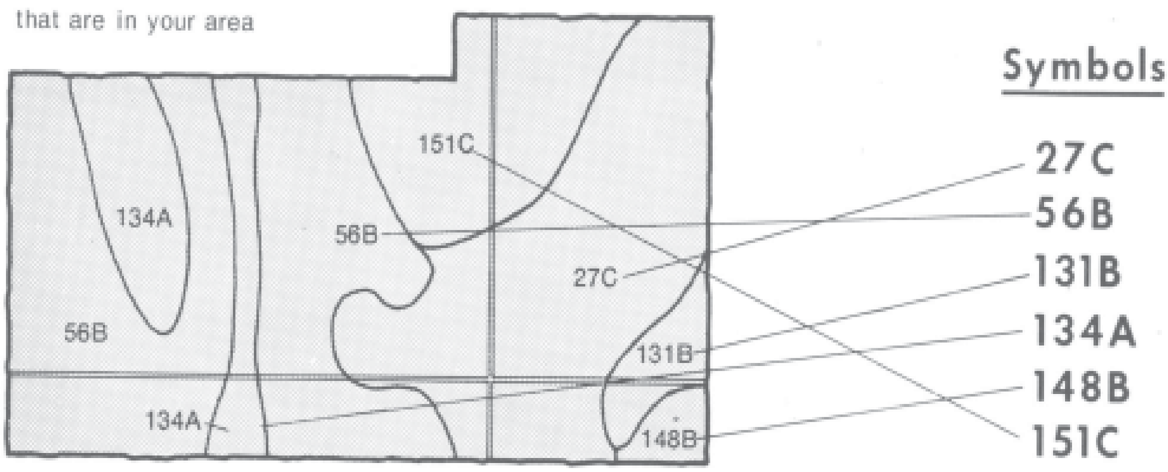
2. Note the number of the map sheet and turn to that sheet.

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



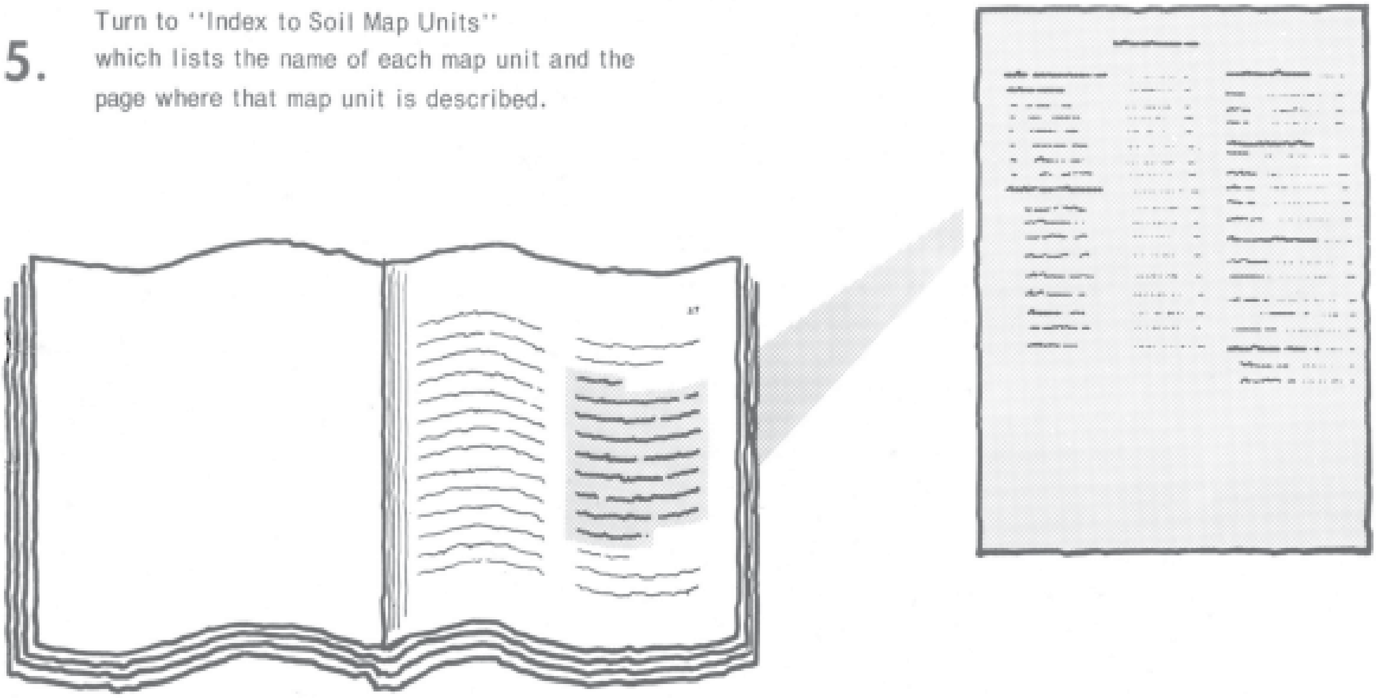


4. List the map unit symbols that are in your area

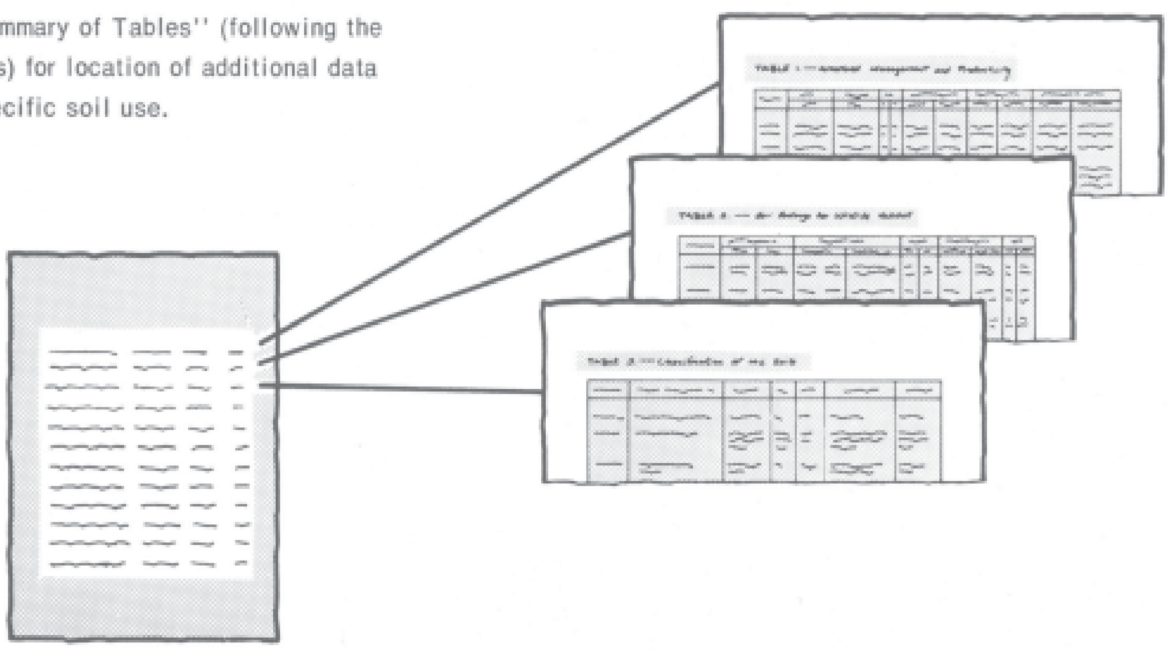


THIS SOIL SURVEY

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



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



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

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and the Minnesota Agricultural Experiment Station. The soil survey was partially funded by Cottonwood County. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1972-1976. Soil names and descriptions were approved in 1977. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1977. This survey was made cooperatively by the Soil Conservation Service and the Minnesota Agricultural Experiment Station. It is part of the technical assistance furnished to the Walking Water Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps can cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

Contents

Issued November 1979

Index to soil map units

Summary of tables

Summary of tables—Continued

Foreword

The Soil Survey of Cottonwood County, Minnesota contains information that is basic to any land-use activity. It can help virtually anyone who uses land.

Farmers, foresters, or agronomists can use it to determine the potential of the soil and the management practices required to produce food and fiber. **Planners, community decision-makers, engineers, developers, builders, or home-buyers can use to plan use of land, select sites for construction, develop** soil resources, and identify any special practices that may be needed to assure proper performance of the soil. Conservationists, recreationists, teachers, students, or specialists in wildlife management, waste disposal, or pollution control can use the soil survey to help understand, protect, and enhance the environment.

Many people assume that soils are all more or less alike. They are unaware that great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding; they may be shallow to bedrock; or they may be too unstable to support buildings or roads. Very clayey or wet soils make poor septic tank absorption fields, and a high water table makes a soil poorly suited to basements or underground installations.

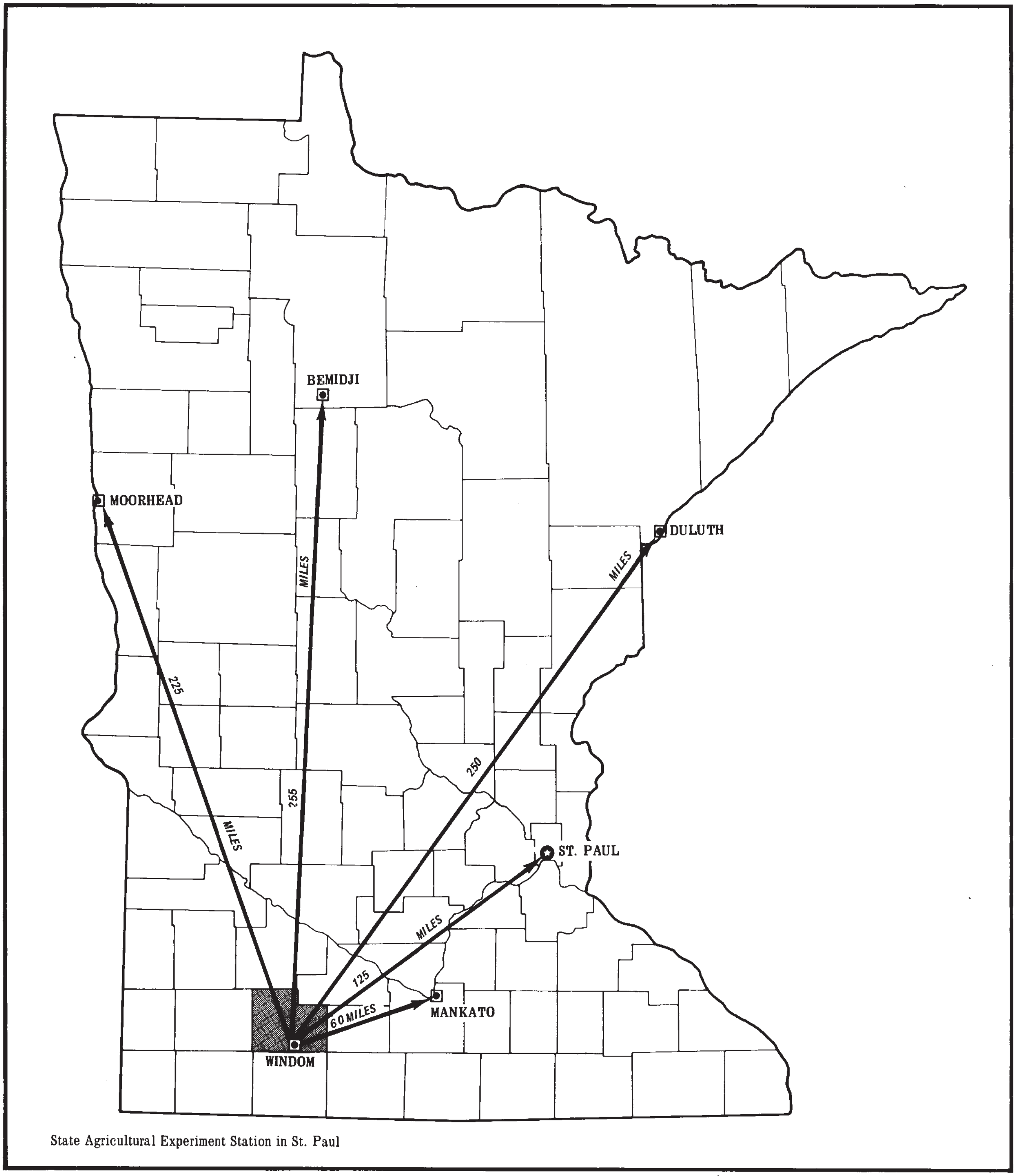
These and many other soil properties that affect land use are described in this soil survey. Of prime importance are the predictions of how soil will react to various land uses. Also highlighted are the limitations or hazards to a given land use that are inherent in the soil, the improvements needed to overcome these limitations, and the impact that a selected land use will have on the environment.

The General Soil Map included in this publication shows the location of broad areas of soils. The location of each kind of soil is shown on detailed soil maps at the back of the publication. Also included are written descriptions of all the soils in the survey area.

If you need more information to help you use this soil survey effectively, please call your local office of the Soil Conservation Service, or the Cooperative Extension Service.

We believe that this soil survey will help you have a better environment. The widespread use of this information by people who use land will help all of us in the conservation and productive use of our soil, water, and related resources.

Harry M. Major
State Conservationist
Soil Conservation Service



Location of Cottonwood County in Minnesota.

SOIL SURVEY OF COTTONWOOD COUNTY, MINNESOTA

By R.E. Rolling, Soil Conservation Service

Soils surveyed by R.E. Rolling and F.D. Lorenzen, Soil Conservation Service

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

COTTONWOOD COUNTY is in the southwestern part of Minnesota. (See map on facing page.) Windom is the county seat. The total area of the county is 412,800 acres, of which lakes make up about 5,825 acres. Farming is the principal business enterprise. Corn, soybeans, small grain, and hay are the main crops grown; and cattle and swine are the main livestock raised.

The soils of Cottonwood County formed in glacial till, in material sorted out of the till by water, and in organic material. The soils are dark colored because they formed under an original vegetation of tall and medium prairie.

General nature of the county

This section contains general information about Cottonwood County. It consists of briefs on geology; climate; physiography, relief, and drainage; history and development; transportation and markets; water supply; and farming.

Geology

Most of Cottonwood County is on the "Coteau des Prairies" or "hill of grasses" (*1*). This is a ridge that extends northwest-southeast across Minnesota from South Dakota to Iowa (fig. 1). The ridge consists of a bedrock core that is overlain by glacial sediment.

Sioux Quartzite is the oldest bedrock noted in the county. It is of Pre-cambrian age and underlies most of the county. The depth to this bedrock is variable. It is deepest in the western part of the county, where it underlies sandstone and shale of Cretaceous age. The sandstone and shale bedrock are overlain by thick deposits of glacial sediment except in river bottom lands. In these areas the glacial sediment is thinner and the sandstone and shale are at shallower depths.

Sioux Quartzite bedrock is at a shallow depth in the central part and outcrops in the northeastern part of the county. A small area also outcrops in the southwest corner of section 6 in Dale township. It is part of a bedrock shelf that extends under the highest part of the county. Sioux Quartzite is composed of fused sandstone. It is very hard and does not fracture along planes. It is interbedded with thin layers of Catlinite shale. Weathered Sioux Quartzite and Catlinite have the same dull red color and are known as "red rock". Catlinite is carvable and is also known as "Pipestone".

Loamy glacial till, sandy and gravelly to clayey glacial outwash, and lacustrine sediment cover most of the county. The glacial till is calcareous and of Wisconsin age (*8*). It is a gently sloping to nearly level ground moraine in most of the county. Undulating to steep, lateral moraines formed along the main axis of glacial ice flow. Pre-glacial river channels formed along the lateral moraines. These channels entered the county on the west-central side and ran in a southeast direction. Glacial action was not sufficient to entirely cover these channels, and the glacial meltwaters reopened some of them. Most of the lakes in the county formed in these channels.

Glacial meltwaters sorted material from the glacial till. Silty and clayey sediments were deposited in glacial lakes in the southwestern and south-central parts of the county. Glacial outwash of sand and gravel was deposited in glacial river terraces in the south-central and north-central parts of the county.

Climate

Cottonwood County is in the great interior climate region of North America. Winters are cold, and summers generally are mild with occasional hot and humid days. Total annual rainfall is normally adequate for corn, soybeans, and small grains.

Table 1 gives data on temperature and precipitation for the survey area, as recorded at Windom, Minnesota, for the period 1951 to 1974. 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 17 degrees F, and the average daily minimum is 8 degrees. The lowest temperature on record, -31 degrees, occurred at Windom on February 19, 1959. In summer the average temperature is 71 degrees, and the average daily maximum is 83 degrees. The highest temperature, 101 degrees, was recorded on June 13, 1956.

Growing degree days, shown in table 1, are equivalent to "heat units." Beginning in spring, 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.

Of the total annual precipitation, 20 inches, or 73 percent, usually falls during the period April through September, which includes the growing season for most crops. Two years in ten, the April-September rainfall is less than 17 inches. The heaviest 1-day rainfall during the period of record was 3.84 inches at Windom on July 13, 1970. Thunderstorms number about 44 each year, 27 of which occur in summer.

Average seasonal snowfall is 35 inches. The greatest snow depth at any one time during the period of record was 32 inches. On the average, 28 days have at least 1 inch of snow on the ground, but the number of days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night in all seasons, and the average at dawn is about 80 percent. The percentage of possible sunshine is 70 percent in summer and 55 percent in winter. The prevailing direction of the wind is from the south. Average windspeed is highest, 14 miles per hour, in April.

Tornadoes and severe thunderstorms strike occasionally. These storms are local 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.

Physiography, relief, and drainage

The physiography of Cottonwood County (*8*) consists of a lowland plain and a plateau (fig. 2). The lowland plain is a narrow area in the northeastern part of the county. It is a nearly level to gently sloping ground moraine that slopes to the northeast at about 30 feet per mile. Its highest area is about 1,200 feet above sea level at the foot of the plateau slope. The lowest area in the county is about 1,100 feet above sea level in the northeast corner of this lowland plain. The rest of the county is on the plateau.

The plateau is composed of nearly level to gently sloping ground moraines, glacial lake plains, glacial river terraces, and undulating to steep lateral moraines. Its central part is closely underlain by bedrock. The bedrock extends as a ridge eastward out of the county. The ridge is 2 to 3 miles wide, and bedrock is exposed in shelves and creeks. The plateau slopes toward the northeast. The steepest slope is adjacent to the lowland plain. It rises 250 feet every 2 to 3 miles from the northeast to the north-central part of the county. It is deeper to bedrock in the north-central part and rises 250 feet every 5 to 6 miles. The highest area in the county is near the center and is closely underlain by bedrock. It is in the west-central part of section 6 of Dale township. The plateau is transected by deeply incised rivers that have little secondary development. The river valley side slopes are steep and river bottom lands are narrow to broad.

The west-central and northern parts of the county are drained by Pell Creek, Dutch Charley Creek, Highwater Creek, and Dry Creek. The north-central and northeastern parts are drained by Mound Creek and the Little Cottonwood River. These streams cross the "Red Rock Ridge" through faults. All of these streams drain northeast to the Cottonwood River that joins the Minnesota River. The central, eastern, and southeastern parts of the county are drained by branches of the Watonwon River. This river joins the Minnesota River. The southwestern and south-central parts of the county are drained by the Des Moines River and its tributaries.

History and development

Cottonwood County was formed by the Minnesota Territorial Legislature in 1857 and named for the cottonwood trees that grow along its streams. The early settlement was slow and interrupted by the Sioux Indian War of 1862. All of the people who homesteaded prior to 1862 were killed or left the county during this war. Resettlement started in 1864, and the county was organized in 1870. At that time there were 535 inhabitants and 143 farms with a total acreage of 6,377, of which 782 acres was improved. Most of the early settlers were of northern European ancestry, particularly Scandinavian. When the railroad crossed the county in 1871, rapid settlement followed. By 1900 a major part of the county was in farms, and 92 percent of the land was improved.

There are seven cities in the county—Westbrook, Storden, Jeffers, Delft, Mountain Lake, Bingham Lake, and Windom. Windom is the county seat and the largest city, with a population of 4,000.

Transportation and markets

One railway crosses the southeastern part of the county and serves Windom, Bingham Lake, and Mountain Lake. A branch line crosses the center of the county and serves Westbrook, Storden, Jeffers, and Delft. It joins the main line at Bingham Lake. Another railway crosses the northeastern part of the county and serves the adjacent town of Comfrey.

The major highways in the county are paved with concrete or asphalt. Nearly every section has gravel roads on all sides, and many county roads are paved with asphalt. U.S. Highway 71 crosses the county from north to south. It intersects Minnesota Highway 30 near the center of the county. Minnesota Highway 30 serves the towns of Westbrook, Storden, and Jeffers. U.S. Highway 71 intersects Minnesota Highways 60 and 62 at Windom. Minnesota Highway 60 crosses the southeast corner of the county and serves the towns of Windom, Bingham Lake, and Mountain Lake. Minnesota Highway 62 crosses the south end of the county and serves the town of Windom.

Livestock is processed in Windom or trucked to Sioux Falls, Sioux City, South St. Paul, or Worthington. A milk processing plant is located in Mountain Lake. All towns except Delft have grain elevators.

Water supply

Water is obtained from wells, ponds, rivers, and lakes in Cottonwood County (*3*). Wells supply most of the potable water. The quantity and quality of well water is variable and directly related to the type, size, and depth of the aquifer.

Wells that terminate in glacial deposits are charged from coarse textured strata. These strata are generally lenses of sand and gravel in glacial till. In a few places they are buried river terraces or outwash deposits at the contact zone of different glacial till sheets. These strata were originally charged by glacial meltwater. Their recharge rate from local precipitation decreases with depth. Strata that are in close contact or continuous with the surface are rapidly recharged. Their water supply fluctuates with the local precipitation and may cease during drouth. Deeper strata are recharged more slowly. They generally contain an ample water supply but depletion results when withdrawal rates exceed recharge rates. Water from glacial deposits has a fairly uniform high carbonate content, but sulfate content increases with depth.

Sioux Quartzite usually yields softer water than glacial till deposits. The carbonate and sulfate content of the water increases with the depth of the overlying glacial till. Water is obtained from fissures of interbedded shale or caverns in the quartzite. Water yield is generally low, but the recharge rate from precipitation is fairly rapid.

Shale or "soapstone" yields small quantities of water. Its quality may also be low because the shale frequently contains strata of coal or lignite. These strata contaminate the water with nitrates and small amounts of oil and natural gas.

Sandstone is the best aquifer in Cottonwood County. It generally underlies the shale but directly underlies glacial deposits in places. Sandstone yields large quantities of hard water. Most of the water has a high content of carbonates and sulfates, but a few thin strata of sandstone yield softer water.

Ponds can be excavated in springs or depressions to supply livestock water. The quantity and quality of pond water is variable and dependent upon local precipitation. The water in most places is fairly soft. It should be treated for human use because ponds have a hazard of pollution from surface sources.

The surface water resources of Cottonwood County are poorly developed. Most of the runoff and drainage water is not retained. A few water retention structures have been built by damming ravines with earth fill. These structures provide water for livestock, recreation, and wildlife habitat. Many sites are suitable for water retention structures, particularly on the Coteau slope in the northern part of the county.

Most rivers in the county do not have retention dams. Two dams have been built on the Des Moines River. One dam is at the outlet of Talcot Lake in the southwestern part of the county. This dam retains water in Talcot Lake and in the flood plains north of the lake. This area is used for wildlife habitat. Its southern half is maintained as a game refuge, particularly for migratory waterfowl. The second dam is in the town of Windom. It was originally built to supply water for a millrace. This dam does not have a constructed reservoir but retains water in the river channel and flood plain for about a mile upstream. The water depth fluctuates with the local precipitation and is generally too shallow and murky for recreation. Siltation of the river channel is caused by erosion of the river bed upstream. This dam also aggravates the flooding problem in Windom to the extent that some well drained soils are occasionally flooded. An earth fill dam on the Watonwon River, north of the town of Mountain Lake, retains water in the Watonwon River. This reservoir is known as Mountain Lake. Most of the other rivers follow natural meanders but some areas have been straightened and diked.

There are about 30 lakes in Cottonwood County. They cover 5,824 acres of land and average about 170 acres in size. Most of the lakes are in the southern half of the county, and nearly all of them formed in glacial river channels. Water quality in these lakes is variable. Lakes that are bounded by and underlain by glacial till are more fertile than lakes that are bounded by and underlain by sand and gravel. Rivers and streams that enter these lakes are few in number and very low in sediment yield. Their bedloads are deposited as deltas at the mouth of the stream or river. Shallow lakes less than 4 feet deep have a dense growth of reeds and rushes. They warm up rapidly, and a dense growth of algae and moss occurs by midsummer. Deeper lakes warm up more slowly, so algae and moss growth is less dense.

All lakes in the county are in the process of natural filling by lake sediment. This can be slowed by maintaining high water levels.

Farming

In Cottonwood County the farms are decreasing in number and increasing in size (*2*). In the period 1962 to 1974, the number of farms decreased from 1,615 to 1,138; and the farm population decreased from 6,530 to 4,323. Farm size increased from 240 acres to 330 acres.

Corn production increased from 139,300 acres in 1962 to 174,400 acres in 1974. Soybean production increased from 78,000 acres to 138,900 acres. The increase in production of corn and soybeans reduced the production of small grain and hay during this period. Small grain production in 1962 was 63,600 acres and 14,600 acres in 1974. Hay production decreased from 27,000 acres to 14,600 acres.

Total livestock production has remained fairly constant. Cattle production decreased from 66,400 to 53,500 head. The decrease in cattle numbers is mostly from dairy herds. Sheep production decreased from 12,900 to 4,300 head. Hog production increased from 107,000 to 118,300 in the period 1962 to 1974.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

After a guide for classifying and naming the soils was worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, roads, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called soil map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Map units are discussed in the sections "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and information available from state and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is readily available to different groups of users, among them farmers, managers of rangeland and woodland, engineers, planners, developers and builders, homebuyers, and those seeking recreation.

General soil map for broad land use planning

The general soil map at the back of this publication shows, in color, map units that have a distinct pattern of soils and of relief and drainage. Each map unit is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it 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 kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

Soil map units on the general soil map in this soil survey do not fully agree with those of the general soil maps in adjacent counties published at different dates. Differences in the maps are the result of improvements in the classification of soils, particularly in the modification or refinements in soil series concepts.

Areas dominated by soils that are underlain by bedrock

These nearly level to gently sloping, well drained soils formed in medium textured and moderately fine textured, calcareous, firm glacial till on uplands under prairie grasses. Slopes are simple and have exposed bedrock.

One map unit in Cottonwood County is in this group. The dominant and potential use of the soils in this unit is intensive farming.

1. Germantown

Nearly level to gently sloping, well drained soils that formed in clay loam and loam glacial till over bedrock

This map unit consists of low, convex knolls and ridges. The knolls have short slopes and are irregular in shape. The ridges have short slopes and are linear in shape. Most areas of this unit are drained by small streams. Slopes are 1 to 6 percent.

This map unit makes up about 2 percent of the survey area. It is about 40 percent Germantown soils and about 60 percent soils of minor extent.

Germantown soils have a surface soil of very dark brown clay loam and a subsoil of olive brown clay loam and loam. They are underlain by bedrock at moderately shallow depths.

The soils of minor extent are poorly drained Webster Variant in drainageways; well drained Everly soils on slightly convex areas; moderately well drained and somewhat poorly drained Wilmonton soils in slightly concave areas; and well drained, calcareous Storden soils on convex side slopes. Rock outcrop occurs in slightly convex areas, and a shallow, well drained soil adjoins the bedrock outcrops.

Most of the soils in this map unit are farmed. The principal crops grown are corn, soybeans, small grain, and forage grasses and legumes. About 20 percent of this map unit is in native grasses and is used for pasture. Beef cattle are an important part of the crop-livestock enterprise.

Most soils in this map unit have fair potential yields for cultivated crops and fair to good potential yields for small grain and forage grasses and legumes. Mulch tillage and other minimum tillage practices help to conserve the soil moisture supply and to control erosion. Areas of these soils have severe limitations for most engineering uses, mostly because of the shallow depth to bedrock. Onsite investigations are needed for engineering uses, as the soils are variable in this unit.

Areas dominated by soils that are underlain by firm glacial till

These gently sloping to nearly level, well drained to very poorly drained soils formed in medium textured and moderately fine textured, calcareous, firm glacial till on uplands under prairie grasses.

Three map units in Cottonwood County are in this group. The dominant and potential use of these soils is intensive farming.

2. Everly-Letri

Gently sloping, well drained soils and nearly level, poorly drained soils that formed in clay loam and loam glacial till

This map unit consists of low knolls separated by broad flats and shallow swales. Knoll slopes are slightly convex, long, and smooth. Low gradient drainageways drain the runoff, and in most places, tile drains remove excessive subsurface water. Slopes are 0 to 6 percent.

This map unit makes up about 10 percent of the survey area. It is about 50 percent Everly soils, 25 percent Letri soils, and 25 percent soils of minor extent (fig. 3).

Well drained Everly soils are on the knolls. They have a surface layer of black clay loam and a subsoil of dark yellowish brown and olive brown light clay loam and loam. The underlying material is light olive brown loam.

Poorly drained Letri soils are in swales. They have a surface layer of black clay loam and a subsoil of olive gray, calcareous clay loam and loam. The underlying material is loam.

The soils of minor extent are very poorly drained Coland soils in creek bottoms; poorly drained Romnell soils in broad depressions; well drained, calcareous Swanlake soils on convex rises and side slopes next to creeks; and moderately well drained and somewhat poorly drained Wilmonton soils on low rises.

Most of the soils in this map unit are farmed. Poorly drained creek bottom lands are used for pasture, trees, and wildlife habitat. Corn, soybeans, small grain, and forage grasses and legumes are the principal crops grown.

Areas of this map unit have good potential yields for cultivated crops, small grain, and forage grasses and legumes. Tile drainage removes excessive subsurface water from the Letri soils, making them easier to manage and more suitable for crops. Conservation tillage practices help to conserve soil moisture and to control erosion. Everly soils have fair potential for most engineering uses, but Letri soils have poor potential for these uses because of wetness.

3. Wilmonton-Letri

Nearly level, moderately well drained to poorly drained soils that formed in clay loam and loam glacial till

This map unit consists of low rises separated by broad flats and shallow swales. The rises are slightly convex, broad, smooth slopes. Low gradient drainageways drain the runoff, and in most places, tile drains remove excessive subsurface water. Slopes are 0 to 3 percent.

This map unit makes up about 12 percent of the survey area. It is about 45 percent Wilmonton soils, 20 percent Letri soils, and 35 percent soils of minor extent.

Wilmonton soils are on low rises. They have a black clay loam surface layer, an olive brown clay loam subsoil, and light olive brown loam underlying material.

The poorly drained Letri soils are on the flats. They have a black clay loam surface layer, an olive gray, calcareous clay loam and loam subsoil, and loam underlying material.

The soils of minor extent are well drained Everly soils on side slopes adjacent to drainageways; very poorly drained Glencoe soils in low gradient drainageways and depressions; poorly drained Romnell soils in swales; and poorly drained, calcareous Jeffers soils on rims of depressions.

Most of the soils in this map unit are farmed. Undrained areas are suitable for pasture and wildlife habitat. Corn, soybeans, small grain, and forage grasses and legumes are the principal crops grown.

Areas of this map unit have good potential yields for cultivated crops, small grain, and forage grasses and legumes. Tile drainage removes excessive subsurface water from the Letri soils and makes them easier to manage and more suitable for crops. Conservation tillage practices help to conserve soil moisture and to control erosion. These soils have poor potential for most engineering uses because of wetness.

4. Glencoe-Jeffers

Nearly level, very poorly drained and poorly drained, calcareous soils that formed in clay loam and silty clay loam glacial till

This map unit consists of low gradient drainageways and depressions. The rims of the depressions are low rises that are slightly convex. Depressions are shallow and round to long and narrow in shape. Runoff water ponds and, in most places, is drained with the subsurface water by tile drainage. Slopes are 0 to 3 percent.

This unit makes up about 5 percent of the survey area. It is about 30 percent Glencoe soils, 15 percent Jeffers soils, and 55 percent soils of minor extent.

Very poorly drained Glencoe soils are in depressions. They have a black clay loam surface layer, an olive gray clay loam subsoil, and clay loam underlying material.

Poorly drained Jeffers soils are on the rims of depressions. They have a black, calcareous clay loam surface layer; a dark gray and grayish brown, calcareous clay loam subsoil; and loam underlying material.

The soils of minor extent are moderately well drained to somewhat poorly drained Nicollet soils and somewhat poorly drained, calcareous Crippin soils on low rises; poorly drained Webster soils on flats; and poorly drained Canisteo and Jeffers soils on rims of depressions.

Most of the soils in this map unit are farmed. Undrained areas are suitable for pasture and wildlife habitat. Corn, soybeans, small grain, and forage grasses and legumes are the principal crops grown.

Areas of this map unit have good potential yields for cultivated crops, small grain, and forage grasses and legumes. Tile drainage removes excessive subsurface water and makes these soils easier to manage and more suitable for crops. Deep tillage or forage grasses and legumes in rotation helps to maintain tilth. These soils have poor potential for most engineering uses because of wetness.

Areas dominated by soils that formed in friable glacial till

These nearly level to very steep, poorly drained to well drained soils formed in medium textured and moderately fine textured, friable, calcareous glacial till on uplands under prairie grasses.

Four map units in Cottonwood County are in this group. The dominant and potential use of these soils is intensive farming.

5. Webster-Nicollet

Nearly level, poorly drained soils and very gently sloping, moderately well drained and somewhat poorly drained soils that formed in clay loam and loam glacial till

This map unit consists of flats and low rises separated by shallow drainageways. The rises are low, slightly convex to slightly concave, and irregular in shape and have broad, smooth slopes. Low gradient drainageways drain the runoff, and in most places, tile drains remove excessive subsurface water. Slopes are 0 to 3 percent.

This unit makes up about 10 percent of the survey area. It is about 30 percent Webster soils, 25 percent Nicollet soils, and 45 percent soils of minor extent (fig. 4).

Poorly drained Webster soils are on flats. They have a black clay loam surface soil, an olive gray clay loam subsoil, and clay loam underlying material.

Nicollet soils are on the low rises. They have a black clay loam surface layer, a grayish brown clay loam and loam subsoil, and loam underlying material.

The soils of minor extent are poorly drained Delft soils in narrow drainageways and on toe slopes; well drained Clarion soils on steeper side slopes; very poorly drained Glencoe soils in depressions and low gradient drainageways; and poorly drained, calcareous Canisteo and Jeffers soils on rims of depressions and on slightly convex flats.

Most of the soils in this unit are farmed. Corn, soybeans, small grain, and forage grasses and legumes are the principal crops grown. The more poorly drained areas that are not artificially drained are suitable for pasture or wildlife habitat.

Areas of this map unit have fair to good potential yields for cultivated crops, small grain, and forage grasses and legumes. Tile drainage, used for removing excessive subsurface water, is desirable on the Webster soil. Drainage makes these soils easier to manage and more suitable for crops. A crop rotation program that includes forage grasses and legumes helps to maintain tilth. These soils have poor potential for most engineering uses because of wetness.

6. Webster-Canisteo

Nearly level, poorly drained soils and nearly level, poorly drained calcareous soils that formed in clay loam and loam glacial till

This map unit consists of broad areas that are slightly concave to slightly convex and irregular in shape. Surface runoff is drained by low gradient drainageways, and excessive subsurface water is removed by tile drainage. Slopes are 0 to 2 percent.

This map unit makes up about 10 percent of the survey area. It is about 30 percent Webster soils, 20 percent Canisteo soils, and 50 percent soils of minor extent.

Webster soils are on the slightly concave flats. They have a black clay loam surface soil, an olive gray clay loam subsoil, and clay loam underlying material.

The Canisteo soils are on slightly convex flats and rims of depressions. They have a black, calcareous clay loam surface soil; a dark gray and olive gray, calcareous clay loam subsoil; and clay loam underlying material.

The soils of minor extent are very poorly drained Glencoe soils in depressions and low gradient drainageways; moderately well drained to somewhat poorly drained Nicollet soils on low rises; and very poorly drained, calcareous, mucky Blue Earth soils in drained lake beds.

Most of the soils in this unit are farmed. Corn, soybeans, small grain, and forage grasses and legumes are the principal crops grown. The more poorly drained areas that are not artificially drained are suitable for pasture or wildlife habitat.

Areas of this map unit have fair to good potential yields for cultivated crops, small grain, and forage grasses and legumes. Tile drainage, used for removing excessive subsurface water, makes these soils easier to manage and more suitable for crops. A crop rotation program that includes forage grasses and legumes helps to maintain tilth. These soils have poor potential for most engineering uses because of wetness.

7. Clarion-Swanlake

Undulating and rolling, well drained soils that formed in loamy glacial till

This map unit consists of knolls, hills, and intermingling swales and draws (fig. 5). The knolls and hills are plane to convex and linear to oblong in shape. Low gradient drainageways drain surface runoff. Slopes are 0 to 12 percent.

This unit makes up about 22 percent of the survey area. It is about 35 percent Clarion soils, 15 percent Swanlake soils, and 50 percent soils of minor extent (fig. 6).

Clarion soils have plane to slightly convex slopes on knolls, hilltops, and side slopes. They have a surface soil of black loam; a subsoil of dark brown, brown, and yellowish brown loam; and loam underlying material.

Swanlake soils have plane to slightly convex slopes on knolls, hilltops, and side slopes. They have a very dark grayish brown loam surface layer, a light olive brown loam subsoil, and loam underlying material.

The soils of minor extent are poorly drained Delft soils in drainageways and on toe slopes; poorly drained, calcareous Canisteo soils on rims of depressions; very poorly drained Glencoe soils and poorly drained Webster soils in depressions and low gradient drainageways; moderately well drained to somewhat poorly drained Nicollet soils on low rises; and very poorly drained, calcareous, mucky Blue Earth soils in drained lake beds.

Most of the soils in this unit are farmed. Corn, soybeans, small grain, and forage grasses and legumes are the principal crops grown. The poorly drained areas that are not artificially drained are suitable for pasture or wildlife habitat.

Areas of this map unit have fair to good potential yields for cultivated crops, small grain, and forage grasses and legumes. Terracing and contour farming on the more sloping areas, along with mulch tillage practices, help to control surface runoff and to conserve moisture. Tile drainage, used for removing excessive subsurface water, is desirable on the more poorly drained included soils. Drainage makes these soils easier to manage and more suitable for crops. A crop rotation program that includes forage grasses and legumes helps to maintain soil tilth. The well drained Clarion and Swanlake soils are suitable for most engineering uses.

8. Swanlake-Storden

Undulating to very steep, well drained soils that formed in loam and clay loam glacial till

This map unit consists mainly of side slopes adjacent to incised streams. Slopes are mostly convex and linear in shape. Many linear drainageways are included. Runoff is drained by draws and low gradient drainageways. Slopes are 0 to 35 percent.

This map unit makes up about 12 percent of the survey area. It is about 25 percent Swanlake soils, 10 percent Storden soils, and 65 percent soils of minor extent.

Swanlake soils are on the undulating and rolling knolls, hilltops, and side slopes. They have a very dark grayish brown loam surface layer, a light olive brown loam subsoil, and loam underlying material.

Storden soils are on the hilly to very steep knolls, hilltops and side slopes. They have a dark grayish brown calcareous loam surface layer and grayish brown and brown loam underlying material.

The soils of minor extent are poorly drained Delft soils in drainageways and on toe slopes; very poorly drained Coland soils on river bottom lands; very poorly drained Glencoe soils in drainageways; moderately well drained Terril soils on foot slopes; and poorly drained Webster soils in swales.

Most of the soils in this unit are used for pasture. The less sloping areas are used for corn, soybeans, small grain, and forage grasses and legumes.

With careful management, the less sloping areas of this unit are suitable for cultivated crops, small grain, and forage grasses and legumes. Terracing and contour farming, along with mulch tillage practices, help to control surface runoff and to conserve moisture. Rotating forage grasses and legumes in the cropping system helps maintain tilth and fertility. These areas are fairly suitable for most engineering uses, although they require leveling for most uses.

Areas dominated by soils that formed in glacial outwash

These nearly level to steep, well drained soils formed in coarse textured, calcareous glacial outwash under prairie grasses. Slopes are simple.

One map unit in Cottonwood County is in this group. The dominant and potential uses of this map unit are intensive farming and as a source of construction material.

9. Estherville-Dickman

Nearly level to steep, well drained soils that formed in loamy and sandy sediments over sandy and gravelly materials

This map unit consists of glacial river terraces and glacial outwash plains. Slopes are mostly plane and convex and linear to irregular in shape. Drainageways intermingle with the slopes. Slopes are 0 to 25 percent.

This unit makes up about 8 percent of the survey area. It is about 40 percent Estherville soils, 13 percent Dickman soils, and 47 percent soils of minor extent.

Estherville soils are on river terraces. They have a surface soil of black and very dark gray sandy loam, a subsoil of dark brown sandy loam and loamy coarse sand, and gravelly coarse sand underlying material.

Dickman soils are on outwash plains. They have a surface soil of very dark brown sandy loam, a subsoil of dark yellowish brown loamy sand and dark brown sand, and sandy underlying material.

The soils of minor extent are poorly drained Biscay soils in swales; poorly drained Coland soils on flood plains; poorly drained, calcareous Mayer soils on rims of depressions; very poorly drained, calcareous Talcot and Blue Earth soils in depressions; excessively drained Salida soils on steeper side slopes; and well drained, calcareous Storden soils on outcrops of glacial till.

Most of the soils in this map unit are farmed. The principal crops grown are corn, soybeans, small grain, and forage grasses and legumes. The more steeply sloping areas are used mostly for pasture.

Areas of this map unit have fair to low potential yields for cultivated crops. Drouth-resistant crops or early-maturing crops are desirable for economical yields. Irrigation is desirable where water sources are available. Mulch tillage or other minimum tillage practices help to conserve the soil moisture supply and to control erosion.

This map unit is a good source of sand and gravel. It is well suited to building site developments; however, when used for sanitary facilities, there is a hazard of contamination of underground water by seepage.

Areas dominated by soils that formed in glacial lacustrine sediment

These nearly level to very gently sloping, poorly drained, somewhat poorly drained, and moderately well drained soils formed in medium textured and moderately fine textured glacial lacustrine sediment on uplands.

One map unit in Cottonwood County is in this group. The dominant and potential use of these soils is intensive farming.

10. Rushmore-Ransom

Nearly level, poorly drained soils and very gently sloping, moderately well drained and somewhat poorly drained soils that formed in silty lacustrine sediment over calcareous loamy glacial till

This map unit consists of swales intermingled with low rises in glacial lake plains. The swales are irregular in shape. The rises are low, plane and slightly convex, and broad and rounded in shape. Ponded surface runoff and subsurface water is drained by tile drainage. Slopes are 0 to 3 percent.

This unit makes up about 3 percent of the survey area. It is about 25 percent Rushmore soils, 25 percent Ransom soils, and 50 percent soils of minor extent.

The poorly drained Rushmore soils are in swales. They have a black and very dark gray silty clay loam surface soil, an olive gray and olive silty clay loam subsoil, and loam underlying material.

Ransom soils are on low rises. They have a black and very dark brown silty clay loam surface soil, a dark brown and olive brown silty clay loam subsoil, and loam underlying material.

The soils of minor extent are somewhat poorly drained Guckeen soils and moderately well drained Kingston soils on low rises, very poorly drained Lura soils in depressions, poorly drained Marna soils in swales, and well drained Clarion Variant and Truman soils on low knolls.

Most of the soils in this unit are farmed. Corn, soybeans, small grain, and forage grasses and legumes are the principal crops grown. The more poorly drained areas that are not artificially drained are suitable for pasture or wildlife habitat.

Areas of this map unit have fair to good potential yields for cultivated crops, small grain, and forage grasses and legumes. Tile drainage, used for removing excessive subsurface water, is desirable on the more poorly drained soils of this unit. Drainage makes these soils easier to manage and more suitable for crops. A crop rotation program that includes forage grasses and legumes helps to maintain the tilth of these soils. These soils have poor potential for most engineering uses because of wetness.

Areas dominated by soils that formed in shaly glacial till

These undulating and nearly level, well drained and poorly drained soils formed in medium textured and moderately fine textured, friable, calcareous glacial till on uplands under prairie grasses.

One map unit in Cottonwood County is in this group. The dominant and potential use of these soils is intensive farming.

11. Ves-Canisteo

Undulating, well drained soils that formed in shaly loam glacial till and nearly level poorly drained soils that formed in loamy glacial till

This map unit consists of low knolls intermingled with shallow swales. The knolls are slightly convex and linear to oblong in shape. The swales are nearly level and slightly concave and irregular in shape. Shallow depressions and low gradient drainageways are in the swales. Runoff ponds in the depressions and is drained with the subsurface water by tile drainage. Slopes are 0 to 6 percent.

This unit makes up about 6 percent of the survey area. It is about 25 percent Ves soils, 25 percent Canisteo soils, and 50 percent soils of minor extent.

Well drained Ves soils are on plane to slightly convex knolls. They have a surface soil of black loam and a subsoil and underlying material of olive brown loam that is high in content of shale.

Poorly drained Canisteo soils are in rims of depressions. They have a black, calcareous clay loam surface soil; dark gray and olive gray, calcareous clay loam subsoil; and clay loam underlying material.

The soils of minor extent are poorly drained Delft soils on toe slopes, very poorly drained Glencoe soils and poorly drained Webster soils in depressions and low gradient drainageways, moderately well drained Normania soils on low rises, and well drained Swanlake soils on steeper areas.

Most of the soils in this map unit are farmed. Poorly drained areas that are not artificially drained are used for pasture, trees, and wildlife habitat. Corn, soybeans, small grain, and forage grasses and legumes are the principal crops grown.

Areas of this map unit have good potential yields for cultivated crops, small grain, and forage grasses and legumes. Tile drainage removes excessive subsurface water from the poorly drained Canisteo soils and included soils, making them easier to manage and more suitable for crops. Conservation tillage practices help to conserve soil moisture and to control erosion. Ves soils have good potential for most engineering uses, but Webster and Canisteo soils have poor potential for these uses because of wetness.

Soil maps for detailed planning

The map units shown on the detailed soil maps at the back of this publication represent the kinds of soil in the survey area. They are described in this section. The descriptions together with the soil maps can be useful in determining the potential of a soil and in managing it for food and fiber production; in planning land use and developing soil resources; and in enhancing, protecting, and preserving the environment. More information for each map unit, or soil, is given in the section "Use and management of the soils."

Preceding the name of each map unit is the symbol that identifies the soil on the detailed soil maps. Each soil description includes general facts about the soil and a brief description of the soil profile. In each description, the principal hazards and limitations are indicated, and the management concerns and practices needed are discussed.

The map units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

Soils that have a similar profile make up a *soil series*. Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped. The Storden series, for example, was named for the town of Storden in Cottonwood County.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Storden loam, 12 to 18 percent slopes is one of several phases within the Storden series.

Some map units are made up of two or more dominant kinds of soil. Such map units are called soil complexes.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Swanlake-Salida complex, 2 to 6 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because there is little value in separating them. The pattern and proportion of the soils are not uniform. An area shown on the map has at least one of the dominant (named) soils or may have all of them. Aquolls and Aquents, ponded is an undifferentiated group in this survey area.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Most mapped areas include places that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas*; they are delineated on the soil map and given descriptive names. Pits, gravel is an example. Some of these areas are too small to be delineated and are identified by a special symbol on the soil map.

The acreage and proportionate extent of each map unit are given in table 4, and additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary.

31D—Storden loam, 12 to 18 percent slopes. This hilly, well drained, calcareous soil is on knolls, hilltops, and side slopes. Slopes are convex, complex, and 100 to 200 feet long. Individual areas are linear and range from 5 to 40 acres.

Typically, the surface layer is dark grayish brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is grayish brown and brown loam. This soil is calcareous throughout. In some places there are small areas of well drained, calcareous soils that have a sandy loam surface layer, and in other places stratified fine sand and silt or firm till is in the underlying material. Included with this soil in mapping are small areas of less sloping Swanlake and Clarion soils, moderately well drained Terril soils on foot slopes, and poorly drained Webster and Delft soils on toe slopes and draws. The included soils make up 10 to 15 percent of the unit.

Water and air move through this soil at a moderate rate. Surface runoff is rapid. Available water capacity is high. Reaction is mildly alkaline or moderately alkaline in the surface soil. The content of organic matter is moderate or low, of phosphorus is low, and of potassium is medium.

Most areas of this soil are in grass. A few areas along ravines and river valley sidewalls are in native trees and shrubs. This soil has poor potential for cultivated crops, hay, and small grain. It has fair potential for pasture and trees and poor potential for most engineering uses.

Pasture is the main use of this soil. Pasture yields can be improved by deferred, limited, and rotational grazing. These practices reestablish a balance between cool-and warm-season grasses. Fertilization and brush and weed control also improve pasture yields. The areas that are in trees and shrubs have limitations for use as pasture because of steepness and inaccessibility and are used mostly for wildlife.

Trees and shrubs can be grown on this soil. Machine planting is limited by the steepness of the slopes. Most native trees and shrubs grow well on north- and east-facing slopes. They need to be protected from damage by livestock. Competing vegetation needs to be controlled in order to obtain the best survival and growth rate of trees and shrubs.

Building sites on this soil are limited by steepness of slope. Septic tank absorption fields function poorly in this soil. Steepness of slope causes lateral seepage and downslope flow of effluent. Road subgrades can be constructed with this soil material. Soil material that has more strength and is less susceptible to frost action is preferred for the road base. Erosion of cutbanks is a problem that can be controlled by seeding, mulching, and sodding.

This soil is in capability subclass IVe.

31E—Storden loam, 18 to 35 percent slopes. This steep and very steep, well drained, calcareous soil is on knolls, hilltops, and side slopes. Slopes are convex, complex, and 100 to 300 feet long. Individual areas are linear and range from 5 to 20 acres.

Typically, the surface layer is dark grayish brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is grayish brown and brown loam. This soil is calcareous throughout. In places there are small areas of well drained, calcareous soils that are steeper or have firm till in the pedon.

Included with this soil in mapping are small areas of less sloping Swanlake and Clarion soils and poorly drained Webster, Delft, and Coland soils. Webster and Delft soils are on the upland draws. Coland soils are on river bottom lands. Small cutbanks are included in a few areas. The included soils make up 5 to 15 percent of the unit.

Water and air move through this soil at a moderate rate. Surface runoff is rapid. Available water capacity is high. Reaction is mildly alkaline or moderately alkaline in the surface soil. The content of organic matter is moderate or low, of phosphorus is low, and of potassium is medium.

Most areas of this soil are in grass. A few areas along ravines and river valley sidewalls are in native trees and shrubs. This soil has poor potential for cultivated crops, hay, and small grain. It has fair potential for pasture and trees and poor potential for most engineering uses.

Pasture is the main use of this soil. Pasture yields can be improved by deferred, limited, and rotational grazing. These practices reestablish a balance between cool- and warm-season grasses. Fertilization and brush and weed control also improve pasture yields. The steeper areas are in trees and shrubs and have limitations for use as pasture.

Trees and shrubs can be established in most areas of this soil. Machine planting is limited by the steepness of the slopes. Most native trees and shrubs grow well on north- and east-facing slopes. They need to be protected from damage by livestock. Competing vegetation needs to be controlled in order to obtain the best survival and growth rate of trees and shrubs.

Building sites on this soil are limited by steepness of slope. Septic tank absorption fields function poorly. Steepness of slope causes lateral seepage and downslope flow of effluent. Road subgrades can be constructed with this soil material. Soil material that has more strength and is less susceptible to frost action is preferred for the road base. Erosion of the cutbanks is a problem that can be controlled by seeding, mulching, and sodding.

This soil is in capability subclass VIIe.

35—Blue Earth mucky silt loam. This nearly level, very poorly drained soil is in lake basins and backwater areas adjacent to lakes. It is subject to flooding. Individual areas are oblong in shape and 5 to several hundred acres in size.

Typically, the surface soil is black mucky silt loam about 11 inches thick. The subsoil is about 33 inches thick. The upper part is black, mottled, very friable mucky silt loam. The lower part is very dark gray, mottled, very friable mucky silt loam. The underlying material to a depth of about 60 inches is black, mottled silt loam. This soil is calcareous throughout. The surface layer and subsoil have few to many snail shells. In slightly convex areas, pedons contain up to 30 percent lime in the surface soil.

Included with this soil in mapping are small areas of poorly drained to well drained sandy soils on beaches. Also included are small areas of very poorly drained soils that have less than 30 inches of coprogenous earth, have coarse textured underlying material, or contain appreciable gypsum or marl. Some areas have up to 40 inches of muck. The included soils make up 5 to 15 percent of the unit.

Water and air move through this soil at a moderately slow rate. Surface runoff is very slow or ponded. Available water capacity is high. A seasonal high water table is at a depth of 0 to 1 foot. Reaction is mildly alkaline or moderately alkaline in the surface soil. The content of organic matter is very high, of phosphorus is medium to low, and of potassium is high.

Most areas of this soil are farmed. This soil has good potential for row crops and fair potential for hay, pasture, and small grain. It has poor potential for trees and for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, pasture, and potatoes. Drainage, correction of fertility imbalance, weed control, and prevention of soil blowing are needed to make and keep this soil suitable for crops. Tile drainage is inadequate in many places. Ditches are needed to prevent accumulation of surface water. Deep tillage helps to aerate the rooting zone. Fertility imbalance is caused by the high lime content that restricts the availability of phosphorus, potassium, and trace nutrients. It can be corrected by applying fertilizer. Crops need to be tolerant of the high lime content and need to mature in time to avoid frost damage. The high organic matter content and lime content also reduce effectiveness of pre-emergence herbicides. They are most effective when shallowly incorporated. Soil blowing is a problem during winter. It can be reduced by using mulch or strip tillage or a winter cover crop. Fall plowing helps to reduce this soil's drying and warming time in spring.

The choice of species or varieties of trees and shrubs used for windbreaks is limited to those that are tolerant of a high lime content and wet soil conditions. If this soil is drained and competing vegetation is controlled, the best survival and growth rate of trees and shrubs is obtained. Trees and shrubs establish themselves and grow well on ditch banks.

This soil is poorly suited to building site development and sanitary facilities. Septic tank absorption fields function poorly because of the seasonal high water table and flooding. This soil is poorly suited as a source of road construction material because it is wet, contains excess humus, and has low strength. Roads need to be constructed with more suitable base material and protected from wetness and flooding by drainage.

This soil is in capability subclass VIw.

41A—Estherville sandy loam, 0 to 2 percent slopes. This nearly level, well drained soil is on river terraces. Individual areas are linear and range from 5 to 80 acres.

Typically, the surface soil is black sandy loam about 15 inches thick. The subsoil is about 13 inches thick. The upper part is dark brown, friable sandy loam. The lower part is dark brown, loose loamy coarse sand. The underlying material to a depth of about 60 inches is grayish brown, yellowish brown, and light yellowish brown, loose, calcareous gravelly coarse sand.

Included with this soil in mapping are small areas of excessively drained Salida soils and somewhat poorly drained Linder soils. Salida soils have steeper convex side slopes. Linder soils are in swales. Also included are small areas of poorly drained sandy soils and somewhat excessively drained sandy soils. The included soils make up 5 to 20 percent of the unit.

Water and air move at a moderately rapid rate through the upper part of this soil and move rapidly through the underlying material. Surface runoff is slow. Available water capacity is low. Reaction is neutral to medium acid in the surface soil. The content of organic matter is low, of phosphorus is low, and of potassium is low to medium.

Most areas of this soil are farmed. A few areas are in pasture. This soil has poor potential for cultivated crops, hay, pasture, small grain, and trees. It has good potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, hay, and pasture. Increased fertility and soil moisture supply and protection from soil blowing are needed to make and keep this soil suitable for cultivated crops. Mulch tillage and minimum tillage conserve moisture and reduce soil blowing. Drouth-tolerant crops, such as milo, need less moisture than corn for comparative yields. The effectiveness of pre-emergence herbicides is often reduced because of low soil moisture. Irrigation makes this soil more suitable for farming.

The choice of trees and shrubs used for windbreaks is limited to species that are tolerant of drouth. Tree and shrub seedlings need to be watered and competing vegetation needs to be controlled in order to obtain the best survival and growth rate.

This soil is a good source of sand and gravel. It is well suited to development of building sites and local roads and streets. Septic tank absorption fields function well, however, there is a hazard of contaminating underground water because of seepage. There is also a hazard of cutbanks caving in shallow excavations. Retaining walls or over-excavating are methods of overcoming this hazard.

This soil is in capability subclass IIIs.

41B—Estherville sandy loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on broad, low rises. Surfaces are plane and convex. Individual areas are irregular and range from 5 to 40 acres.

Typically, the surface soil is about 13 inches thick. The upper part is black sandy loam. The lower part is very dark gray sandy loam. The subsoil is about 14 inches thick. The upper part is dark brown, friable sandy loam. The lower part is dark brown, loose loamy coarse sand. The underlying material to a depth of about 60 inches is grayish brown and yellowish brown gravelly coarse sand.

Included with this soil in mapping are small areas of somewhat poorly drained Linder soils, well drained Dickman soils, and excessively drained Salida soils. Linder soils are in swales, Dickman soils are on low rises, and Salida soils are on convex ridges. Also included are small areas of poorly drained sandy soils in draws. The included soils make up 5 to 20 percent of the unit.

Water and air move at a moderately rapid rate through the upper part of the soil and move rapidly through the underlying material. Surface runoff is slow to medium. Available water capacity is low. Reaction is neutral to medium acid in the surface soil. The content of organic matter is low, of phosphorus is low, and of potassium is low to medium.

Most areas of this soil are farmed. A few areas are in pasture. This soil has poor potential for cultivated crops, hay, pasture, small grain, and trees. It has good potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, hay, and pasture. Increased fertility and available water and protection from soil blowing are needed to make and keep this soil suitable for cultivated crops. Mulch tillage and minimum tillage conserve moisture and reduce soil blowing. Drouth-tolerant crops, such as milo, require less moisture than corn for comparative yields. The effectiveness of pre-emergence herbicides is often reduced because of low soil moisture. Irrigation makes this soil more suitable for farming.

The choice of trees and shrubs used for windbreaks is limited to species that are tolerant of drouth. Tree and shrub seedlings need to be watered and competing vegetation needs to be controlled in order to obtain the best survival and growth rate.

This soil is a good source of sand and gravel. It is well suited to development of building sites and local roads and streets. Septic tank absorption fields function well in this soil. There is a hazard of contaminating underground water because of seepage. There is also a hazard of cutbanks caving in shallow excavations. Retaining walls or over excavating are methods of overcoming this hazard.

This soil is in capability subclass IIIs.

41C—Estherville sandy loam, 6 to 12 percent slopes. This sloping, well drained soil is on side slopes of glacial river terraces. Slopes are mostly plane and convex, simple, and 100 to 200 feet long. Individual areas are linear to irregular and range from 5 to 40 acres.

Typically, the surface soil is about 12 inches thick. The upper part is black sandy loam. The lower part is very dark gray sandy loam. The subsoil is about 8 inches thick. It is brown, friable sandy loam. The underlying material to a depth of about 60 inches is grayish brown, yellowish brown, and light yellowish brown, loose, calcareous gravelly coarse sand.

Included with this soil in mapping are small areas of excessively drained Salida soils and well drained Dickman soils. Salida soils are on convex, low rises. Dickman soils are on flats. Also included are small areas of well drained soils that formed mostly in glacial till. They are on convex side slopes. The included soils make up 5 to 20 percent of the unit.

Water and air move at a moderately rapid rate through the upper part of this soil and move rapidly through the underlying material. Surface runoff is medium. Available water capacity is low. Reaction is neutral to medium acid in the surface soil. The content of organic matter is low, of phosphorus is low, and of potassium is low to medium.

Most areas of this soil are farmed. A few areas are in pasture. This soil has poor potential for cultivated crops, hay, pasture, small grain, and trees. It has fair potential for most engineering uses.

This soil is mostly used for small grain, hay, and pasture. Increased fertility and soil moisture supply and protection from soil blowing are needed to make and keep this soil suitable for cultivated crops. Mulch tillage and minimum tillage conserve moisture and reduce soil blowing. Drouth-tolerant crops such as grain sorghum require less moisture than corn for comparative yields. The effectiveness of pre-emergence herbicides is often reduced because of low soil moisture.

The choice of trees and shrubs used for windbreaks is limited to species or varieties that are tolerant of drouth. Tree and shrub seedlings need to be watered and competing vegetation needs to be controlled in order to obtain the best survival and growth rate.

This soil is a good source of sand and gravel. Building site developments and local roads and streets need location planning because of slope. Slope also limits this soil for septic tank absorption fields. There is a hazard of contaminating underground water because of seepage. Shallow excavations have a hazard of cutbanks caving. Retaining walls or over-excavating are methods of overcoming this hazard.

This soil is in capability subclass IVs.

41D—Estherville sandy loam, 12 to 25 percent slopes. This moderately steep to steep, well drained soil is on side slopes and hilltops. Slopes are mostly plane and convex, simple, and 50 to 200 feet long. Individual areas are linear to irregular and range from 5 to 20 acres in size.

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

Included with this soil in mapping are small areas of excessively drained Salida soils and well drained Dickman soils. Also included are small areas of well drained soils that formed mostly in glacial till. They are on convex side slopes. The included soils make up 5 to 20 percent of the unit.

Water and air move at a moderately rapid rate through the upper part of the soil and move rapidly through the underlying material. Surface runoff is medium. Available water capacity is low. Reaction is neutral to medium acid in the surface soil. The content of organic matter is low, of phosphorus is low, and of potassium is low to medium.

Most areas of this soil are in pasture. This soil has poor potential for cultivated crops, hay, pasture, small grain, and trees. It has fair to poor potential for most engineering uses.

This soil is mostly used for pasture. Pasture can be improved by deferred and rotational grazing. These practices increase grass growth by reestablishing a balance between cool- and warm-season grasses. Brush and weed control and fertilization improve grass growth.

Windbreaks established on this soil provide livestock shelter and wildlife habitat. The choice of trees and shrubs is limited to drouth-tolerant species. Tree and shrub seedlings need to be watered and competing vegetation needs to be controlled in order to obtain the best survival and growth rate.

This soil is a good source of sand and gravel. Building site developments and local roads and streets need location planning because of slope. Slope also limits this soil for septic tank absorption fields. There is a hazard of contaminating underground water because of seepage. Shallow excavations have a hazard of cutbanks caving. Retaining walls or over excavating are methods of overcoming this hazard.

This soil is in capability subclass VIs.

86—Canisteo clay loam. This nearly level, poorly drained, calcareous soil is on slightly convex, broad flats and rims of depressions. Individual areas are irregular and range from 2 to several hundred acres.

Typically, the surface soil is black clay loam about 21 inches thick. The subsoil is about 19 inches thick. The upper part is dark gray, friable clay loam; and the lower part is olive gray, mottled, friable clay loam. The underlying material to a depth of about 60 inches is olive gray, mottled clay loam.

Included with this soil in mapping are small areas of very poorly drained Glencoe and poorly drained Jeffers and Webster soils. Glencoe soils are in depressions and low gradient drainageways. Jeffers soils are on convex, slight rises; have underlying material of firm glacial till; and contain gypsum. Webster soils are on slightly concave flats. Also included are small areas of poorly drained soils that contain gypsum or lime, are stratified with silt, or underlain by very fine sand. The included soils make up 5 to 20 percent of the unit.

Water and air move through this soil at a moderate rate. Surface runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 1 to 3 feet. Reaction is mildly alkaline or moderately alkaline in the surface soil. The content of organic matter is high, of phosphorus is low or very low, and of potassium is medium or high.

Most areas of this soil are farmed. This soil has fair potential for cultivated crops, hay, pasture, and small grain and poor potential for trees. It has poor potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and forage grasses and legumes. Drainage and correction of fertility imbalance are needed for good crop growth. Adequate drainage is usually provided by tile drainage. Deep tillage helps to aerate the rooting zone. Fertility imbalance is caused by the high lime content that restricts availability of phosphorus, potassium, and trace nutrients. Crop rotations that include forage grasses and legumes and returning all crop residue to the soil help to maintain tilth. Grasses and legumes need to be tolerant of wetness and high lime content. Fall plowing helps to reduce the soil's drying and warming time in spring.

The species of trees and shrubs are limited to those that are tolerant of high lime content and wetness. Competing vegetation needs to be controlled for the best survival and growth rate of trees and shrubs.

This soil is poorly suited to building site developments and as a source of road construction material. Building sites on this soil need protection from damage by wetness. Protection can be provided by draining this soil and covering it with several feet of fill. Septic tank absorption fields function poorly in this soil because of the seasonal high water table. Roads need to be constructed from more suitable base material. Surface water needs to be removed by adequately designed ditches.

This soil is in capability subclass IIw.

94B—Terril loam, 2 to 6 percent slopes. This gently sloping, moderately well drained soil is on foot slopes. Individual areas are long and narrow and range from 5 to 20 acres.

Typically, the surface soil is black loam about 24 inches thick. The subsoil to a depth of about 60 inches is very dark grayish brown, friable loam in the upper part; brown, friable clay loam in the middle part; and olive brown, mottled, friable loam in the lower part.

Included with this soil in mapping are small areas of poorly drained Coland soils, well drained Estherville soils, and poorly drained Webster and Delft soils. Coland soils are on bottom lands. Webster and Delft soils are in draws and on toe slopes. Estherville soils are on river terraces. These inclusions make up 5 to 10 percent of the unit.

Water and air move through this soil at a moderate rate. Surface runoff is medium. Available water capacity is high. Reaction is slightly acid or neutral in the surface soil. The content of organic matter is high, of phosphorus is low, and of potassium is medium.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, small grain, and trees. It has good or fair potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and forage grasses and legumes. The hazard of erosion is slight. Fertilizer application rates need to be determined by soil tests and crop needs. Grassed waterways are needed in order to prevent erosion and the formation of gullies wherever water collects and crosses this soil.

Most native trees and shrubs grow well on this soil. Competing vegetation needs to be controlled for the best survival and growth rate of trees and shrubs.

This soil is a good source of topsoil. Damage to foundations, floors, and footings of buildings because of low strength, can be prevented by placing them on a base of coarser material. Roads need to be constructed with more suitable base material. Septic tank absorption fields function well in this soil.

This soil is capability subclass IIe.

101B—Truman silt loam, 2 to 8 percent slopes. This gently sloping, well drained soil is on convex knolls and ridges. Individual areas are linear to oblong and range from 5 to 40 acres in size.

Typically, the surface soil is about 14 inches thick. The upper part is black silt loam, and the lower part is very dark grayish brown silt loam. The subsoil is about 26 inches thick. The upper part is brown, friable silt loam; the middle part is dark grayish brown, friable, calcareous silt loam; and the lower part is dark yellowish brown, mottled, friable, calcareous silt loam. The underlying material to a depth of about 60 inches is light olive brown, calcareous silt loam.

Included with this soil in mapping are small areas of poorly drained Madelia soils and moderately well drained Kingston soils. Madelia soils are in swales. Kingston soils are on low rises. Also included are small areas of well drained, calcareous silty soils. The included soils make up 10 to 15 percent of the unit.

Water and air move through this soil at a moderate rate. Surface runoff is medium. Available water capacity is very high. Reaction is slightly acid or neutral in the surface soil. The content of organic matter is high, of phosphorus is low, and of potassium is medium.

Most areas of this soil are farmed. This soil has good potential for crops, hay, pasture, small grain, and trees. It has good potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and forage grasses and legumes. Maintenance of soil fertility is needed. Organic matter content and tilth can be maintained by applying manure, using crop rotations that include forage grasses and legumes, or by returning crop residue to the soil. Minimum tillage practices, such as mulch tillage, conserve moisture and reduce soil blowing and water erosion.

Windbreaks can be grown on this soil, and most native trees and shrubs grow well. Control of competing vegetation is needed to obtain the best survival and growth rate of trees and shrubs.

This soil is well to fairly suited to building site developments and roads. Damage to foundations, floors, and footings of buildings because of low strength can be prevented by placing them on a bed of coarser material. Roads need to be constructed with more suitable base material. Septic tank absorption fields function well in this soil, however, steeper areas have a slight hazard of lateral seepage and downslope flow.

This soil is in capability subclass IIe.

102B—Clarion loam, 2 to 4 percent slopes. This well drained soil is on plane to slightly convex knolls, side slopes and hilltops. Individual areas are irregular and range from 5 to 20 acres.

Typically, this soil has a black loam surface soil about 14 inches thick. The subsoil is about 29 inches thick. The upper part is dark brown, very friable loam; the middle part is brown, friable loam; and the lower part is yellowish brown, friable, calcareous loam. The underlying material to a depth of about 60 inches is light olive brown and olive brown, friable, calcareous loam. A zone of lime accumulation is at the boundary of the subsoil and underlying material.

Included with this soil in mapping are small areas of moderately well drained to somewhat poorly drained Nicollet soils and poorly drained Webster and Delft soils. Nicollet soils are on slightly concave flats. Webster and Delft soils are in draws and on toe slopes. Also included are small areas of very poorly drained Glencoe soils in depressions and well drained Swanlake soils on convex hillsides. The included soils make up 5 to 15 percent of the unit.

Water and air move through this soil at a moderate rate. Surface runoff is medium. Available water capacity is high. Reaction is slightly acid or neutral in the surface soil. The content of organic matter and potassium is high and of phosphorus is low.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, small grain, and trees. It has good potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and forage grasses and legumes. The hazard of erosion is slight. The organic matter content and tilth can be maintained by applying manure and by using crop rotations that include forage grasses and legumes. Mulch tillage and minimum tillage conserve moisture and reduce soil blowing.

Most native trees and shrubs used for windbreaks grow well in this soil. Control of competing vegetation is needed in order to obtain the best survival and growth rate of trees and shrubs.

This soil is well suited to building site developments and waste disposal areas. Septic tank absorption fields function well in this soil. This soil is a fair source of road construction material. Road bases need to be constructed from more suitable material because this soil has low strength.

This soil is in capability subclass IIe.

110—Marna silty clay loam. This nearly level, poorly drained soil is in shallow drainageways and swales. Individual areas are irregular and range from 3 to 60 acres.

Typically, the surface soil is about 22 inches thick. The upper part is black silty clay loam. The lower part is very dark gray silty clay loam. The subsoil is about 26 inches thick. The upper part is olive gray, mottled, friable silty clay loam. The lower part is olive gray, friable, calcareous clay loam. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous loam.

Included with this soil in mapping are small areas of somewhat poorly drained Guckeen soils and very poorly drained Lura soils. Guckeen soils are on low rises. Lura soils are in depressions. Also included are small areas of poorly drained soils that have silty underlying material or contain appreciable amounts of gypsum. The included soils make up 5 to 10 percent of the unit.

Water and air move through this soil at a slow rate. Surface runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 1 to 2.5 feet. Reaction is slightly acid or neutral in the surface soil. The content of organic matter is high, of phosphorus is high, and of potassium is high.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, and small grain and fair potential for trees. It has poor potential for most engineering uses.

This soil is used for corn, soybeans, small grain, and forage grasses and legumes. Drainage and maintenance of fertility and tilth are needed to make and keep this soil suitable for these crops. Adequate drainage is usually provided by tile drainage. Deep tillage helps to aerate this soil. Organic matter content and tilth can be maintained by returning crop residue to the soil. Proper timing and cultivation at proper moisture content help to maintain tilth. Fall plowing helps to reduce drying and warming time in spring.

The choice of trees and shrubs used for windbreaks is limited to species that are tolerant of wetness. This soil needs to be drained and the competing vegetation needs to be controlled in order to obtain the best survival and growth rate of trees and shrubs.

This soil is poorly suited to building site developments and most other engineering uses. Buildings need to be protected from damage by wetness and constructed without basements. Protection can be provided by draining this soil and covering it with several feet of fill. Septic tank absorption fields function poorly in this soil because of the seasonal high water table. Roads need to be constructed with more suitable base material and protected from wetness and frost action damage by drainage.

This soil is in capability subclass IIw.

113—Webster clay loam. This nearly level, poorly drained soil is on slightly concave, broad flats. Individual areas are irregular and range from 5 to several hundred acres in size.

Typically, the surface soil is black, clay loam about 15 inches thick. The subsoil is olive gray, mottled, friable clay loam about 23 inches thick. The lower part is calcareous. The underlying material to a depth of about 60 inches is gray, mottled, calcareous clay loam.

Included with this soil in mapping are small areas of poorly drained, calcareous Canisteo soils; poorly drained Delft soils; and very poorly drained Glencoe soils. Canisteo soils are on rims of depressions. Delft soils are in narrow draws and on toe slopes. Glencoe soils are in depressions. Also included are small areas of poorly drained soils that have lime beginning at a depth of about 15 inches. The included soils make up 10 to 20 percent of the unit.

Water and air move through this soil at a moderate or moderately slow rate. Surface runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 1 to 3 feet. Reaction is neutral in the surface soil. The content of organic matter is high, of phosphorus is low, and of potassium is medium to high.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, and small grain and poor potential for trees. It has poor potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and forage grasses and legumes. Drainage and maintenance of fertility and tilth are needed to make and keep this soil suitable for these crops. Adequate drainage is usually provided by tile drainage. Deep tillage helps aerate this soil. Fall plowing helps to reduce the drying and warming time in spring. Organic matter content can be maintained by returning crop residue to the soil. Tilth can be maintained by proper timing of cultivation and by crop rotations that include forage grasses and legumes.

The choice of trees and shrubs used for windbreaks is limited to species or varieties that are tolerant of wetness. Surface water and competing vegetation needs to be controlled in order to obtain the best survival and growth rate of trees and shrubs.

This soil is poorly suited to building sites, roads, and sanitary facilities. Buildings need to be protected from damage by wetness and need to be constructed without basements. Protection can be provided by draining this soil and covering it with several feet of fill. Septic tank absorption fields function poorly in this soil because of the seasonal high water table. Roads need to be constructed with more suitable base material and protected from wetness by drainage.

This soil is in capability subclass IIw.

114—Glencoe clay loam. This nearly level, very poorly drained soil is in drainageways and depressions. It is subject to flooding. Individual areas range from 5 to 40 acres.

Typically, the surface soil is about 44 inches thick. The upper part is black clay loam. The lower part is very dark gray, mottled clay loam. The subsoil is olive gray, mottled, friable clay loam about 5 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous clay loam.

Included with this soil in mapping are small areas of poorly drained Webster, Canisteo, and Jeffers soils. Webster soils are on adjoining flats. Canisteo and Jeffers soils are on rims of depressions. Also included are small areas of very poorly drained soils that contain more clay or silt or have a shallow layer of muck in the surface layer. The included soils make up 5 to 10 percent of the unit.

Water and air move through this soil at a moderately slow rate. Surface runoff is slow or ponded. Available water capacity is high. A seasonal high water table is at a depth of 0 to 1 foot. Reaction is slightly acid to mildly alkaline in the surface soil. The content of organic matter is high, of phosphorus is medium to low, and of potassium is high.

Most areas of this soil are farmed. This soil has good potential for cultivated crops; fair potential for hay, pasture, and small grain; and poor potential for trees. It has poor potential for most engineering uses.

This soil is used for corn, soybeans, small grain, and forage grasses and legumes. Drainage and maintenance of soil tilth and fertility are needed to make and keep this soil suitable for these crops. Adequate drainage is usually provided by tile drainage. Runoff water from adjacent soils needs to be diverted and ditches or waterways need to be constructed in order to prevent accumulation of surface water. Deep tillage helps to aerate this soil. Good soil tilth can be maintained by returning all crop residue to the soil or by using a crop rotation program that includes forage grasses and legumes. Fall plowing helps to reduce drying and warming time in spring.

The choice of species or varieties of trees and shrubs used for windbreaks is limited to those that are tolerant of occasional ponding and wetness. Surface water needs to be removed from this soil and competing vegetation needs to be controlled in order to obtain the best survival and growth rate.

This soil is poorly suited to building sites, roads, and sanitary facilities. Building sites need protection from damage by wetness. Protection can be provided by draining this soil and covering it with several feet of fill. Septic tank absorption fields function poorly in this soil because of wetness and occasional ponding. Roads need to be constructed with more suitable base material and protected from wetness by drainage.

This soil is in capability subclass IIIw.

128B—Grogan fine sandy loam, 1 to 8 percent slopes. This nearly level to sloping, well drained soil is on convex ridges. Individual areas are linear and range from 5 to 20 acres in size.

Typically, the surface soil is about 16 inches thick. The upper part is very dark brown fine sandy loam. The lower part is very dark gray fine sandy loam. The subsoil is about 26 inches thick. The upper part is dark yellowish brown, very friable fine sandy loam. The middle part is dark yellowish brown, loose fine sandy loam. The lower part is yellowish brown, loose fine sandy loam. The upper part of the underlying material, to a depth of about 49 inches, is yellowish brown, friable very fine sand and gray silt loam. The lower part to a depth of about 60 inches is pale brown, friable, calcareous silt loam. The surface soil is darker and thicker in less sloping areas and lighter colored and thinner in more sloping areas.

Included with this soil in mapping are small areas of well drained Clarion Variant and Truman soils. Clarion Variant soils are on side slopes and ridge tops. Truman soils are on slightly concave flats. Also included are small areas of well drained, silty and sandy soils. The included soils make up 0 to 5 percent of the unit.

Water and air move through this soil at a moderately rapid rate. Surface runoff is slow. Available water capacity is high. Reaction is slightly acid or neutral in the surface soil. The content of organic matter is moderate, of phosphorus is low, and of potassium is medium.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, small grain, and trees. It has good potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and forage grasses and legumes. Maintenance of soil fertility is needed. Organic matter content and tilth can be maintained by applying manure and by using a crop rotation program that includes forage grasses and legumes. Mulch tillage and other minimum tillage practices conserve moisture and reduce soil blowing.

Most native trees and shrubs used for windbreaks grow well. Control of competing vegetation is needed in order to obtain the best survival and growth rate of trees and shrubs.

This soil is well suited to building sites, however, some areas may need leveling when used for small commercial buildings. Septic tank absorption fields function well in this soil, but there is a hazard of groundwater contamination and lateral seepage and downslope flow on the steeper areas. Roads require stronger base material to prevent excessive damage from frost action.

This soil is in capability subclass IIe.

130—Nicollet clay loam. This very gently sloping, moderately well drained to somewhat poorly drained soil is on broad, plane or slightly convex, low rises. Individual areas are irregular and range from 5 to 25 acres.

Typically, the surface soil is black clay loam about 16 inches thick. The subsoil is about 21 inches thick. The upper part is dark grayish brown, mottled, very friable clay loam. The lower part is grayish brown, mottled, friable loam. The underlying material to a depth of about 60 inches is grayish brown, mottled, friable loam.

Included with this soil in mapping are small areas of somewhat poorly drained, calcareous Crippin soils and poorly drained Webster soils. Crippin soils are on slightly convex rises and narrow side slopes. Webster soils are in swales. Also included are small areas of moderately well drained to somewhat poorly drained soils that have a leached, dark colored layer 18 to 24 inches thick or are leached of lime to a depth below 50 inches. The included soils make up 5 to 20 percent of the unit.

Water and air move through this soil at a moderate rate. Surface runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 2.5 to 5 feet. Reaction is medium acid to neutral in the surface soil. The content of organic matter is high, of phosphorus is low, and of potassium is medium to high.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, small grain, and trees. It has poor to fair potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grains, forage grasses, and legumes. It has few limitations that restrict its use; therefore, it can be cropped intensively. Soil tilth can be maintained by returning crop residue to the soil. Crop residue left on the surface of fall-plowed fields helps to control soil blowing.

Most native trees and shrubs used for windbreaks grow well. Competing vegetation needs to be controlled for the best survival and growth rate of trees and shrubs.

This soil is suited to building site developments but is poorly suited to sanitary facilities and local roads and streets. Buildings with basements need protection from damage by wetness. Basements can be protected from damage by placing drainage tile around footings. Foundations, footings, and floors of buildings can be protected by building them on a base of coarse material. Seasonal wetness interferes with the proper functioning of septic tank absorption fields. Roads need to be constructed with more suitable base material and protected from wetness by drainage.

This soil is in capability class I.

136—Madelia silty clay loam. This nearly level, poorly drained soil is in broad, flat depressions on lake plains. Individual areas are irregular and range from 5 to 40 acres.

Typically, the surface soil is about 22 inches thick. The upper part is black silty clay loam. The lower part is very dark gray silt loam. The subsoil is dark gray and olive gray, friable silty clay loam about 11 inches thick. The underlying material, to a depth of 48 inches, is light olive gray, mottled, friable silt loam and olive very fine sand. Below this to a depth of about 60 inches is light olive brown, mottled loam.

Included with this soil in mapping are small areas of poorly drained Rushmore and Spicer soils. Rushmore soils are in drainageways. Spicer soils are on low rises. Also included are small areas of poorly drained soils that have glacial till underlying material and contain appreciable amounts of gypsum. The included soils make up 5 to 10 percent of the unit.

Water and air move through this soil at a moderate rate. Surface runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 1 to 2.5 feet. Reaction is slightly acid or neutral in the surface soil. The content of organic matter is high, of phosphorus is low, and of potassium is medium.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, and small grain and poor potential for trees. It has poor potential for most engineering uses.

This soil is used for corn, soybeans, small grain, and forage grasses and legumes. Drainage and maintenance of fertility and tilth are needed to make and keep this soil suitable for these crops. Adequate drainage is provided by tile drainage. Deep tillage and deep rooted legumes help to aerate this soil. Tilth can be maintained by returning crop residue to the soil and by using a crop rotation program that includes forage grasses and legumes. Fall plowing helps to reduce drying and warming time in spring.

The choice of trees and shrubs used for windbreaks is limited to species that are tolerant of wetness. This soil needs to be drained and the competing vegetation needs to be controlled in order to obtain the best survival and growth rate of trees and shrubs.

This soil is poorly suited to building site developments, sanitary facilities, and roads. Buildings need to be protected from damage by wetness and need to be constructed without basements. Protection can be provided by draining this soil and covering it with several feet of fill. Septic tank absorption fields function poorly in this soil because of the seasonal high water table. Roads need to be constructed with more suitable base material and protected from wetness by drainage.

This soil is in capability subclass IIw.

140—Spicer silt loam. This nearly level, poorly drained, calcareous soil is on slightly convex, broad flats and on rims of depressions. Individual areas are irregular and range from 5 to 200 acres.

Typically, the surface soil is black silt loam about 18 inches thick. The subsoil is dark grayish brown, olive brown, and grayish brown, mottled, very friable silt loam about 25 inches thick. The underlying material to a depth of about 60 inches is gray, mottled silt loam. This soil is calcareous throughout.

Included with this soil in mapping are small areas of moderately well drained Kingston soils, calcareous soils similar to Kingston soils, and poorly drained Madelia soils. Kingston soils are on low rises. Madelia soils are on broad, flat areas. Also included are small areas of soils that have underlying material that is glacial till or coarse textured sediment. The included soils have appreciable gypsum. They make up 10 to 20 percent of the unit.

Water and air move through this soil at a moderate rate. Surface runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 1 to 3 feet. Reaction is mildly alkaline or moderately alkaline in the surface soil. The content of organic matter is high, of phosphorus is low, and of potassium is medium.

Most areas of this soil are farmed. This soil has fair potential for cultivated crops, hay, pasture, and small grain and poor potential for trees. It has poor potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and forage grasses and legumes. Drainage and correction of the fertility imbalance are needed to make and keep this soil suitable for these crops. Adequate drainage is provided by tile drainage. Deep tillage and deep rooted legumes help to aerate the rooting zone. The fertility imbalance is caused by the high lime content that limits the availability of phosphorus, potassium, and trace nutrients. The imbalance can be corrected by fertilization. A crop rotation program that includes forage grasses and legumes and returning crop residue to the soil helps to maintain soil tilth. Grasses and legumes need to be tolerant of wetness and a high lime content. Fall plowing helps to reduce drying and warming time in spring.

The choice of trees and shrubs used for windbreaks is limited to species or varieties that are tolerant of a high lime content and wetness. Surface water needs to be removed and competing vegetation needs to be controlled for the best survival and growth rate of trees and shrubs.

This soil is poorly suited to building sites, sanitary facilities, and roads. Buildings need to be protected from damage by wetness and constructed without basements.

Protection can be provided by draining this soil and covering it with several feet of fill. Septic tank absorption fields function poorly in this soil because of the seasonal high water table. Roads need to be constructed with more suitable base material and protected from wetness by drainage.

This soil is in capability subclass IIw.

149B—Everly clay loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on slightly convex summits and side slopes. Individual areas of this soil are irregular and range from 5 to 40 acres.

Typically, the surface soil is black clay loam about 17 inches thick. The subsoil is about 29 inches thick. The upper part is dark yellowish brown and yellowish brown, friable clay loam. The lower part is light olive brown, firm, calcareous loam. The underlying material to a depth of about 60 inches is light olive brown, firm, calcareous loam. Depth to firm till and lime is shallower in more convex areas and deeper in less convex areas.

Included with this soil in mapping are small areas of poorly drained Letri soils, moderately well drained to somewhat poorly drained Wilmonton soils, and well drained Swanlake soils. Letri soils are in drainageways. Wilmonton soils are on slightly concave flats. Swanlake soils are on convex rises and side slopes. Also included are small areas of well drained soils that have firm till in the surface soil and are leached of lime below a depth of 50 inches or have stratified silt and sand in the underlying material. The included soils make up 5 to 20 percent of the unit.

Water and air move through this soil at a moderately slow rate. Surface runoff is medium. Available water capacity is high. Reaction is slightly acid or medium acid in the surface soil. The content of organic matter is high, of phosphorus is low, and of potassium is medium or high.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, and trees. It has fair potential for most engineering uses.

This soil is used for corn, soybeans, small grain, and forage grasses and legumes. Soil tilth can be maintained by returning crop residue to the soil, applying manure, and using a crop rotation program that includes forage grasses and legumes. Mulch tillage and other minimum tillage practices conserve moisture and reduce soil blowing and water erosion.

Most native trees and shrubs used for windbreaks grow well on this soil. Control of competing vegetation is needed in order to obtain the best survival and growth rate of trees and shrubs.

This soil is suited to building site developments, sanitary facilities, and roads. The proper function of septic tank absorption fields is limited by the moderately slow permeability. This limitation can be overcome by increasing the size of the absorption field. This soil has only fair suitability for use as a source of road fill because of low strength.

Most of the small areas of contrasting soils in this unit have a seasonal high water table at a depth of less than 6 feet. Depending on the depth to the water table, these areas have severe limitations for most engineering uses.

This soil is in capability subclass IIe.

154—Blue Earth muck. This nearly level, very poorly drained soil is in ponded drainageways. It is subject to flooding. Individual areas are oblong and range from 5 to 100 acres.

Typically, the surface layer is black muck about 8 inches thick. The subsoil is black, friable, mucky silty clay loam about 48 inches thick, and it is mottled. The underlying material to a depth of about 60 inches is black silty clay loam. This soil is calcareous throughout. In swales the muck surface soil is thicker and leached of lime in the upper part.

Included with this soil in mapping are small areas of poorly drained Canisteo soils. Also included are small areas of very poorly drained soils that have a similar surface layer but have coarse textured underlying material or a muck subsoil. They are in depressions and seeps. The included soils make up 5 to 15 percent of the unit.

Water and air move through this soil at a moderately slow rate. Surface runoff is very slow or ponded. Available water capacity is high. A seasonal high water table is at a depth of 0 to 1 foot. Reaction is mildly alkaline or moderately alkaline in the surface soil. The content of organic matter is high, of phosphorus is medium to low, and of potassium is high.

Most areas of this soil are not drained and are used for pasture or wetland wildlife habitat. Some areas are drained and farmed. Areas that are not drained have fair to poor potential for pasture and hay and fair to good potential for wetland wildlife habitat. Drained areas have good potential for cultivated crops; fair potential for hay, pasture, and small grain; and poor potential for trees. Drained areas and those that are not drained have poor potential for most engineering uses.

Wildlife uses of this soil are mostly for wetland habitat. Most areas contain seasonal or permanent, shallow-water ponds. The ponds contain reeds and open water and are used mostly by native waterfowl, shorebirds, and mammals. Wildlife habitat can be improved by deepening the ponds and by establishing wildlife plantings on the adjoining uplands.

This soil is mostly used for pasture in areas that are not drained and is used for corn, soybeans, small grain, and potatoes in drained areas. Areas that are not drained have pasture of low quality because the native grasses have a high fiber content and limited accessibility. Ditches improve accessibility. Drainage, correction of fertility imbalance, weed control, and prevention of soil blowing are needed to make and keep this soil suitable for cultivated crops. Tile drainage is needed to control the seasonal high water table. Extensive ditches are necessary to prevent accumulation of surface water.

The fertility imbalance is caused by the high lime content that restricts the availability of phosphorus, potassium, and trace nutrients. The imbalance can be corrected by fertilization. Crop varieties need to mature in time to avoid frost damage. The high organic matter content promotes rapid growth of small grain crops. These crops need to be very resistant to lodging, otherwise yields and test weight will be low. The high organic matter content also reduces the effectiveness of pre-emergence herbicides, which are most effective when shallowly incorporated. Fall plowing helps to reduce drying and warming time in spring. Deep tillage helps to aerate the rooting zone. Soil blowing can be a problem during winter, but its severity can be reduced by mulch or strip tillage or a winter cover crop.

The choice of species or varieties of trees and shrubs used for windbreaks is limited to those that are tolerant of high lime content and wetness. This soil needs to be drained and competing vegetation controlled in order to obtain the best survival and growth rate of trees and shrubs. Trees and shrubs establish naturally and grow well on ditch banks.

This soil is poorly suited to building sites, sanitary facilities, and roads. Buildings should not be built on this soil because it has low strength, is wet, and floods. Septic tank absorption fields function poorly in this soil because it floods and has a seasonal high water table. This soil should not be used as a source of road construction material because it is wet, contains excess humus, and has low strength. Roads need to be constructed from more suitable material and protected from wetness by drainage.

This soil is in capability subclass VIw.

197—Kingston silt loam. This very gently sloping, moderately well drained soil is on broad, low rises. Individual areas are round and range from 5 to 40 acres.

Typically, the surface soil is about 20 inches thick. The upper part is black silt loam. The lower part is very dark gray silt loam. The subsoil is about 18 inches thick. The upper part is dark grayish brown, very friable silt loam. The lower part is olive brown, mottled, very friable, calcareous silt loam. The underlying material to a depth of about 60 inches is light olive brown, mottled, very friable, calcareous silt loam. The depth to lime is shallower in more convex areas and deeper in less convex areas.

Included with this soil in mapping are small areas of moderately well drained and somewhat poorly drained Ransom soils and poorly drained Madelia soils. Ransom soils are in slightly convex, low rises. Madelia soils are in swales and flat depressions. Also included are areas of calcareous soils that are otherwise similar to Kingston soils and small areas of well drained sandy soils. The included soils make up 10 to 20 percent of the unit.

Water and air move through this soil at a moderate rate. Surface runoff is medium. Available water capacity is high. A seasonal high water table is at a depth of 3 to 5 feet. Reaction is slightly acid or neutral in the surface soil. The content of organic matter is high, of phosphorus is medium, and of potassium is high.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, small grain, and trees. It has poor to fair potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and forage grasses and legumes. Fertility maintenance is needed. Soil tilth can be maintained by returning all crop residue to the soil and by using a crop rotation program that includes forage grasses and legumes.

Most native trees and shrubs used for windbreaks grow well. Competing vegetation needs to be controlled in order to obtain the best survival and growth rate of trees and shrubs.

This soil is suited to building site developments, but has severe limitations for sanitary facilities and roads. Buildings with basements need protection from damage by wetness. Basements can be protected from damage by placing drainage tile around footings. Foundations, footings, and floors of buildings can be protected by building them on a base of coarse material. Septic tank absorption fields function poorly in this soil because of seasonal wetness. This soil has low strength. Roads need to be constructed with more suitable base material and protected from wetness by drainage.

This soil is in capability class I.

211—Lura silty clay. This nearly level, very poorly drained soil is in depressions. It is subject to flooding. Individual areas are elongated to oblong and range from 5 to 40 acres in size.

Typically, the surface soil is about 37 inches thick. The upper part is black silty clay. The lower part is black, mottled clay. The subsoil is about 15 inches thick. It is dark gray, mottled, firm clay in the upper part and olive gray, mottled, firm silty clay in the lower part. The underlying material to a depth of about 60 inches is olive gray, firm, mottled silty clay loam.

Included with this soil in mapping are large areas of similar soils that are on flood plains in Southbrook Township along the Des Moines River. Also included are small areas of very poorly drained Glencoe soils in drainageways on uplands and small areas of poorly drained soils that have stratified coarse material or soft shale as underlying material. The included soils make up 2 to 10 percent of the unit.

Water and air move through this soil at a slow rate. Surface runoff is slow or ponded. Available water capacity is moderate or high. A seasonal high water table is at a depth of 0 to 1 foot. Reaction is slightly acid or neutral in the surface soil. The content of organic matter, phosphorus, and potassium is high.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, fair potential for hay and small grain, and poor potential for trees. It has poor potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and forage grasses and legumes. Drainage and maintenance of tilth and fertility are needed to make and keep this soil suitable for these crops. Adequate drainage is provided by tile drainage. Runoff water from adjacent soils needs to be diverted and ditches or waterways need to be constructed to prevent accumulation of surface water. Deep tillage and deep rooted legumes help to aerate this soil. Good tilth can be maintained by returning crop residue to the soil or by using a crop rotation program that includes forage grasses and legumes that are tolerant of occasional ponding and of wetness. Proper timing of cultivation also helps to maintain tilth. Fall plowing helps to reduce drying and warming time in spring.

The choice of species or varieties of trees and shrubs used for windbreaks is limited to those that are tolerant of occasional ponding and of wetness. This soil needs to be drained and competing vegetation controlled to obtain the best survival and growth rate of trees and shrubs.

This soil is poorly suited to building site developments, sanitary facilities, and roads. Building site developments need protection from damage by wetness. Protection can be provided by draining the soil and covering it with several feet of fill. Septic tank absorption fields function poorly in this soil because of wetness and occasional ponding. Roads need to be constructed from more suitable base material and protected from wetness by drainage.

This soil is in capability subclass IIIw.

214—Talcot silty clay loam. This nearly level, very poorly drained soil is in closed depressions and low gradient drainageways. It is subject to flooding. Individual areas are elongated and range from 5 to several hundred acres.

Typically, the surface soil is about 22 inches thick. The surface is black, calcareous silty clay loam in the upper part. The lower part is very dark gray, mottled, calcareous silty clay loam. The subsoil is about 14 inches thick. The upper part is olive gray, mottled, friable, calcareous clay loam. The lower part is olive, mottled, friable, calcareous loam. The underlying material to a depth of about 60 inches is grayish brown and olive, mottled, stratified coarse sand and gravelly coarse sand.

Included with this soil in mapping are small areas of poorly drained, calcareous Mayer soils and Aquolls and Aquents. Mayer soils are on low rises. Aquolls and Aquents are in ponded areas. Also included are small areas of very poorly drained soils that have a mucky surface soil and gypsum or marl in the subsoil. The included soils make up 10 to 20 percent of the unit.

Water and air move through this soil at a moderate rate in the upper part and at a rapid rate below. Surface runoff is slow or ponded. Available water capacity is moderate. A seasonal high water table is at a depth of 0 to 1 foot. Reaction is mildly alkaline or moderately alkaline in the surface soil. The content of organic matter is high, of phosphorus is low, and of potassium is medium.

Most areas of this soil are farmed or in pasture. This soil has fair potential for cultivated crops, hay, pasture, and small grain and poor potential for trees. It has poor potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, pasture, and forage grasses and legumes. Drainage and correction of the fertility imbalance are needed to make and keep this soil suitable for these crops. Adequate drainage is provided by tile drainage, but ditches or waterways are needed in many places to prevent accumulation of surface water. Deep tillage and deep rooted legumes help to aerate the rooting zone. The fertility imbalance is caused by the high lime content that restricts the availability of phosphorus, potassium, and trace nutrients. The imbalance can be corrected by applying fertilizer. Crops need to be tolerant of wetness and a high lime content. Fall plowing helps to reduce drying and warming time in spring. Pasture yields can be improved by deferred, limited, and rotational grazing.

The choice of species or varieties of trees and shrubs used for windbreaks is limited to those that are tolerant of a high lime content and wetness. This soil needs to be drained and competing vegetation controlled for the best survival and growth rate of trees and shrubs.

This soil is poorly suited to building site developments, sanitary facilites, and roads. Building sites on this soil need protection from damage by wetness. Protection can be provided by draining this soil and covering it with several feet of fill. This soil has a hazard of cutbanks caving during excavation. This can be corrected by using retaining walls or over-excavating. Septic tank absorption fields function poorly in this soil because of a seasonal high water table. Roads need to be built from more suitable base material and protected from wetness by drainage.

This soil is in capability subclass IIIw.

230—Guckeen silty clay loam. This very gently sloping, somewhat poorly drained soil is on broad, low rises. Individual areas are round and range from 10 to 40 acres.

Typically, the surface soil is black silty clay loam about 21 inches thick. The subsoil is about 13 inches thick. The upper part is dark grayish brown, firm silty clay. The lower part is olive gray, mottled, firm silty clay. The upper part of the underlying material, to a depth of about 42 inches, is olive gray, mottled, friable silt loam and very fine sand. It is calcareous and stratified. The lower part is olive brown, mottled, firm, and calcareous clay loam to a depth of about 60 inches.

Included with this soil in mapping are small areas of poorly drained Marna soils. These soils are in swales. Also included are small areas of moderately well drained to somewhat poorly drained soils in which glacial till is deeper or shallower than in the Guckeen soil. The included soils make up 5 to 15 percent of the unit.

Water and air move through this soil at a slow rate. Surface runoff is medium. Available water capacity is high. A seasonal high water table is at a depth of 2 to 3.5 feet. Reaction is medium acid to neutral in the surface soil. The content of organic matter, phosphorus, and potassium is high.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, small grain, and trees. It has poor to fair potential for most engineering uses.

This soil is used for corn, soybeans, small grain, and forage grasses and legumes. Fertility and maintenance of soil tilth are needed. Soil tilth can be maintained by returning all crop residue to the soil or by using a crop rotation program that includes forage grasses and legumes. Timely cultivation is also beneficial.

Most native trees and shrubs used for windbreaks grow well. Competing vegetation needs to be controlled for the best survival and growth rate of trees and shrubs.

This soil has severe limitations for building site developments, sanitary facilities, and roads. Building sites need protection from damage by wetness. Basements can be protected by placing drainage tile around footings. Foundations, footings, and floors of buildings can be protected by building them on a base of coarse material. Septic tank absorption fields function poorly in this soil because of seasonal wetness and slow permeability. Roads need to be constructed with more suitable base material and protected from wetness by drainage.

This soil is in capability subclass IIw.

241—Letri clay loam. This nearly level, poorly drained soil is in shallow swales and on broad flats that are in a low position on the landscape. Individual areas are irregular and range from 10 to 100 acres.

Typically, the surface soil is black, friable clay loam about 19 inches thick. The subsoil is about 14 inches thick. The upper part is olive gray, friable, calcareous clay loam. The lower part is olive gray, friable, calcareous, mottled loam. The underlying material to a depth of about 60 inches is olive gray and light brownish gray, firm, calcareous, mottled loam. The depth to lime and firm till is shallower in more convex areas and deeper in less convex areas.

Included with this soil in mapping are small areas of poorly drained, calcareous Jeffers soils and poorly drained Delft and Romnell soils. Jeffers soils are on low, convex rises. Delft soils are in draws and on toe slopes. Romnell soils are in nearly level, slightly concave areas. Also included are small areas of poorly drained soils that contain appreciable amounts of gypsum or do not have lime in the upper part of the subsoil. The included soils make up 5 to 20 percent of the unit.

Water and air move through this soil at a moderately slow rate. Surface runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 0.5 to 2 feet. Reaction is slightly acid to mildly alkaline in the surface soil. The content of organic matter is high, of phosphorus is low, and of potassium is medium to high.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, and small grain and poor potential for trees. It has poor potential for most engineering uses.

This soil is used for corn, soybeans, small grain, and forage grasses and legumes. Drainage and maintenance of fertility and tilth are needed to make and keep this soil suitable for these crops. Adequate drainage is provided by tile drainage. Deep tillage and deep rooted legumes help to aerate this soil. Fertilizer application rates need to be determined by soil tests and crop needs. Tilth can be maintained by returning crop residue to the soil or by using a crop rotation program that includes forage grasses and legumes. Fall plowing helps to reduce the drying and warming time in spring.

The choice of trees and shrubs used for windbreaks is limited to species or varieties that are tolerant of wetness. This soil needs to be drained and the competing vegetation controlled in order to obtain the best survival and growth rate of trees and shrubs.

This soil is poorly suited to building site developments, sanitary facilities, and roads. Building sites on this soil need protection from damage by wetness. Protection can be provided by draining this soil and covering it with several feet of fill. Septic tank absorption fields function poorly in this soil because of a seasonal high water table and moderately slow permeability. This soil has low strength. Roads need to be constructed with more suitable base material and protected from wetness by drainage.

This soil is in capability subclass IIw.

247—Linder loam. This nearly level, somewhat poorly drained soil is on broad, low rises. Individual areas are irregular and range from 5 to 20 acres.

Typically, the surface soil is about 16 inches thick. The upper part is black loam, and the lower part is very dark brown loam. The subsoil is about 17 inches thick. The upper part is dark grayish brown, friable sandy loam. The lower part is dark grayish brown, mottled, friable loamy sand. The underlying material to a depth of about 60 inches is dark brown and light olive brown sand.

Included with this soil in mapping are small areas of well drained Estherville soils and poorly drained Biscay soils. Estherville soils are on low rises and Biscay soils are in swales. Also included are small areas of moderately well drained soils that are calcareous throughout or have a dark surface layer that is more than 24 inches thick. The included soils make up 5 to 15 percent of the unit.

Water and air move through this soil at a moderate to moderately rapid rate in the solum and a rapid rate in the underlying material. Surface runoff is slow. Available water capacity is moderate. A seasonal high water table is at a depth of 3 to 5 feet. Reaction is medium acid to mildly alkaline in the surface soil. The content of organic matter is high, of phosphorus is low, and of potassium is moderate.

Most areas of this soil are farmed. This soil has poor potential for cultivated crops, hay, pasture, small grain, and trees. It has poor potential for most engineering uses.

This soil is used for corn, soybeans, small grain, forage grasses, and legumes. Maintaining fertility and increasing the soil moisture supply are needed. Mulch tillage and minimum tillage practices conserve moisture. Drouth-tolerant crops, such as milo, use less moisture than corn for comparable yields. The effectiveness of pre-emergence herbicides is often reduced by low soil moisture. This soil needs to be irrigated for profitable farming or grazing.

The choice of trees and shrubs used for windbreaks is limited to species or varieties that are drouth tolerant. Trees and shrubs need to be watered and competing vegetation controlled for the best survival and growth rate.

This soil is poorly to fairly suited to building site developments and poorly suited to sanitary facilities and roads. Building sites need protection from wetness. Protection can be provided by placing drainage tile around basements and footings. Septic tank absorption fields function poorly in this soil because of wetness. Roads can be constructed with this soil but need to be protected from damage by wetness. A drainage system can provide this protection. This soil has a hazard of cutbanks caving during excavation. This can be corrected by using retaining walls or by over excavating. This soil is good as a source of sand and topsoil and fair as a source of gravel.

This soil is in capability subclass IIs.

255—Mayer loam. This nearly level, poorly drained, calcareous soil is on slightly convex, broad flats and on rims of depressions. Individual areas are irregular and range from 5 to 20 acres.

Typically, the surface soil is black loam about 17 inches thick. The subsoil is about 23 inches thick. The upper part is dark olive gray, mottled, friable loam. The middle part is olive gray, mottled, friable sandy loam. The lower part is olive gray, mottled, friable gravelly sandy loam. The underlying material to a depth of 60 inches is light olive brown, mottled gravelly loamy sand. This soil is calcareous throughout.

Included with this soil in mapping are small areas of poorly drained Biscay soils and very poorly drained Talcot soils. Biscay soils are in swales. Talcot soils are in depressions and low-gradient drainageways. Also included are small areas of poorly drained soils that have appeciable amounts of gypsum in the solum or poorly drained soils that have a dark colored surface soil more than 40 inches thick and contain up to 15 percent gravel. The included soils make up 5 to 10 percent of the unit.

Water and air move through this soil at a moderate rate. Surface runoff is slow. Available water capacity is moderate. A seasonal high water table is at a depth of 1 to 3 feet. Reaction is mildly alkaline or moderately alkaline in the surface soil. The content of organic matter is high, of phosphorus is low, and of potassium is medium.

Most areas of this soil are farmed. This soil has fair potential for cultivated crops, hay, pasture, and small grain and poor potential for trees. It has poor potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and forage grasses and legumes. Drainage and correcting the fertility imbalance are needed to make and keep this soil suitable for these crops. Adequate drainage is generally provided by tile drainage. Deep tillage and deep rooted legumes help to aerate the rooting zone. A fertility imbalance is caused by the high lime content that restricts the availability of phosphorus, potassium, and trace nutrients. The imbalance can be corrected by fertilization. Crops need to be tolerant of a high lime content. A crop rotation program that includes forage grasses and legumes or returning crop residue to the soil helps to maintain tilth. Grasses and legumes need to be tolerant of wetness and the high lime content. Fall plowing helps to reduce the drying and warming time in spring.

The choice of trees and shrubs used for windbreaks is limited to species or varieties that are tolerant of a high lime content and wetness. This soil needs to be drained and competing vegetation controlled for the best survival and growth rate of trees and shrubs.

This soil is a good source of sand and gravel. It is poorly suited for building site developments, sanitary facilities, and roads. Building sites on this soil need protection from damage by wetness. Protection can be provided by draining this soil and covering it with several feet of fill. This soil has a hazard of cutbanks caving during excavation. This can be corrected by using retention walls or by over excavating. Septic tank absorption fields function poorly in this soil because of a seasonal high water table. Roads need to be constructed with more suitable base material and protected from wetness and frost action by drainage.

This soil is in capability subclass IIw.

269—Millington silty clay loam. This nearly level, poorly drained soil is on slightly convex low rises on bottom lands. It is subject to flooding. Individual areas are broad and elongated and range from 20 to 100 acres.

Typically, the surface soil is about 30 inches thick. The upper part is black silty clay loam. The lower part is very dark gray silty clay loam. The subsoil is about 18 inches thick. The upper part is very dark gray, mottled, friable clay loam. The lower part is dark olive gray, mottled, friable clay loam. The underlying material to a depth of about 60 inches is olive, mottled, friable clay loam. This soil is calcareous throughout.

Included with this soil in mapping are small areas of very poorly drained Coland soils and moderately well drained to somewhat poorly drained Spillville soils. Coland soils are on slightly concave flats and Spillville soils are on low rises and toe slopes of valley sidewalls. Also included are small areas of soils that are similar to Millington soils. They are in lower lying areas adjacent to streams or in meander scars and are frequently flooded. The included soils make up 10 to 20 percent of the unit.

Water and air move through this soil at a moderate rate. Surface runoff is slow to ponded. Available water capacity is high. A seasonal high water table is at a depth of 0 to 2 feet. Reaction is mildly alkaline or moderately alkaline in the surface soil. The content of organic matter is high, of phosphorus is low, and of potassium is medium.

Most areas of this soil are in pasture. This soil has fair potential for cultivated crops, hay, pasture, and small grain and poor potential for trees. It has poor potential for most engineering uses.

This soil is mostly used for pasture. Pasture can be improved by deferred, limited, and rotational grazing. These practices help to reestablish a balance between cool-season and warm-season grasses. Sites for livestock watering pits are plentiful in this soil. A few areas are used for corn, soybeans, and small grain. Drainage, correcting the fertility imbalance, and maintaining soil tilth are needed to make and keep this soil suitable for these crops. Drainage is generally natural, but some areas are artificially drained by tile drainage and ditches or are protected from flooding by levees. Deep tillage helps to aerate this soil. The fertility imbalance is caused by a high lime content that restricts the availability of phosphorus, potassium, and trace nutrients. The fertility imbalance can be corrected by fertilizer application. Crops that mature early are likely to avoid frost damage. Fall plowing helps to reduce the warming and drying time in spring.

The choice of trees and shrubs used for windbreaks is limited to the species or varieties that are tolerant of a high lime content and wetness.

Because this soil has a hazard of occasional flooding and wetness, it has severe limitations for dwellings, septic tank absorption fields, and local roads and streets. Before local roads are constructed across areas of this soil, onsite investigations are needed to determine the extent of flooding and to determine proper design.

This soil is in capability subclass IIw.

291—Ransom silty clay loam. This very gently sloping, moderately well drained and somewhat poorly drained soil is on broad, low rises. Surfaces are plane and slightly concave. Individual areas are round and range from 5 to 30 acres.

Typically, the surface soil is black and very dark brown silty clay loam about 14 inches thick. The subsoil is about 21 inches thick. The upper part is dark brown, friable silty clay loam. The middle part is olive brown, mottled, friable silty clay loam. The lower part is olive brown, friable, mottled, calcareous silty clay loam. The underlying material to a depth of about 60 inches is light olive brown and olive brown, mottled, firm, calcareous loam.

Included with this soil in mapping are small areas of poorly drained Rushmore, well drained Clarion Variant, and moderately well drained Kingston soils. Rushmore soils are in swales. Clarion Variant soils are on convex rises. Kingston soils are on low rises. Also included are small areas of moderately well drained to somewhat poorly drained soils that have a thinner silt mantle. The included soils make up 5 to 20 percent of the unit.

Water and air move through this soil at a moderately slow rate. Surface runoff is medium. Available water capacity is high. A seasonal high water table is at a depth of 2.5 to 5 feet. Reaction is neutral in the surface soil. The content of organic matter is high, of phosphorus is low, and of potassium is medium.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, small grain, and trees. It has poor to fair potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and forage grasses and legumes. It has few limitations for this use. Fertility maintenance is needed. Soil tilth can be maintained by returning crop residue to the soil or by using a crop rotation program that includes forage grasses and legumes.

Most native trees and shrubs used for windbreaks grow well. Competing vegetation needs to be controlled for the best survival and growth rate of trees and shrubs.

Building site developments on this soil need protection from damage by wetness and by shrinking and swelling of the soil. Basements can be protected from damage by placing drainage tile around footings. Foundations, footings, and floors of buildings can be protected by building them on a base of coarse material. Septic tank absorption fields function poorly in this soil because of seasonal wetness and moderately slow permeability, which can be corrected by increasing the size of the absorption field. Roads need to be constructed with more suitable base material and protected from wetness by drainage.

This soil is in capability class I.

304—Rushmore silty clay loam. This nearly level, poorly drained soil is in swales and slightly concave, broad flats. Some areas flood after snowmelt in spring or after heavy rains. Individual areas are irregular and range from 10 to 80 acres.

Typically, the surface soil is about 19 inches thick. The upper part is black silty clay loam. The lower part is very dark gray silty clay loam. The subsoil is olive gray and olive, mottled, friable silty clay loam about 12 inches thick. The underlying material to a depth of about 60 inches is olive brown, mottled, firm, calcareous loam.

Included with this soil in mapping are small areas of poorly drained Madelia soils; very poorly drained soils in depressions; and poorly drained, calcareous Spicer soils. Madelia soils are on flats. Spicer soils are on rims of depressions. Also included are small areas of poorly drained soils that contain appreciable amounts of gypsum. The included soils make up 5 to 10 percent of the unit.

Water and air move through this soil at a moderately slow rate. Surface runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 1 to 3 feet. Reaction is slightly acid to mildly alkaline in the surface soil. The content of organic matter is high, of phosphorus is low, and of potassium is medium.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, and small grain, and poor potential for trees. It has poor potential for most engineering uses.

This soil is used for corn, soybeans, small grain, and forage grasses and legumes. Drainage and maintenance of fertility and tilth are needed to make and keep this soil suitable for these crops. Adequate drainage is provided by tile drainage. Deep tillage helps to aerate this soil. Soil tilth can be maintained by returning crop residue to the soil and by using a crop rotation program that includes forage grasses and legumes. Fall plowing helps to reduce drying and warming time in spring.

Windbreaks can be established in this soil. The choice of trees and shrubs used for windbreaks is limited to species or varieties that are tolerant of wetness. This soil needs to be drained and the competing vegetation controlled in order to obtain the best survival and growth rate of trees and shrubs.

This soil is poorly suited to building sites, sanitary facilities, and roads. Building sites on this soil need protection from damage by wetness. Protection can be provided by draining this soil and covering it with several feet of fill. Septic tank absorption fields function poorly in this soil because of the seasonal high water table. This soil has low strength. Roads need to be constructed with more suitable base material and protected from wetness by drainage.

This soil is in capability subclass IIw.

313—Spillville loam, occasionally flooded. This nearly level, moderately well drained to somewhat poorly drained soil is on slightly convex, low rises on bottom lands. This soil is occasionally flooded. Individual areas are elongated and range from 5 to 80 acres.

Typically, the surface soil is about 45 inches thick. The upper part is black loam. The lower part is very dark gray loam. The underlying material to a depth of about 60 inches is very dark gray, calcareous loam.

Included with this soil in mapping are small areas of poorly drained Coland soils and moderately well drained Terril soils. Coland soils are in depressions and low gradient drainageways. Terril soils are on foot slopes of valley sidewalls. In some areas the stream meanders, and these areas are subject to frequent flooding. Also included are small areas of moderately well drained to somewhat poorly drained soils that contain stratified sand and gravel. The included soils make up 5 to 10 percent of the unit.

Water and air move through this soil at a moderate rate. Surface runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 3 to 5 feet. Reaction is slightly acid or neutral in the surface soil. The content of organic matter is high, of phosphorus is low, and of potassium is medium or high.

Most areas of this soil are farmed or used for pasture. This soil has good potential for cultivated crops and fair potential for hay, pasture, small grain, and trees. It has poor potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and pasture. Soil fertility and tilth are easy to maintain. This soil has few limitations other than occasional flooding. In some years, flooding delays the planting of crops. Crops that mature earlier minimize potential frost damage in those years.

The choice of trees and shrubs used for windbreaks is limited to species or varieties that are tolerant of occasional flooding. Competing vegetation needs to be controlled in order to obtain the best survival and growth rate of trees and shrubs. Trees and shrubs establish naturally on levees.

This soil is poorly suited to building sites and most other engineering uses. It has a hazard of occasional flooding. Septic tank absorption fields function poorly in this soil because of flooding and the seasonal high water table. This soil has low strength. Roads need to be constructed from more suitable material.

This soil is in capability subclass IIw.

319—Barbert silt loam. This nearly level, very poorly drained soil is in shallow, closed depressions. It is subject to flooding. Individual areas are elongated to oblong and range from 2 to 20 acres.

Typically, the surface soil is black silt loam about 11 inches thick. The subsurface layer is dark gray silt loam about 12 inches thick. The subsoil is about 31 inches thick. The upper part is black, firm clay. The lower part is olive gray, mottled silty clay and silty clay loam. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous clay loam. In some places the subsoil is thinner and lime is shallower than in the typical profile. In other places the subsoil is thicker and lime is deeper than in the typical profile. In some areas the surface soil is dark gray when dry, as a result of mixing with gray subsurface material by tillage.

Included with this soil in mapping are small areas of very poorly drained Glencoe soils. They are in low gradient, interconnecting drainageways. Also included are some small areas of soil that are similar to Barbert soils but the surface soil extends below a depth of 24 inches. They formed in glacial till. The included soils make up 0 to 15 percent of the unit.

Water and air move through this soil at a slow rate. Surface runoff is slow or ponded. Available water capacity is high. A seasonal high water table is at a depth of 0 to 1 foot. Reaction is strongly acid to slightly acid in the surface soil. The content of organic matter, phosphorus, and potassium is high.

Most areas of this soil are farmed. This soil has good potential for cultivated crops; fair potential for hay, pasture, and small grain; and poor potential for trees. It has poor potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and forage grasses and legumes. Drainage and maintenance of soil tilth and fertility are needed to make and keep this soil suitable for these crops. Adequate drainage is generally provided by tile drainage. Because of the slow permeability, french drains and surface intakes are used to improve efficiency. Runoff water from adjacent soils can be diverted and ditches or waterways constructed to prevent accumulation of surface water. Deep tillage and deep-rooted legumes help to aerate this soil. Good soil tilth can be maintained by returning all crop residue to the soil or by using a crop rotation program that includes forage grasses and legumes. Fall plowing helps to reduce the drying and warming time in spring.

The choice of trees and shrubs used for windbreaks is limited to those species or varieties that are tolerant of occasional ponding and wetness. This soil needs to be drained and competing vegetation controlled in order to obtain the best survival and growth rate of trees and shrubs.

This soil is poorly suited to building sites, sanitary facilities, and roads. Building sites on this soil need protection from damage by wetness. Protection can be provided by draining the soil and covering it with several feet of fill. Septic tank absorption fields function poorly in this soil because of the slow permeability, wetness, and occasional ponding. This soil has a high shrink-swell potential and low strength. Roads need to be constructed with more suitable base material and protected from wetness by drainage.

This soil is in capability subclass IIIw.

327A—Dickman sandy loam, 0 to 2 percent slopes. This nearly level, well drained soil is on broad, plane or convex flats. Individual areas are irregular and range from 5 to 100 acres in size.

Typically, the surface soil is very dark brown sandy loam about 15 inches thick. The subsoil is about 23 inches thick. The upper part is dark yellowish brown, loose loamy sand. The lower part is dark brown, loose sand. The underlying material to a depth of about 60 inches is yellowish brown and brown sand.

Included with this soil in mapping are small areas of somewhat poorly drained Linder soils and poorly drained Biscay soils. Linder soils are in swales. Biscay soils are in draws. Also included are small areas of well drained soils that have a fine sand surface soil and moderately well drained to somewhat poorly drained soils underlain by silt or glacial till. The included soils make up 10 to 20 percent of the unit.

Water and air move through this soil at a moderately rapid rate. Surface runoff is slow. Available water capacity is low. Reaction is slightly acid or medium acid in the surface soil. The content of organic matter is moderate, of phosphorus is low, and of potassium is medium.

Most areas of this soil are farmed. A few areas are irrigated. If this soil is not irrigated, it has poor potential for cultivated crops, hay, pasture, small grain, and trees. It has good potential for most engineering uses, except those uses affected by seepage or cutbank caving.

This soil is mostly used for corn, soybeans, small grain, forage grasses, and legumes. Increase of soil fertility, improvement of available water capacity, and protection from soil blowing are necessary to make and keep this soil suitable for cultivated crops (fig. 7). Applying manure and returning crop residue to the soil help to maintain and improve the available water capacity. Mulch tillage and minimum tillage conserve moisture and reduce soil blowing. Drouth-tolerant crops, such as grain sorghum, require less moisture than corn for comparative yields. The effectiveness of pre-emergence herbicides is often reduced because of low soil moisture. Irrigation makes this soil more suitable for farming.

Field windbreaks help to conserve moisture and control soil blowing. The choice of trees and shrubs used for windbreaks is limited to species or varieties that are tolerant of drouth. Tree and shrub seedlings need to be watered and competing vegetation controlled in order to obtain the best survival and growth rate.

This soil is well suited to building site developments and local roads and streets. It has a hazard of cutbanks caving during excavations. This can be corrected by using retaining walls or by over-excavating. Septic tank absorption fields function well in this soil, however, there is a hazard of polluting underground water because of seepage of effluent. This soil is a good source of road construction material and topsoil and a fair source of sand.

This soil is in capability subclass IIIs.

327B—Dickman sandy loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on broad, plane or convex side slopes. Individual areas are irregular and range from 5 to 100 acres.

Typically, the surface soil is very dark brown sandy loam about 15 inches thick. The subsoil is about 23 inches thick. The upper part is dark yellowish brown, loose loamy sand. The lower part is dark brown, loose sand. The underlying material to a depth of about 60 inches is yellowish brown and brown sand.

Included with this soil in mapping are small areas of well drained Swanlake and Estherville soils. Swanlake soils are on side slopes. Estherville soils are on low, convex rises. Also included are small areas of somewhat excessively drained soils that have a very fine sand surface layer and well drained sandy soils that have glacial till, silt, or stratified sand and silt in the underlying material. The included soils make up 10 to 20 percent of the unit.

Water and air move through this soil at a moderately rapid rate. Surface runoff is medium. Available water capacity is low. Reaction is slightly acid or medium acid in the surface soil. The content of organic matter is moderate, of phosphorus is low, and of potassium is medium.

Most areas of this soil are farmed. A few areas are irrigated. This soil has poor dryland potential for cultivated crops, hay, pasture, small grain, and trees. It has good potential for most engineering uses, except those uses affected by seepage or cutbank caving.

This soil is mostly used for corn, soybeans, small grain, and forage grasses and legumes. Increase of soil fertility, improvement of available water capacity, and protection from soil blowing are necessary to make and keep this soil suitable for cultivated crops. Applying manure and returning crop residue to the soil help to maintain and improve available water capacity. Mulch tillage and minimum tillage conserve moisture and reduce soil blowing. Drouth-tolerant crops, such as grain sorghum, require less moisture than corn for comparative yields. The effectiveness of pre-emergence herbicides is often reduced because of low soil moisture. Irrigation makes this soil more suitable for farming.

Field windbreaks help to conserve moisture and control soil blowing. The choice of trees and shrubs is limited to species or varieties that are tolerant of drouth. Tree and shrub seedlings need to be watered and competing vegetation controlled in order to obtain the best survival and growth rate.

This soil is well suited to building site developments and local roads and streets. It has a hazard of cutbanks caving during excavations. This can be corrected by using retaining walls or by over-excavating. Septic tank absorption fields function well in this soil, however, there is a hazard of polluting underground water because of seepage of effluent. This soil is a good source of road construction material and topsoil and a fair source of sand.

This soil is in capability subclass IIIe.

327C—Dickman sandy loam, 6 to 12 percent slopes. This rolling, well drained soil is on plane or convex side slopes and hilltops. Slopes are complex, 50 to 200 feet wide, and 100 to several hundred feet long. Individual areas are irregular and range from 5 to 40 acres.

Typically, the surface soil is very dark brown sandy loam about 11 inches thick. The subsoil is about 22 inches thick. The upper part is dark yellowish brown, very friable loamy sand. The lower part is dark yellowish brown, loose sand. The underlying material to a depth of about 60 inches is yellowish brown and brown, loose sand.

Included with this soil in mapping are small areas of well drained Estherville and Storden soils. Estherville soils are on low, convex rises. Storden soils are on side slopes. Also included are small areas of excessively well drained soils that have a very fine sand surface soil and well drained sandy soils that have glacial till, silt, or stratified sand and silt in the underlying material. The included soils make up 10 to 20 percent of the unit.

Water and air move through this soil at a moderately rapid rate. Surface runoff is medium. Available water capacity is low. Reaction is slightly acid or medium acid in the surface soil. The content of organic matter is moderate, of phosphorus is low, and of potassium is medium.

Most areas of this soil are farmed. A few areas are irrigated. This soil has poor dryland potential for cultivated crops, hay, pasture, small grain, and trees. It has fair potential for most engineering uses, except those uses affected by seepage or cutbank caving.

This soil is mostly used for small grain and forage grasses and legumes. Increase of soil fertility, improvement of available water capacity, and protection from soil blowing are necessary to make and keep this soil suitable for cultivated crops. Applying manure and returning crop residue to the soil help to maintain and improve available water capacity. Mulch tillage and other minimum tillage practices increase and conserve available water capacity and reduce soil blowing and erosion. Drouth-tolerant crops, such as grain sorghum, require less moisture than corn for comparative yields. The effectiveness of pre-emergence herbicides is often reduced because of low soil moisture. Irrigation would make this soil more suitable for farming.

Field windbreaks help to conserve moisture and control soil blowing. The choice of trees and shrubs is limited to species or varieties that are tolerant of drouth. Tree and shrub seedlings need to be watered and competing vegetation controlled in order to obtain the best survival and growth rate.

This soil is suited to building site developments and local roads and streets. Building site developments and local roads and streets need location planning because of slope. Slope also limits this soil for septic tank absorption fields. This soil has a hazard of contaminating underground water because of seepage of effluent. Shallow excavations have a hazard of cutbanks caving. Retaining walls or over excavating are methods of overcoming this hazard.

This soil is in capability subclass IVe.

345—Wilmonton clay loam. This very gently sloping, moderately well drained and somewhat poorly drained soil is on low rises and broad, flat areas on hilltops. Surfaces are slightly concave to slightly convex. Individual areas are oblong and range from 5 to 100 acres.

Typically, the surface soil is about 22 inches thick. The upper part is black clay loam. The lower part is very dark grayish brown clay loam. The subsoil is olive brown, mottled, friable clay loam that contains numerous worm casts in the upper part. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous loam.

Included with this soil in mapping are small areas of well drained Everly soils and poorly drained Letri soils. Everly soils are on small rises. Letri soils are in draws and on toe slopes. Also included are small areas of moderately well drained and somewhat poorly drained soils that are calcareous, have lime concentrations in the upper part of the subsoil, or have a surface soil more than 36 inches thick. The included soils make up 5 to 20 percent of the unit.

Water and air move through this soil at a moderately slow rate. Surface runoff is medium. Available water capacity is high. A seasonal high water table is at a depth of 2.5 to 5 feet. Reaction is slightly acid or neutral in the surface soil. The content of organic matter and potassium is high, and the content of phosphorus is low.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, small grain, and trees. It has poor to fair potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grains, and forage grasses and legumes. It has few limitations that restrict its use, so it can be cropped intensively. Soil tilth can be maintained by returning crop residue to the soil. Crop residue left on the surface of fall-plowed fields helps to control soil blowing.

Most native trees and shrubs used for windbreaks grow well. Competing vegetation needs to be controlled for the best survival and growth rate of trees and shrubs.

This soil is suited to building site developments but has limitations for sanitary facilities and local roads and streets. Building sites on this soil need protection from damage by wetness. Basements can be protected from damage by placing drainage tile around footings. Foundations, footings, and floors of buildings can be protected from wetness by building them on a base of coarse material. Seasonal wetness interferes with the proper functioning of septic tank absorption fields. Roads need to be constructed with more suitable base material and protected from wetness by drainage.

This soil is in capability class I.

392—Biscay loam. This nearly level, poorly drained soil is in swales and on broad flats on uplands. Individual areas are irregular and range from 2 to 100 acres.

Typically, the surface soil is black loam about 20 inches thick. The subsoil is about 19 inches thick. The upper part is dark gray, mottled, friable loam. The middle part is grayish brown, mottled, friable sandy clay loam. The lower part is grayish brown, mottled, friable, gravelly sandy loam. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous, gravelly coarse sand. In areas that are slightly convex, depth to gravelly material and lime is less than in the typical profile.

Included with this soil in mapping are small areas of poorly drained, calcareous Mayer soils and very poorly drained, calcareous Talcot soils. Mayer soils are on low, convex rises. Talcot soils are in shallow depressions and in low gradient drainageways. Also included are small areas of poorly drained soils that are underlain by sand or small areas that have a surface layer more than 24 inches thick and contain up to 15 percent gravel. The included soils make up 0 to 15 percent of the unit.

Water and air move at a moderate rate in the upper part of the soil and rapidly below. Surface runoff is slow. Available water capacity is moderate. A seasonal high water table is at a depth of 1 to 3 feet. Reaction is slightly acid to mildly alkaline in the surface soil. The content of organic matter is high, of phosphorus is low, and of potassium is medium to high.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, and small grain and poor potential for trees. It has poor potential for most engineering uses.

This soil is used for corn, soybeans, small grain, and forage grasses and legumes. Drainage and maintenance of fertility and tilth are needed to make and keep this soil suitable for these crops. Adequate drainage is generally provided by tile drainage. Spacing between lines is greater than normal because of coarse textured underlying material. Deep tillage helps to aerate this soil. Tilth can be maintained by returning crop residue to the soil and by using a crop rotation program that includes forage grasses and legumes. Fall plowing helps to reduce drying and warming time in spring.

The choice of trees and shrubs used for windbreaks is limited to species or varieties that are tolerant of wetness. This soil needs to be drained and the competing vegetation controlled in order to obtain the best survival and growth rate of trees and shrubs.

This soil is a good source of sand and gravel. Building site developments need protection from damage by wetness. Protection can be provided by draining this soil and covering it with several feet of fill. This soil has a hazard of cutbanks caving during excavations. This can be overcome by using retaining walls or over-excavating.

Septic tank absorption fields function poorly in this soil because of the seasonal high water table. Roads can be constructed with this soil, but they need to be protected from wetness by drainage.

This soil is in capability subclass IIw.

421B—Ves loam, 2 to 6 percent slopes. This undulating, well drained soil is on convex knolls and side slopes. Individual areas are elongated to oblong and range from 5 to 20 acres.

Typically, the surface soil is black loam about 16 inches thick. The subsoil is olive brown, friable loam about 24 inches thick. The lower part is calcareous. The underlying material to a depth of about 60 inches is olive brown, calcareous loam.

Included with this soil in mapping are small areas of moderately well drained Normania soils, poorly drained Webster and Delft soils, and well drained Swanlake soils. Normania soils are on slightly concave flats. Webster and Delft soils are in draws and on toe slopes. Swanlake soils are on convex side slopes. Also included are small areas of well drained soils that have a silt loam or sandy loam surface soil. The included soils make up 10 to 20 percent of the unit.

Water and air move through this soil at a moderate rate. Surface runoff is medium. Available water capacity is high. Reaction is slightly acid to mildly alkaline in the surface soil. The content of organic matter is moderate, of phosphorus is low, and of potassium is high.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, small grain, and trees. It has good potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and forage grasses and legumes. Control of erosion and maintenance of soil fertility are needed. Organic matter content and tilth can be maintained by returning crop residue to the soil or by using a crop rotation program that includes forage grasses and legumes. Mulch tillage and minimum tillage practices conserve moisture and reduce erosion.

Most native trees and shrubs used for windbreaks grow well. Competing vegetation needs to be controlled in order to obtain the best survival and growth rate.

This soil is well suited to building site developments and sanitary facilities. Septic tank absorption fields function well in this soil. This soil is a fair source of road construction material and a good source of topsoil.

This soil is in capability subclass IIe.

446—Normania loam. This very gently sloping, moderately well drained soil is on broad, low rises. Individual areas are irregular and range from 5 to 25 acres.

Typically, the surface soil is black loam about 18 inches thick. The subsoil is about 16 inches thick. The upper part is olive brown, friable loam. The lower part is light olive brown, friable, calcareous loam. The underlying material, to a depth of about 60 inches, is light olive brown and olive brown, mottled, friable, calcareous loam.

Included with this soil in mapping are small areas of poorly drained Delft and Webster soils and well drained Ves soils. Delft soils are on toe slopes. Webster soils are in swales. Ves soils are on low convex rises and side slopes. Also included are small areas of moderately well drained soils that have lime at a depth of about 10 inches. The included soils make up 5 to 10 percent of the unit.

Water and air move through this soil at a moderate rate. Surface runoff is medium or slow. Available water capacity is high. A seasonal high water table is at a depth of 3 to 6 feet. Reaction is slightly acid or neutral in the surface soil. The content of organic matter and potassium is high, and the content of phosphorus is low.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, small grain, and trees. It has poor or fair potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and forage grasses and legumes. It has few limitations that restrict its use, so it can be cropped intensively. Soil tilth can be maintained by applying manure and returning crop residue to the soil or by using a crop rotation program that includes forage grasses and legumes.

Most native trees and shrubs used for windbreaks grow well. Competing vegetation needs to be controlled for the best survival and growth rate of trees and shrubs.

This soil is suited to building site developments but has limitations for sanitary facilities and local roads and streets. Dwellings on this soil need protection from damage by wetness. Basements can be protected by placing drainage tile around footings. Foundations, footings, and floors of buildings can be protected by building them on a base of coarse material. Septic tank absorption fields function poorly in this soil because of seasonal wetness. This soil has low strength. Roads need to be constructed with more suitable base material and protected from wetness by drainage.

This soil is in capability class I.

588B—Clarion Variant loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on convex surfaces on low knolls. Individual areas are oblong and range from 5 to 30 acres.

Typically, the surface soil is about 18 inches thick. The upper part is black loam. The lower part is very dark gray loam. The subsoil is about 28 inches thick. The upper part is dark brown and dark yellowish brown, very friable silt loam. The lower part is dark yellowish brown to olive brown, friable, calcareous loam. The underlying material to a depth of 60 inches is olive brown, calcareous loam.

Included with this soil in mapping are small areas of moderately well drained and somewhat poorly drained Ransom soils and poorly drained Rushmore soils.

Ransom soils are on slightly concave flats. Rushmore soils are in draws. Also included are small areas of well drained soils that have a sandy loam surface soil, formed in glacial till, or are underlain by coarse sand. The included soils make up 10 to 15 percent of the unit.

Water and air move through this soil at a moderately slow rate. Surface runoff is medium. Available water capacity is high. Reaction is slightly acid or neutral in the surface soil. The content of organic matter is high, of phosphorus is low, and of potassium is medium.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, small grain, and trees. It has good or fair potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and forage grasses and legumes. Control of erosion and maintenance of soil fertility are needed. Tilth can be maintained by returning all crop residue to the soil or by using a crop rotation program that includes forage grasses and legumes. Mulch tillage and minimum tillage practices conserve moisture and reduce water erosion or soil blowing.

Most native trees and shrubs used for windbreaks grow well. Competing vegetation needs to be controlled in order to obtain the best survival and growth rate of trees and shrubs.

This soil is suited to building site developments and roads. Septic tank absorption fields function poorly in this soil because of the moderately slow permeability. This can be corrected by increasing the size of the absorption field. This soil is a fair source of road construction material.

This soil is in capability subclass IIe.

589—Romnell clay loam. This nearly level, poorly drained soil is on slightly concave, broad depressions. Individual areas are irregular and range from 5 to 80 acres.

Typically, the surface soil is about 18 inches thick. The upper part is black, friable clay loam. The lower part is very dark gray silt loam. The subsoil is about 25 inches thick. The upper part is very dark gray, friable, mottled clay loam. The middle part is olive gray, mottled, friable clay loam. The lower part is gray, mottled, firm, calcareous clay loam. The underlying material to a depth of about 60 inches is gray, mottled, firm, calcareous clay loam.

Included with this soil in mapping are small areas of very poorly drained Glencoe soils; poorly drained, calcareous Jeffers soils; and poorly drained Letri soils. Glencoe soils are in depressions. Jeffers soils are on rims of depressions. Letri soils are in slightly concave flats. Also included are small areas of poorly drained soils that contain gypsum and have a surface soil less than 24 inches thick. The included soils make up 5 to 10 percent of the unit.

Water and air move through this soil at a moderately slow rate. Surface runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 0.5 foot to 2.0 feet. Reaction is neutral or mildly alkaline in the surface soil. The content of organic matter and potassium is high, and the content of phosphorus is medium.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, and small grain and poor potential for trees. It has poor potential for most engineering uses.

This soil is used for corn, soybeans, small grain, and forage grasses and legumes. Drainage and maintenance of fertility and tilth are needed to make and keep this soil suitable for these crops. Adequate drainage is provided by tile drainage. Deep tillage and deep rooted legumes help to aerate this soil. Fall plowing helps to reduce drying and warming time in spring. Soil tilth can be maintained by returning crop residue to the soil or by using a crop rotation program that includes forage grasses and legumes.

The choice of trees and shrubs used for windbreaks is limited to species or varieties that are tolerant of wetness. This soil needs to be drained and the competing vegetation controlled in order to obtain the best survival and growth rate of trees and shrubs.

This soil is poorly suited to building site developments, sanitary facilities, and local roads and streets. Building sites on this soil need protection from damage by wetness. Protection can be provided by draining this soil and covering it with several feet of fill. Septic tank absorption fields function poorly in this soil because of the seasonal high water table and moderately slow permeability. This soil has low strength. Roads need to be constructed with more suitable base material and protected from wetness by drainage.

This soil is in capability subclass IIw.

590B—Jeffers Variant clay loam, 2 to 4 percent slopes. This gently sloping, somewhat poorly drained, calcareous, gypsic soil is on convex rises adjacent to closed depressions. Individual areas are oblong and range from 2 to 20 acres.

Typically, the surface soil is black clay loam and loam about 16 inches thick. The subsoil is about 19 inches thick. The upper part is dark grayish brown, mottled, friable loam. The lower part is olive brown, mottled, friable loam. The underlying material to a depth of about 60 inches is grayish brown, mottled, friable loam. This soil is calcareous throughout. A zone of gypsum accumulation is at the boundary of the surface soil and subsoil.

Included with this soil in mapping are small areas of poorly drained, calcareous Jeffers soils and very poorly drained Glencoe soils. Jeffers soils are on adjacent flats. Glencoe soils are in adjacent depressions. Also included are small areas of moderately well drained to somewhat poorly drained soils that do not have gypsum but contain stratified silts. The included soils make up 5 to 10 percent of the unit.

Water and air move through this soil at a moderately slow rate. Surface runoff is medium or slow. Available water capacity is high. A seasonal high water table is at a depth of 1.5 to 3 feet. Reaction is mildly alkaline or moderately alkaline in the surface soil. The content of organic matter is high, of phosphorus is low, and of potassium is medium.

Most areas of this soil are farmed. This soil has good potential for cultivated crops and fair potential for hay, pasture, small grain, and trees. It has poor potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and forage grasses and legumes. Correcting the fertility imbalance, increasing the soil moisture supply, and maintaining soil tilth are the main management needs. Although this soil is sloping, the hazard of erosion is slight. The fertility imbalance is caused by the high lime content that restricts the availability of phosphorus, potassium, and trace nutrients. Mulch tillage and minimum tillage practices conserve moisture and control erosion. A crop rotation program that includes forage grasses and legumes or returning all crop residue to the soil helps to maintain soil tilth.

The choice of trees and shrubs used for windbreaks is limited to species or varieties that are tolerant of a high lime content. Competing vegetation needs to be controlled in order to obtain the best survival and growth rate of trees and shrubs.

This soil is poorly to fairly suited to building site developments, sanitary facilities, and local roads and streets. Building sites on this soil need protection from damage by wetness. Basements can be protected by placing drainage tile around footings. Foundations, footings, and floors of buildings can be protected by building them on a base of coarse material. Septic tank absorption fields function poorly in this soil because of seasonal wetness. This can be corrected by increasing the size of the absorption field. Roads need to be constructed with more suitable base material and protected from wetness by drainage.

This soil is in capability subclass IIe.

594—Jeffers clay loam. This nearly level, poorly drained soil is on slightly convex, low rises and on rims of depressions. Individual areas are elongated and range from 2 to 45 acres.

Typically, the surface soil is about 16 inches thick. The upper part is black clay loam. The lower part is very dark gray clay loam. The subsoil is about 14 inches thick. The upper part is dark gray, very friable clay loam. The lower part is grayish brown, mottled, very friable clay loam. The underlying material to a depth of about 60 inches is grayish brown and light olive brown, mottled, firm loam. This soil is calcareous throughout. The gypsum content is higher in more convex areas and lower in less convex areas.

Included with this soil in mapping are small areas of very poorly drained Glencoe soils in depressions. Also included are small areas of poorly drained soils that contain appreciable amounts of lime or gypsum. The included soils make up 5 to 20 percent of the unit.

Water and air move through this soil at a moderately slow rate. Surface runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 1 to 2 feet. Reaction is mildly alkaline or moderately alkaline in the surface soil. The content of organic matter is high, of phosphorus is low, and of potassium is medium.

Most areas of this soil are farmed. This soil has fair potential for cultivated crops, hay, pasture, and small grain and poor potential for trees. It has poor potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and forage grasses and legumes. Drainage and correcting the fertility imbalance are needed to make and keep this soil suitable for these crops. Adequate drainage is generally provided by tile drainage. Deep tillage and deep rooted legumes help to aerate the rooting zone. The fertility imbalance is caused by the high lime content that restricts the availability of phosphorus, potassium, and trace nutrients. The imbalance can be corrected by fertilization. A crop rotation program that includes forage grasses and legumes or returning all crop residue to the soil helps to maintain soil tilth. Grasses and legumes need to be tolerant of wetness and a high lime content. Fall plowing reduces the drying and warming time in spring.

The choice of trees and shrubs used for windbreaks is limited to species or varieties that are tolerant of a high lime content and wetness. This soil needs to be drained and competing vegetation controlled for the best survival and growth rate of trees and shrubs.

This soil is poorly suited to building site developments, sanitary facilities, and roads. Building sites on this soil need protection from damage by wetness. Protection can be provided by draining this soil and covering it with several feet of fill. Septic tank absorption fields function poorly in this soil because of the seasonal high water table. This soil has low strength. Roads need protection from wetness by drainage.

This soil is in capability subclass IIw.

595B—Swanlake loam, 2 to 6 percent slopes. This undulating, well drained soil is on knolls, hilltops, and side slopes. Surfaces are convex. Individual areas are elongated and range from 5 to 30 acres.

Typically, the surface layer is very dark grayish brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is light olive brown loam. This soil is calcareous throughout.

Included with this soil in mapping are small areas of well drained Clarion soils and poorly drained Webster and Delft soils. Clarion soils are on slightly concave side slopes. Webster and Delft soils are in draws and on toe slopes. Also included are small areas of well drained, calcareous soils that have a sandy surface soil or have firm till in the underlying material. The included soils make up 5 to 10 percent of the unit.

Water and air move through this soil at a moderate rate. Surface runoff is medium. Available water capacity is high. Reaction is mildly alkaline in the surface soil. The content of organic matter is moderate, of phosphorus is low, and of potassium is medium.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, hay, pasture, small grain, and trees. It has good potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and forage grasses and legumes. Erosion control and maintenance of soil fertility are needed. Tilth can be maintained by returning crop residue to the soil and by using a crop rotation program that includes forage grasses and legumes. Mulch tillage and minimum tillage practices conserve soil moisture and reduce soil blowing and water erosion.

Windbreaks can be established in this soil and most native trees and shrubs grow well. Competing vegetation needs to be controlled in order to obtain the best survival and growth rate.

This soil is well suited to building site developments and sanitary facilities and is fairly suited to roads. Septic tank absorption fields function well in this soil. Local roads are susceptible to frost action. This soil is a fair source of road construction material. A cover of more suitable base material is preferred.

This soil is in capability subclass IIe.

595C—Swanlake loam, 6 to 12 percent slopes. This rolling, well drained soil is on knolls, hilltops, and side slopes. Slopes are convex, complex, and 100 to 200 feet long. Individual areas are elongated and range from 5 to 30 acres.

Typically, the Swanlake soil has a very dark brown loam surface layer about 8 inches thick. The underlying material to a depth of about 60 inches is light olive brown loam. This soil is calcareous throughout. In places there are small areas of well drained, calcareous soils that have a sandy loam surface soil or have stratified sand and silt loam or firm till in the underlying material.

Included with this soil in mapping are small areas of well drained Storden and Clarion soils and poorly drained Webster and Delft soils. Storden soils have a thinner surface layer. Clarion soils are in a lower position on the landscape. Webster and Delft soils are in draws and on toe slopes. The included soils make up 5 to 15 percent of the unit.

Water and air move through Swanlake soil at a moderate rate. Surface runoff is medium. Available water capacity is high. Reaction is mildly alkaline in the surface soil. The content of organic matter is moderate, of phosphorus is low, and of potassium is medium.

Most areas of this soil are farmed. This soil has good to fair potential for cultivated crops, hay, pasture, small grain, and trees. It has fair potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and forage grasses and legumes. Maintenance of soil fertility, organic matter content, control of erosion, and increasing the soil moisture supply are needed to keep this soil suitable for these crops. Soil tilth and organic matter content can be maintained by applying manure, returning crop residue to the soil, and by using a crop rotation program that includes forage grasses and legumes. Mulch tillage and minimum tillage practices conserve moisture and reduce soil blowing and water erosion. These practices are most effective when the soil is on the contour.

Most native trees and shrubs used for windbreaks grow well. Competing vegetation needs to be controlled in order to obtain the best survival and growth rate of trees and shrubs.

This soil is fairly suited to building site developments and sanitary facilities because of slope. It requires leveling for conventional buildings. Septic tank absorption fields have a hazard of lateral seepage and downslope flow because of slope. A more suitable material in the base of roads and good drainage help to overcome the low strength and susceptibility to frost action of the soil material.

This soil is in capability subclass IIIe.

884—Webster-Delft clay loams. This map unit consists of nearly level and very gently sloping, poorly drained soils on broad flats. Individual areas are irregular and range from 10 to several hundred acres. They are 50 to 70 percent Webster soils and 30 to 50 percent Delft soils. The Webster and Delft soils are on similar planes and in slightly concave positions on the landscape. Webster soils have 0 to 2 percent slopes, Delft soils are on toe slopes and have slopes of 1 to 3 percent. These soils are so intricately mixed that it is not practical to separate them in mapping.

Typically, the Webster soils have a black clay loam surface soil about 15 inches thick. The subsoil is olive gray, mottled, friable, calcareous clay loam. The underlying material is gray, mottled, calcareous clay loam.

Typically, the Delft soils have a surface soil of black clay loam and loam about 29 inches thick. The subsoil is about 17 inches thick. The upper part is dark gray, friable silt loam. The lower part is olive gray, mottled, friable clay loam. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous loam.

Included with these soils in mapping are small areas of poorly drained, calcareous Canisteo and Jeffers soils on rims of depressions; very poorly drained Glencoe soils in depressions; and moderately well drained to somewhat poorly drained Nicollet soils on low rises. These inclusions make up as much as 15 percent of the mapped area.

Water and air move through the Webster soils at a moderate or moderately slow rate and through the Delft soils at a moderately slow rate. Surface runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 1 to 3 feet in the Webster soils and at a depth of 1 to 2 feet in the Delft soils. Reaction is neutral in the surface soil of Webster soils and ranges from medium acid to mildly alkaline in Delft soils. The content of organic matter is high, of phosphorus is low, and of potassium is medium to high.

Most areas of the Webster and Delft soils are farmed. They have good potential for cultivated crops, hay, pasture, and small grain and poor potential for trees. They have poor potential for most engineering uses.

The soils in this unit are used for corn, soybeans, small grain, and forage grasses and legumes. Drainage and maintenance of fertility and tilth are needed to make and keep these soils suitable for these crops. Adequate drainage is generally provided by tile drainage. Deep tillage and deep rooted legumes help to aerate these soils. Soil tilth can be maintained by returning crop residue to the soil and by using a crop rotation program that includes forage grasses and legumes. Fall plowing helps to reduce the drying and warming time in spring.

The choice of trees and shrubs used for windbreaks is limited to species or varieties that are tolerant of wetness. These soils need surface drainage and the competing vegetation needs to be controlled in order to obtain the best survival and growth rate of trees and shrubs.

These soils are poorly suited to building site developments, sanitary facilities, and local roads and streets. Building sites need protection from wetness. Protection can be provided by draining these soils and covering them with several feet of fill. Septic tank absorption fields function poorly in these soils because of the seasonal high water table. These soils have low strength. Roads need to be constructed with a more suitable base material and protected from wetness by drainage.

These soils are in capability subclass IIw.

885B—Swanlake-Salida complex, 2 to 6 percent slopes. This map unit consists of undulating, well drained and excessively drained soils on knolls, hilltops, and side slopes. Individual areas are elongated to irregular and range from 5 to 30 acres. They are 40 to 50 percent Swanlake soils and 30 to 40 percent Salida soils. The Swanlake and Salida soils are on convex surfaces. The Salida soils commonly are on the tops of knolls and on hilltops. These soils are so intricately mixed that it is not practical to separate them in mapping.

Typically, the Swanlake soils have a very dark brown surface layer, about 9 inches thick. The underlying material, to a depth of about 60 inches, is light olive brown loam. These soils are calcareous throughout.

Typically, the Salida soils have a very dark gray, gravelly sandy loam surface layer about 7 inches thick. The subsoil is dark yellowish brown, very friable, gravelly loamy coarse sand about 10 inches thick. The underlying material, to a depth of about 60 inches, is dark yellowish brown, very gravelly coarse sand.

Included with these soils in mapping are small areas of well drained Storden and Clarion soils, well drained Estherville soils, and poorly drained Webster and Delft soils. Storden soils have steeper convex slopes. Clarion soils have slightly convex slopes. Estherville soils are on flat hilltops. Webster and Delft soils are on toe slopes and draws. Also included are small areas of gravel pits and poorly drained to very poorly drained soils in depressions. These included soils make up 10 to 30 percent of the unit.

Water and air move through the Swanlake soils at a moderate rate. Surface runoff is medium. Available water capacity is high. Reaction is mildly alkaline in the surface layer. The content of organic matter is moderate, of phosphorus is low, and of potassium is medium.

Water and air move through the Salida soils at a very rapid rate. Surface runoff is slow. Available water capacity is very low. Reaction is slightly acid to moderately alkaline in the surface layer. The content of organic matter, phosphorus, and potassium is low.

Most areas of these soils are farmed. They have fair to poor potential for cultivated crops, hay, pasture, small grain, and trees. The potential for engineering uses differs with the soil or the specific use.

These soils are used for corn, soybeans, small grain, and forage grasses, and legumes. Maintenance of soil fertility and increasing the soil moisture supply are needed to keep these soils suitable for these crops. Organic matter content and soil tilth can be maintained by applying manure, by returning crop residue to the soil, and by using a crop rotation program that includes forage grasses and legumes. Mulch tillage and minimum tillage conserve moisture and reduce soil blowing and water erosion.

The Swanlake soils are better suited to trees and shrubs than Salida soils. Tree and shrub seedlings need to be watered and competing vegetation controlled in order to obtain the best survival and growth rate.

The soils in this unit are suited to building site developments and septic tank absorption fields, but in the Salida soils there is a hazard of contamination of underground water because of rapid percolation of effluent through the gravelly material. Salida soils are a good source of roadfill. The underlying material from the Swanlake soils is suitable for use as subgrade material, but material with more strength and less susceptibility to frost action, such as the Salida soils, is preferred for the base of the roadway. Because of the variability of materials, onsite investigations and soil borings are needed before suitability for a specific use can be determined.

This complex is in capability subclass IIIe.

885C—Swanlake-Salida complex, 6 to 12 percent slopes. This map unit consists of rolling, well drained and excessively drained soils on knolls, hilltops, and side slopes. Slopes are 100 to 200 feet long. Individual areas are elongated to irregular and range from 5 to 40 acres. They are 40 to 50 percent Swanlake soils and 30 to 40 percent Salida soils. The Swanlake and Salida soils are on convex surfaces. The Salida soils commonly are on higher positions on the landscape on the tops of knolls and on hilltops. These soils are so intricately mixed that it is not practical to separate them in mapping.

Typically, the Swanlake soils have a very dark brown loam surface layer about 8 inches thick. The underlying material to a depth of about 60 inches is light olive brown loam. This soil is calcareous throughout.

Typically, the Salida soils have a very dark gray, gravelly sandy loam surface layer about 7 inches thick. The subsoil is dark yellowish brown, loose, gravelly loamy coarse sand about 8 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown, gravelly coarse sand.

Included with these soils in mapping are small areas of Clarion and Estherville soils, moderately well drained Terril soils, and poorly drained Webster and Delft soils. Clarion soils are less sloping and have less lime. Estherville soils are on flat hilltops. Terril soils are on foot slopes. Webster and Delft soils are on toe slopes and in draws. Also included are small areas of gravel pits and poorly drained to very poorly drained soils in depressions. The included soils make up 10 to 25 percent of the unit.

Water and air move through the Swanlake soils at a moderate rate. Surface runoff is medium. Available water capacity is high. Reaction is mildly alkaline in the surface soil. The content of organic matter is moderate, of phosphorus low, and of potassium is medium.

Water and air move through the Salida soils at a very rapid rate. Surface runoff is slow. Available water capacity is very low. Reaction is slightly acid to moderately alkaline in the surface soil. The content of organic matter is low, of phosphorus is low, and of potassium is low.

Most areas of these soils are farmed. They have fair to poor potential for cultivated crops, hay, pasture, small grain, and trees. Potential for engineering uses depends upon the soil or the specific use.

Small grain and hay are better suited to these soils. The hazard of erosion is severe. The hazard of drought is severe on the Salida soils. The main management needs are controlling erosion, conserving water, and improving fertility. Spring plowing, the heavy application of manure, and returning all crop residue to the soil are included in the management of these soils. Terraces generally are not built on these soils because areas of the Salida soils are shallow over gravelly sand. Waterways need to be maintained, and some need to be reestablished. Wherever gravelly sand has been exposed by erosion in waterways, a layer of soil needs to be replaced to help the grass grow.

Swanlake soils are better suited to growing trees than Salida soils. Windbreaks planted in areas of Salida soils are likely to have a severe mortality rate if drought occurs while the trees and shrubs are becoming established. This limitation can be partly overcome by providing special care in site preparation, planting, and weed control. Erosion and soil blowing can be controlled by maintaining a cover of crop residue. In addition, windbreaks can be planted on the contour in some places. Weeds and grasses can be controlled at the site of the newly established windbreaks by using shallow cultivation or approved herbicides. If the site for the windbreaks is in sod, plow and disc the preceding summer or fall to increase moisture and kill vegetation.

Because of the variability of the soils in this unit, onsite investigations and soil borings need to be made to determine the suitability of the soils for special engineering uses. Salida soils are a good source of roadfill. Small gravel pits are present in some areas. Roadfill material from areas of Swanlake soils is suitable for subgrades, but material having more strength and less susceptibility to frost action is preferred in the base of roads. Except for problems in construction because of slope, these soils are suitable for septic tank absorption fields. Some areas of Salida soils have a hazard of contamination of underground water because of rapid percolation through gravelly material. Areas of Salida soils are well suited to dwellings and local roads and streets. Areas of Swanlake soils are also suitable for dwelling sites if the hazards of slope and erosion are overcome.

This complex is in capability subclass IVe.

886—Nicollet-Crippin clay loams. This map unit consists of very gently sloping, moderately well drained to somewhat poorly drained soils on low rises. Individual areas are circular to irregular and range from 5 to 40 acres. They are 50 to 60 percent Nicollet soils and 30 to 40 percent Crippin soils. The Nicollet and Crippin soils are in similar plane or slightly convex positions on the landscape. These soils are so intricately mixed that it is not practical to separate them in mapping.

Typically, the Nicollet soils have a black clay loam surface soil about 16 inches thick. The subsoil is about 21 inches thick. The upper part is dark grayish brown, mottled, friable clay loam. The lower part is grayish brown, mottled, friable loam. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous loam.

Typically, the Crippin soils have a black clay loam surface soil about 17 inches thick. The subsoil is about 14 inches thick. The upper part is very dark grayish brown, friable, calcareous clay loam. The lower part is olive brown, mottled, friable, calcareous loam. The underlying material to a depth of about 60 inches is olive brown and light olive brown, mottled, calcareous loam.

Included with these soils in mapping are small areas of poorly drained Webster soils; poorly drained, calcareous Jeffers soils; and very poorly drained Glencoe soils. Webster soils are in swales. Jeffers soils are on rims of depressions. Glencoe soils are in depressions. The included soils make up 10 to 20 percent of the unit.

Water and air move through these soils at a moderate rate. Surface runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 2.5 to 5 feet in the Nicollet soils and at a depth of 2 to 4 feet in the Crippin soils. Reaction is medium acid to neutral in the surface soil of the Nicollet soils and neutral to moderately alkaline in the Crippin soils. The content of organic matter is high, of phosphorus is low, and of potassium is medium or high.

Most areas of these soils are farmed. They have good potential for cultivated crops, hay, pasture, small grain, and trees. They have poor to fair potential for most engineering uses.

These soils are mostly used for corn, soybeans, small grain, and forage grasses and legumes. They have few limitations that restrict their use, therefore, they can be cropped intensively. Soil tilth can be maintained by returning crop residue to the soil or by using a crop rotation program that includes forage grasses and legumes.

Most native trees and shrubs used for windbreaks grow well. Competing vegetation needs to be controlled for the best survival and growth rate of trees and shrubs.

These soils are suited to building site developments but have limitations for sanitary facilities and local roads and streets. Building sites on these soils need protection from damage by wetness. Basements can be protected from damage by placing drainage tile around footings. Foundations, footings, and floors of buildings can be protected by building them on a base of coarse material. Septic tank absorption fields function poorly in these soils because of seasonal wetness. These soils have low strength. Roads need to be constructed with more suitable base material and protected from wetness by drainage.

These soils are in capability class I.

887B—Clarion-Swanlake loams, 3 to 6 percent slopes. This map unit consists of undulating, well drained soils on knolls, hilltops, and side slopes. These soils have convex and complex slopes that are 100 to 300 feet long. Individual areas are elongated to oblong and range from 5 to 30 acres. They are 55 to 60 percent Clarion loam and 25 to 35 percent Swanlake loam. The Clarion soil is on plane to slightly convex slopes. The Swanlake soil is on strongly convex slopes. These soils are so intricately mixed that it is not practical to separate them in mapping.

Typically, the Clarion soil has a black loam surface soil about 14 inches thick. The subsoil is about 29 inches thick. The upper part is dark brown, very friable loam. The middle part is brown, friable loam. The lower part is yellowish brown, friable loam. The underlying material to a depth of about 60 inches is light olive brown and olive brown, calcareous loam.

Typically, the Swanlake soil has a very dark brown loam surface layer about 9 inches thick. The underlying material to a depth of about 60 inches is light olive brown loam. This soil is calcareous throughout.

Included with these soils in mapping are small areas of moderately well drained to somewhat poorly drained Nicollet soils and poorly drained Webster and Delft soils. Nicollet soils are on flats. Webster and Delft soils are in draws and on toe slopes. Also included are small areas of well drained soils that have a sandy surface soil or have stratified fine sand and silt loam in the underlying material. The included soils make up 10 to 20 percent of the unit.

Water and air move through these soils at a moderate rate. Surface runoff is medium. Available water capacity is high. Reaction is slightly acid or neutral in the surface of the Clarion soil and is mildly alkaline in the Swanlake soil. The content of organic matter is moderate or high, of phosphorus is low, and of potassium is high.

Most areas of these soils are farmed. They have good potential for cultivated crops, hay, pasture, small grain, and trees. They have good potential for most engineering uses.

These soils are used for corn, soybeans, small grain, and forage grasses and legumes. Erosion control and maintenance of soil fertility is needed. Organic matter content and tilth can be maintained by returning crop residue to the soil, by using a crop rotation program that includes forage grasses and legumes, and by applying manure. Mulch tillage and minimum tillage practices conserve moisture and reduce soil blowing and water erosion.

Windbreaks can be established in these soils, and most native trees and shrubs used for windbreaks grow well. Control of competing vegetation is needed in order to obtain the best survivial and growth rate of trees and shrubs.

These soils are well suited to building site developments and sanitary facilities but have some limitations for local roads and streets. Septic tank absorption fields function well in these soils. Local roads and streets need good drainage to reduce the effects of frost action. The soils in this unit are a fair source of road construction material, however, material with more strength is preferred in the base.

These soils are in capability subclass IIe.

887C—Clarion-Swanlake loams, 6 to 12 percent slopes. This map unit consists of rolling, well drained soils on knolls, hilltops, and side slopes. Slopes are convex, complex, and 100 to 200 feet long. Individual areas are elongated to oblong and range from 5 to 50 acres. They are 55 to 65 percent Clarion soil and 25 to 35 percent Swanlake soil. The Clarion soil has plane to slightly convex slopes. The Swanlake soil is more strongly sloping, and slopes are convex. These soils are so intricately mixed that it is not practical to separate them in mapping (fig. 6).

Typically, the Clarion soil has a black loam surface soil about 11 inches thick. The subsoil is about 24 inches thick. The upper part is dark brown, very friable loam. The middle part is brown, friable loam. The lower part is yellowish brown, friable loam. The underlying material to a depth of about 60 inches is light olive brown and olive brown, calcareous loam. Some areas have a thin lacustrine mantle over till.

Typically, the Swanlake soil has a very dark brown loam surface layer about 8 inches thick. The underlying material to a depth of about 60 inches is light olive brown loam. This soil is calcareous throughout.

Included with this soil in mapping are small areas of moderately well drained to somewhat poorly drained Nicollet soils, poorly drained Webster and Delft soils, and well drained Storden soils. Nicollet soils are on flats. Webster and Delft soils are in draws and on toe slopes. Storden soils are on steeper, more convex side slopes. Also included are small areas of well drained soils that have a sandy loam surface soil, or have stratified fine sand and silt loam in the underlying material. The included soils make up 10 to 20 percent of the unit.

Water and air move through these soils at a moderate rate. Surface runoff is rapid. Available water capacity is high. Reaction is slightly acid or neutral in the surface of the Clarion soil and is mildly alkaline in the Swanlake soil. The content of organic matter is moderate or high, of phosphorus is low, and of potassium is medium or high.

Most areas of these soils are farmed. They have good to fair potential for cultivated crops, hay, pasture, small grain, and trees. They have fair potential for most engineering uses.

These soils are mostly used for corn, soybeans, small grain, and forage grasses and legumes. Maintenance of soil fertility and organic matter content, controlling erosion, and increasing the moisture supply are needed. Organic matter content can be maintained by applying manure, returning crop residue to the soil, and by using a crop rotation program that includes forage grasses and legumes. Mulch tillage practices increase and conserve the moisture supply in these soils and decrease soil blowing and water erosion. These practices are most effective on soils that are on the contour.

These soils are suited to trees and shrubs that are used for windbreaks. Trees and shrubs planted in areas of the Swanlake soil have a higher mortality rate and slower growth because of low fertility and excessive lime. Erosion can be controlled by planting on the contour or by maintaining a mulch of crop residue. Weeds and grasses can be controlled at the site of newly established windbreaks by using shallow cultivation or approved herbicides. If the site for windbreaks is in sod, plow and disc the preceding summer or fall to increase moisture and kill competing vegetation.

These soils are fairly suited to building sites, sanitary facilities, and roads. Where building sites are located on less sloping foot slopes or the more gentle ridgetops, the hazard of erosion is easier to control. Erosion can be controlled on shoulders and side slopes or roads by seeding, mulching, and sodding. Slope is a problem for septic tank absorption fields because of the hazard of lateral seepage. The hazard of frost heave and shrink-swell on roads can be partly overcome by providing good surface drainage and by using materials in the base that are less subject to frost action.

These soils are in capability subclass IIIe.

961D—Storden-Salida complex, 12 to 25 percent slopes. This map unit consists of hilly to steep, well drained and excessively drained soils on knolls, hilltops, and side slopes. Slopes are 100 to 300 feet long. Individual areas are elongated to irregular and range from 5 to 20 acres. About 40 to 50 percent of this unit is Storden loam, and 30 to 40 percent is Salida gravelly sandy loam. These soils are on convex surfaces. The Salida soil is commonly on the tops of the knolls and hilltops. They are so intricately mixed that it is not practical to separate them in mapping.

Typically, the Storden soil has a dark grayish brown loam surface layer about 7 inches thick. The underlying material to a depth of about 60 inches is grayish brown and brown loam. This soil is calcareous throughout.

Typically, the Salida soil has a very dark gray, gravelly sandy loam surface layer about 7 inches thick. The subsoil is dark yellowish brown, loose, gravelly loamy coarse sand about 8 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown, loose, very gravelly coarse sand. This soil is calcareous throughout.

Included with these soils in mapping are small areas of well drained Swanlake, Clarion, and Estherville soils, moderately well drained Terril soils, and poorly drained Webster and Delft soils. Swanlake and Clarion soils are on convex side slopes. Estherville soils are on flat hilltops. Terril soils are on foot slopes. Webster and Delft soils are on toe slopes and in draws. Also included are small gravel pits and small areas of poorly drained to very poorly drained soils in depressions. The included soils make up 5 to 10 percent of the unit.

Water and air move through the Storden soil at a moderate rate. Surface runoff is rapid. Available water capacity is high. Reaction is mildly alkaline or moderately alkaline in the surface soil. The content of organic matter and phosphorus is low, and the content of potassium is medium.

Water and air move through the Salida soil at a very rapid rate. Surface runoff is medium. Available water capacity is very low. Reaction is slightly acid to moderately alkaline in the surface soil. The content of organic matter, phosphorus, and potassium is low.

Most areas of these soils are in grass. These soils have poor potential for cultivated crops, hay, small grain, and trees and fair potential for pasture. They have poor potential for most engineering uses.

These soils are mostly used for pasture. Pasture yields can be improved by deferred, limited, and rotational grazing. These practices reestablish a balance between cool- and warm-season grasses. Fertilization and brush and weed control also improve pasture yields.

Trees and shrubs used for windbreaks can be established in these soils. Machine planting is limited by the steepness of the slopes. Most native trees and shrubs grow well but need to be protected from damage by livestock. Tree and shrub seedlings need to be watered and competing vegetation controlled in order to obtain the best survival and growth rate.

These soils are poorly suited to building sites, sanitary facilities, and roads because of slope. Septic tank absorption fields have a hazard of lateral seepage because of slope. The Swanlake soil is a fair source of road construction material. The Salida soil is a fair to good source of gravel and road construction material.

This complex is in capability subclass VIe.

1029—Pits, gravel. This map unit consists of open pits that have been excavated by removal of sand and gravel. Individual areas are irregular, 10 to 100 feet deep, and range from 3 to 80 acres. Most of the large pits are in areas of Estherville soils and most of the small pits are in areas of Salida soils.

Typically, the soils from these areas have been removed or altered. Piles of rocks and boulders are in some pits. They have open water in places that are below the water table or are underlain by relatively impervious material. Included with open pits are adjoining areas of soils that have been altered by partial removal, by mixing, or by adding stockpiled material from the pit.

Most pits are used as a source of sand, gravel, and topsoil. They are a fair to good source of these materials. Some pits have been abandoned and naturally revegetated with grass and a few trees. They are used for pasture or left idle. A few gravel pits have been leveled. They have fair to poor potential for crops and pasture. Gravel pits require onsite investigation to determine suitability for most uses.

This map unit was not placed in a capability subclass.

1053—Aquolls and Aquents, ponded. These nearly level, very poorly drained soils are in ponds, marshes, and shallow areas of lakes. They are covered by 1 to 3 feet of water except during extended dry periods. Individual areas are irregular to circular and range from 3 to several hundred acres.

Most of these soils have a dark colored surface soil that is more than 24 inches thick. Texture ranges from fine to moderately coarse, and these soils are underlain by similar material.

Included with these soils in mapping are large areas of artificially ponded soils that are upstream from the dam on the Des Moines River at Talcot Lake. These soils are similar to the poorly drained Biscay and Mayer soils. A few small islands of better drained soils are also included.

Most areas of this unit are vegetated by reeds and used for wetland wildlife habitat (fig. 8). A few areas have been excavated to form livestock watering pits.

These soils are in capability subclass VIIIw.

1833—Coland clay loam, occasionally flooded. This nearly level, poorly drained soil is on river bottom lands. Areas of this soil occasionally flood after snowmelt in spring or after heavy rains. Individual areas are linear and range from 30 to several hundred acres.

Typically, the surface soil is black clay loam about 42 inches thick. The underlying material to a depth of about 60 inches is very dark gray and olive gray, mottled clay loam. The surface soil is thicker in swales and thinner on flats.

Included with this soil in mapping are small areas of poorly drained, calcareous Millington soils and moderately well drained to somewhat poorly drained Spillville soils. Millington soils are on slight rises, and Spillville soils are on low rises and on toe slopes along sidewalls of river valleys. Also included are small areas of poorly drained soils that have a muck surface soil, have thick seams of coarse material, or formed in clayey material. The included soils make up 10 to 20 percent of the unit.

Water and air move through this soil at a moderately slow rate. Surface runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 1 to 3 feet. Reaction is slightly acid or neutral in the surface soil. The content of organic matter and potassium is high, and the content of phosphorus is medium to low.

Most areas of this soil are farmed or used for pasture. This soil has good potential for cultivated crops; fair potential for hay, pasture, and small grain; and poor potential for trees. It has poor potential for most engineering uses.

This soil is mostly used for corn, soybeans, small grain, and pasture. Drainage and maintenance of soil tilth and fertility are necessary to make and keep this soil suitable for cultivated crops. Natural drainage is generally adequate, but some areas are artificially drained by drainage tile and ditches or waterways. Deep tillage helps to aerate this soil and maintain its tilth. Fall plowing helps to reduce the drying and warming time in spring.

Pasture can be improved by deferred, limited, and rotational grazing. These practices increase pasture yields by reestablishing a balance between cool- and warm-season grasses. Fertilization and brush and weed control also increase pasture yields.

The choice of trees and shrubs used for windbreaks is limited to species or varieties that are tolerant of occasional flooding and wetness. Competing vegetation needs to be controlled in order to obtain the best survival and growth rate of trees and shrubs. Trees and shrubs establish naturally on levees.

This soil is poorly suited to building sites, sanitary facilities, and roads. This soil has a hazard of occasional flooding. Building sites need protection from flooding and wetness. Diking, draining, and covering this soil with several feet of fill provide limited protection from floods. Septic tank absorption fields function poorly in this soil because of flooding and the high seasonal water table. Roads need to be constructed with more suitable base material and protected from flooding and wetness by drainage.

This soil is in capability subclass IIw.

1834—Coland clay loam, frequently flooded. This nearly level, poorly drained soil is in swales on river bottom land. Areas of this soil frequently flood after snowmelt in spring and after heavy rains. Individual areas are linear and range from 15 to several hundred acres.

Typically, the black clay loam surface soil is about 42 inches thick. It is thicker in depressions and thinner on flats. The underlying material to a depth of about 60 inches is very dark gray and olive gray, mottled clay loam.

Included with this soil in mapping are small areas of poorly drained, calcareous Millington soils and moderately well drained to somewhat poorly drained Spillville soils. Millington soils are on slight rises, and Spillville soils are on low rises and on toe slopes along sidewalls of river valleys. Also included are small areas of poorly drained and very poorly drained soils that have a muck surface soil, have thick seams of coarse material, or formed in clayey material. The included soils make up 10 to 20 percent of the unit.

Water and air move through this soil at a moderately slow rate. Surface runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 1 to 3 feet. Reaction is slightly acid or neutral in the surface soil. The content of organic matter and potassium is high, and the content of phosphorus is medium to low.

Most areas of this soil are used for pasture. This soil has poor potential for cultivated crops; fair potential for hay, pasture, and small grain; and poor potential for trees. It has poor potential for most engineering uses.

Most areas of this soil are not suitable for crops because they flood too often or are dissected by too many streams or by old meanders. They are well suited to range. Most areas have been overgrazed, and native grass species have declined in vigor and decreased in abundance. They have been replaced by a less productive grass, mainly Kentucky bluegrass and an overstory of weeds, such as gumweed and goldenrod. Proper stocking rates, uniform distribution of grazing, timely deferment of grazing, and a planned grazing system help to improve the range and keep it in good condition. Potential dugout pond sites are plentiful. If the stream channels are improved, many areas can be suitable for crops. These improved areas are suited to the crops and practices used on occasionally flooded Coland soils.

Most areas of this soil are very poorly suited to trees and shrubs because of frequent flooding. On improved areas of this soil, however, treatment needs and the species of trees are the same as those used on the occasionally flooded Coland soils.

Because this soil has a severe hazard of flooding and wetness in some places, it is poorly suited to dwellings, septic tank absorption fields, and most other engineering uses. Local roads constructed across areas of this soil need onsite investigation to determine the extent of flooding and to plan proper design.

This soil is in capability subclass Vw.

1835B—Germantown clay loam, 1 to 6 percent slopes. This nearly level to gently sloping, well drained soil is on low, convex ridges and knolls. Individual areas are irregular and range from 5 to 100 acres.

Typically, the surface soil is about 14 inches thick. The upper part is very dark brown clay loam. The lower part is very dark gray clay loam. The subsoil is about 13 inches thick. The upper part is olive brown, friable clay loam. The lower part is olive brown, friable calcareous loam. The underlying material to a depth of about 36 inches is olive brown, firm, calcareous loam. Bedrock composed of pinkish red, hard Sioux Quartzite is below the underlying material. Depth to lime and bedrock is shallower in more convex areas and deeper in less convex areas.

Included with this soil in mapping are small areas of moderately well drained and somewhat poorly drained Wilmonton soils and well drained Everly and Storden soils. Wilmonton soils are on slightly concave flats. Everly soils are on slightly convex flats. Storden soils are on convex side slopes. Also included are small areas of bedrock outcrops surrounded by a soil that is shallow to bedrock, well drained, and dark colored. The included soils make up 10 to 20 percent of the unit.

Water and air move through this soil at a moderately slow rate. Surface runoff is medium. Available water capacity is moderate. Reaction is medium acid or slightly acid in the surface soil. The content of organic matter is moderate, of phosphorus is low, and of potassium is medium to high.

Most areas of this soil are farmed or used for pasture. This soil has fair potential for cultivated crops; fair to good potential for small grain, hay, and pasture; and fair potential for trees. It has poor potential for most engineering uses.

This soil is mostly used for corn, soybeans, pasture, small grain, and forage grasses and legumes. Erosion control, increased soil moisture supply, and maintenance of fertility are needed. Mulch tillage and other minimum tillage practices conserve moisture and control erosion. Lime is needed in some areas to establish forage legumes and to obtain good yields. Applying manure, returning crop residue to the soil, and using a crop rotation program that includes forage grasses and legumes maintain soil tilth.

Pasture can be improved by deferred, limited, and rotational grazing. These practices increase pasture yields by reestablishing a balance between cool- and warm-season grasses. Fertilization and brush and weed control also improve pasture yields.

Windbreaks can be established in this soil. Most native trees and shrubs can grow in this soil, but their growth rate varies with the depth to bedrock. Competing vegetation needs to be controlled in order to obtain best survival and growth rate of trees and shrubs.

This soil has some limitations for most engineering uses because of depth to bedrock. Its suitability for building site developments needs to be determined by onsite investigation because some more favorable soils are included in this map unit. Basements are difficult to build because the underlying rock is very hard and non-rippable. Onsite investigations are needed in order to find suitable sites that have enough cover to install septic tank absorption fields. This soil is a poor source of road construction material.

This soil is in capability subclass IIe.

1836B—Germantown-Rock outcrop complex, 2 to 6 percent slopes. This map unit consists of gently sloping, well drained soils and rock outcrops on hilltops, side slopes, and dells. It contains 40 to 50 percent Germantown clay loam and 30 to 40 percent rock outcrops. The soil and Rock outcrop are so intricately mixed that it is not practical to separate them in mapping.

Typically, the Germantown soil has a surface soil about 14 inches thick. The upper part is very dark brown, clay loam. The lower part is very dark gray clay loam. The subsoil is about 13 inches thick. The upper part is olive brown, friable clay loam. The lower part is olive brown, friable, calcareous loam. The underlying material to a depth of about 36 inches is olive brown, firm, calcareous loam. Below this is pinkish red, hard, quartzite bedrock.

Typically, rock outcrops are on narrow, angular ridges; slightly convex, smooth areas on hilltops and side slopes; and in dells. Ridges of bedrock are about 10 to 100 feet wide, several hundred feet long, and generally on southeast- and south-facing slopes. Smooth areas of bedrock are about 10 to 100 feet long, are oblong, and on north- and east-facing slopes. Dells are along rivers and drainageways.

Included with this complex in mapping are small areas of other soils. They are poorly drained Webster Variant soils in drainageways and well drained Everly soils on isolated, slightly convex areas. Also included are small areas of a shallow, well drained, black loam soil that surrounds and is intermingled with rock outcrops. The included soils make up 15 percent of the unit.

Water and air move through the Germantown soil at a moderately slow rate. Surface runoff is medium, and available water capacity is moderate. Reaction is medium acid or slightly acid in the surface soil. The content of organic matter is moderate, of phosphorus is low, and of potassium is medium to high. The rock outcrops are very hard and impervious.

Most areas of this complex are in pasture. This complex has poor potential for cultivated crops and trees and poor to fair potential for hay and pasture. It has poor potential for most engineering uses.

This soil is mostly used for pasture. Pasture can be improved by deferred, limited, and rotational grazing. These practices increase pasture yields by reestablishing a balance between cool- and warm-season grasses. Fertilization and brush and weed control also increase pasture yields.

Most native trees and shrubs grow in the Germantown soil, but their growth rate varies with the depth to bedrock. Competing vegetation needs to be controlled in order to obtain the best growth rate of trees and shrubs.

The soil in this complex is poorly suited to building sites, sanitary facilites, and ponds. Its suitability as a building site needs to be determined by onsite investigation because some deeper, more favorable soils are included in this map unit. Basements are difficult to build because the underlying rock is very hard and non-rippable. Septic tank absorption fields function poorly in this complex because of bedrock. This soil is a poor source of road construction material because it is thin.

This complex is in capability subclass VIe.

1837—Webster Variant clay loam. This nearly level, poorly drained soil is in narrow drainageways. Individual areas are linear and range from 5 to 15 acres.

Typically, the surface layer is black, clay loam about 9 inches thick. The subsoil is about 10 inches thick. The upper part is very dark grayish brown, mottled, friable clay loam. The lower part is olive gray, mottled, friable clay loam. The underlying material is pinkish red, hard, quartzite bedrock. Roots form a mat over the bedrock in many places.

Included with this soil in mapping are small areas of bedrock on bottoms and sidewalls of drainageways. Also included are small areas of poorly drained soils that have bedrock at a depth of 20 to 40 inches. The included soils make up 10 to 20 percent of the unit.

Water and air move through this soil at a moderate rate. Surface runoff is slow. Available water capacity is low. This soil is seasonally saturated with water, and a seasonal high water table is at a depth of 0.5 foot to 1.5 feet. Reaction is medium acid or slightly acid in the surface soil. The content of organic matter is high, of phosphorus is low, and of potassium is medium.

Most areas of this soil are in pasture. This soil is poorly suited to cultivated crops, hay, pasture, small grain, and trees. It is poorly suited to most engineering uses.

Farm uses of this soil are mostly for production of pasture. Pasture can be improved by deferred, limited, and rotational grazing. These practices increase pasture yields by reestablishing a balance between cool- and warm-season grasses. Fertilization and brush and weed control also increase pasture yields.

Windbreaks of trees and shrubs are difficult to establish in this soil. The choice of species and varieties is limited to those that are tolerant of shallow soils and wetness. This soil needs to be covered by several feet of fill and competing vegetation needs to be controlled in order to obtain the best survival and growth rate of trees and shrubs.

This soil is poorly suited to building sites, sanitary facilities, and roads. It is poorly suited to building sites because it is shallow to bedrock and is wet. It is a poor source of road construction material because it has a thin layer that is wet and has low strength.

This soil is in capability subclass Vw.

Use and management of the soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area—the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic tank disposal systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for crops and pasture, and woodland, as sites for buildings, highways and other transportation systems, sanitary facilities, and parks and other recreation facilities, and for wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

Crops and pasture

Gregory L. Brown, district conservationist, Soil Conservation Service, assisted in writing this section.

The major management concerns in the use of the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited to the soil, including some not commonly grown in the survey area, are discussed; 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 presented for each soil.

This section provides information about the overall agricultural potential of the survey area and about the management practices that are needed. The information is useful to equipment dealers, land improvement contractors, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management is presented in the section "Soil maps for detailed planning." Planners of management systems for individual fields or farms should also consider the detailed information given in the description of each soil.

More than 357,101 acres in the county were used for crops and pasture in 1967 according to the Minnesota Soil and Water Conservation Needs Inventory. Of this total, 257,055 acres was used for row crops, mainly corn and soybeans; 20,000 acres for close-grown crops, mainly oats, flax, and wheat; 24,589 acres for rotation of hay and pasture; and 16,048 acres for permanent pasture. The rest was idle cropland.

Potential of the soils in Cottonwood County for increased production of food is good. About 6,299 acres of potentially good cropland is currently used as pasture. In addition to the reserve productive capacity represented by this land, food production could also be increased considerably by extending the latest crop production technology to all cropland in the county and by expanding irrigation. This soil survey can greatly facilitate the application of such technology.

Erosion is a major problem on about 10 percent of the cropland in Cottonwood County. It is a hazard on the undulating and steeper soils. Clarion, Storden, and Swanlake soils are examples. Loss of the surface layer through erosion is damaging because productivity is reduced as the surface layer is reduced, and part of the subsoil is incorporated into the plow layer. Erosion is especially damaging on soils that have a limited available water capacity, such as Estherville soils.

Erosion control practices provide protective surface cover, reduce runoff, and increase infiltration. A cropping system that keeps vegetative cover on the soil for extended periods can hold soil erosion losses to amounts that will not reduce the productive capacity of the soil. On livestock farms, which require pasture and hay, the legume and grass forage crops in the cropping system reduce erosion on sloping land and also provide nitrogen and improve tilth for the following crop.

Slopes are so short and irregular that contour tillage or terracing is difficult in most areas of Clarion, Storden, and Swanlake soils. In some areas of these soils, cut and fill terraces can be used. In most areas of these soils, cropping systems that provide substantial vegetative cover are needed to control erosion unless minimum tillage is practiced. Minimizing tillage and leaving crop residue on the surface help to increase infiltration and reduce the hazards of runoff and erosion. These practices can be adapted to most soils in the survey area. Contouring and contour stripcropping are other erosion control practices used in the survey area. They are best adapted to soils that have regular slopes.

Soil blowing is a hazard on the Dickman and Estherville soils (fig. 7). It can damage these soils in a few hours if the winds are strong and the soils are dry and bare of vegetation or surface mulch. Maintaining vegetative cover, surface mulch, or rough surfaces through proper tillage minimizes soil blowing. All of the soils in the county can be damaged by soil blowing, especially after soybeans have been grown. Windbreaks are effective in reducing soil blowing.

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

Soil drainage is the major management need on about 20 percent of the acreage used for crops in the county. The soils are too wet for crops, and drainage must be provided by ditches and tile drainage. Some soils are ponded so that crop production is not possible without drainage. These soils are the very poorly drained Blue Earth, Barbert, Glencoe, Lura, and Talcot soils. They make up about 29,450 acres.

The poorly drained soils have a high seasonal water table and crops can not be grown on them without damage during most years. They are the Biscay, Canisteo, Delft, Jeffers, Letri, Madelia, Marna, Mayer, Romnell, Rushmore, Spicer, and Webster soils. These soils make up 116,728 acres.

Small areas of somewhat poorly drained soils in drainageways and swales are commonly included in mapping with areas of better drained soils, such as the Crippin, Guckeen, Jeffers Variant, Linder, Nicollett, Ransom, and Spillville soils. Drainage is needed in some of these wetter areas.

The design for both surface and subsurface drainage systems varies with the kind of soil. A combination of both surface and subsurface drainage is needed in most areas of the poorly drained and very poorly drained soils that are used for intensive row crops. Tile drain lines need to be more closely spaced in the less permeable soils such as Barbert, Marna, Letri, and Romnell soils. Adequate tile drainage outlets are difficult to locate for Coland and Millington soils, which have a hazard of occasional to frequent flooding. Biscay, Mayer, and Talcot soils have a hazard of cutbanks caving.

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

Soil fertility is naturally medium or high in most soils in the county. Most of the soils are neutral or mildly alkaline in reaction. Barbert soils are acid in reaction.

Crops on most of the soils in the county respond to fertilizer. Fertility of the surface soil varies with past management. Fertility, as discussed in the description of the soils, refers to the subsoil. The soils are especially low in phosphorus. The need for fertilizer depends on the kind of soil, past and present management, and the kind of crop that is grown. Soil tests provide part of the information needed to choose the proper kinds and amounts of fertilizer.

Application of fertilizer and organic matter generally improve plant growth on some poorly drained and moderately well drained to somewhat poorly drained soils in which excess lime causes a fertility imbalance. These are the poorly drained Canisteo, Jeffers, Mayer, and Spicer soils; the very poorly drained Millington and Talcot soils; and moderately well drained to somewhat poorly drained Crippin and Moines soils.

Soil tilth is an important factor in germination of seeds and in the infiltration of water into the soils. Soils with good tilth are granular and porous. Regular additions of crop residue, manure, and other organic material can help to improve tilth and increase infiltration.

Fall plowing is generally not a good practice on the sandy soils because of the hazard of soil blowing. Sloping and steeper soils and soils on which soybeans have been grown may also need protection from soil blowing.

Most of the soils in the county are either wet or are intermingled with wet soils. Maintenance of tilth is a problem because the soils often stay wet late in the spring. If these soils are tilled when they are wet, they become cloddy. Good seedbeds are difficult to prepare in cloddy soils. Fall plowing generally results in good tilth in the spring.

Field crops suited to the soils and climate of the county include many that are not commonly grown. Corn and soybeans are the principal row crops. Grain sorghum, sunflowers, edible beans, sugar beets, and other crops can be grown if economic conditions are favorable.

Oats, wheat, and flax are the common close-grown crops. Rye, barley, and buckwheat are grown in smaller amounts. Grasses and legumes are produced for hay and pasture but could be grown for seed.

Special crops are vegetables, small fruits, tree fruits, nursery plants, and potatoes. They are mostly grown by home gardeners and in a few small commercial gardens. Some farms specialize in potato production, particularly on the Blue Earth soils. Most vegetables and fruit crops do well on soils that have good natural drainage, warm up early in the spring, and are protected by windbreaks. Supplemental water is needed.

Latest information and suggestions for growing special crops can be obtained from local offices of the Agricultural Extension Service and the Soil Conservation Service.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the crop is not suited to or not commonly grown on the soil.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes suited to the climate and the soil. A few farmers may be obtaining average yields higher than those shown in table 5.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; 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 residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

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

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Agricultural Extension Service can provide information about the management concerns and productivity of the soils for these crops.

Capability classes and subclasses

Capability classes and subclasses show, in a general way, the suitability of soils for most kinds of field crops. The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit. The capability class and subclass are defined in the following paragraphs. A survey area may not have soils of all classes.

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

Class I soils have few limitations that restrict their use.

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

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

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

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

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

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

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

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

The capability subclass is identified in the description of each soil mapping unit in the section "Soil maps for detailed planning."

Windbreaks and environmental plantings

Windbreaks are established to protect livestock, buildings, and yards from wind and snow. Windbreaks also help protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broad-leaved and coniferous species 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 depending on erodibility of the soil. They protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

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

Table 6 shows the height that locally grown trees and shrubs are expected to reach on various kinds of soil in 20 years. The estimates in table 6, based on measurements and observation of established plantings that have been given adequate care, can be used as a guide in planning windbreaks and screens. Additional information about planning windbreaks and screens and the planting and care of trees can be obtained from local offices of the Soil Conservation Service or the Agricultural Extension Service or from nurserymen.

Engineering

Clarence P. Simonsen, Engineer, Soil Conservation Service, helped to prepare this section.

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational uses; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 7 shows, for each kind of soil, the degree and kind of limitations for building site development; table 8, for sanitary facilities; and table 10, for water management. Table 9 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

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

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 7. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 7 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and streets referred to in table 7 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 8 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight*, soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate*, soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good*, *fair*, or *poor*, which, respectively, mean about the same as the terms *slight*, *moderate*, and *severe*.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold 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. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation, because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 8 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 9 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 13 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 9 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, and stratification are given in the soil series descriptions and in table 13.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can limit or prevent plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils and very firm clayey soils; soils with suitable layers less than 8 inches thick; soils having large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 10 site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks; susceptibility to flooding; salinity and alkalinity; and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Recreation

Dennis L. Radi, district aide, Walking Water Soil and Water Conservation District, assisted in writing this section.

The major recreational areas are the county parks. Red Rock Park is in the northeastern part of the county. Dutch Charley and Highwater Creek Parks are north of Storden. A state historic site, the Petroglyphs, is east of Jeffers. Each town and city has at least one park, and small picnic areas are located throughout the county. Picnic areas are located at most of the 30 lakes in the county. Water sports are permitted in all lakes except Talcot Lake, which is managed as a wildlife refuge. Hunting is permitted along the boundary of Talcot Lake and at most other lakes in the county. Many areas of state and federally owned land are opened to hunting and other recreation.

The soils of the survey area are rated in table 11 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

The degree of the limitation of the soils is expressed as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the 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 11 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 8, and interpretations for dwellings without basements and for local roads and streets, given in table 7.

Camp areas require such site preparation as shaping and leveling for 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 for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as 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 will 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 or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over bedrock should be enough to allow necessary grading.

Paths and trails for walking, horseback riding, bicycling, and other uses should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the annual period of use. They should have moderate slopes and have 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 should have a surface that is free of stones and boulders and have moderate slopes. Suitability of the soil for traps, tees, or greens was not considered in rating the soils. Irrigation is an assumed management practice.

Wildlife habitat

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, is inadequate, or is inaccessible, wildlife either are scarce or do not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by helping the natural establishment of desirable plants.

In table 12, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and 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* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

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

Grain and seed crops are seed-producing annuals used by wildlife. The major soil properties 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 that are planted for wildlife food and cover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bluegrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Major soil properties 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 the associated woody understory provide cover for wildlife and produce nuts or other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of native plants are oak, cottonwood, choke cherry, ash, wild plum, hawthorn, maple, basswood and raspberry. Examples of fruit-producing shrubs that are commercially available and suitable for planting on soils rated *good* are Russian-olive, honeysuckle, and crabapple.

Coniferous plants are cone-bearing trees, shrubs, or ground cover plants that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. Soil properties that have a major effect on the growth of coniferous plants 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, exclusive of submerged or floating aquatics (fig. 8). They produce food or cover for wildlife that use wetland as habitat. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, and cordgrass and rushes, sedges, and reeds.

Shallow water areas are bodies of water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control structures in marshes or streams. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat 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 kinds of wildlife attracted to these areas include Hungarian partridge, pheasant, meadowlark, field sparrow, cottontail rabbit, and red fox.

Woodland habitat consists of areas of hardwoods or conifers, or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include thrushes, woodpeckers, squirrels, red fox, raccoon and deer.

Wetland habitat consists of open, marshy or swampy, shallow water areas where water-tolerant plants grow. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Soil properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features.

Engineering properties

Table 13 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 13 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil series and morphology."

Texture is described in table 13 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 soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO).

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, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging 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. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The estimated classification, without group index numbers, is given in table 13. Also in table 13 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

Physical and chemical properties

Table 14 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as a range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

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

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are

moderately erodible, but crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.

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

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Table 15 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received 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 chiefly of deep, well drained to excessively drained sands or gravels. 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 that have a layer that impedes the downward movement of water or soils that have 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 clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding; and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 15 are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action results from the movement of soil moisture into the freezing temperature zone in the soil, which causes ice lenses to form. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Soil series and morphology

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

Characteristics of the soil and the material in which it formed are discussed for each series. The soil is then compared to similar soils and to nearby soils of other series. Then a pedon, a small three-dimensional area of soil that is typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (*4*). Unless otherwise noted, colors described are for moist soil.

Following the pedon description is the range of important characteristics of the soil series in this survey area. Phases, or map units, of each soil series are described in the section "Soil maps for detailed planning."

Barbert series

The Barbert series consists of very poorly drained, slowly permeable soils. These soils formed in clayey glacial lacustrine sediment over loamy glacial till. They are in closed depressions of glacial lake plains. Slopes are less than 1 percent.

Barbert soils are similar to Lura soils and are commonly adjacent to Lura and Marna soils. Lura soils also are in closed depressions but do not have an albic or an argillic horizon. Marna soils are clayey but are poorly drained and do not have an albic or an argillic horizon. They are in low gradient drainageways and swales.

Typical pedon of Barbert silt loam, 640 feet north and 30 feet east of the SW corner of sec. 36, T. 107 N., R. 34 W.:

Ap—0 to 11 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; strongly acid; abrupt smooth boundary.

A2—11 to 23 inches; dark gray (10YR 4/1) silt loam, gray (10YR 6/1) dry; weak fine and medium platy structure; friable; common fine vertical tubular pores; strongly acid; clear irregular boundary.

B21tg—23 to 32 inches; black (5Y 2/1) clay, very dark gray (5Y 3/1) dry; many fine faint dark olive gray (5Y 5/2) mottles; strong coarse prismatic structure; thick continuous clay films on faces of peds; firm; strongly acid; clear irregular boundary.

B22tg—32 to 39 inches; olive gray (5Y 4/2) silty clay; many fine faint olive (5Y 5/4) and common medium prominent yellowish brown (10YR 5/6) mottles; strong coarse prismatic structure parting to strong coarse angular blocky; thick continuous black (5Y 2/1) clay films on faces of peds and filling root channels; firm; strongly acid; clear irregular boundary.

B23tg—39 to 47 inches; olive gray (5Y 4/2) silty clay; many coarse prominent yellowish brown (10YR 5/6) and many fine faint olive (5Y 5/4) mottles; moderate medium prismatic structure; thin continuous very dark gray (5Y 3/1) clay films on faces of peds; firm; slightly acid; clear irregular boundary.

B3tg—47 to 54 inches; olive gray (5Y 5/2) silty clay loam; common coarse prominent yellowish brown (10YR 5/6) and many fine faint olive (5Y 5/4) mottles; moderate medium prismatic structure; thin discontinuous very dark gray (5Y 3/1) clay films on faces of peds; friable; neutral; clear wavy boundary.

IICg—54 to 60 inches; olive gray (5Y 5/2) clay loam; common coarse prominent yellowish brown (10YR 5/6) mottles; massive; friable; about 5 percent coarse fragments; slight effervescence; mildly alkaline.

Thickness of the solum and depth to free carbonates are 35 to 75 inches. The mollic epipedon is 9 to 24 inches thick and can include the upper part of the B horizon.

The Ap horizon has hue of 10YR and value of 2 or 3. It typically is silt loam but includes light silty clay loam. It is strongly acid to slightly acid. The A2 horizon has hue of 10YR and value of 4 or 5. It is silt loam or light silty clay loam and is strongly acid to slightly acid. The Btg horizon has hue of 10YR, 2.5Y, or 5Y; value of 2 to 5; and chroma of 1 or 2. At least the upper 20 inches of the Btg horizon is clay or silty clay, and the lower part is silty clay loam, silty clay, or clay. The IIC horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 2 or 3. It is clay loam or loam. A C1 horizon that is silt loam, silty clay loam, or silty clay is in some pedons.

Biscay series

The Biscay series consists of poorly drained soils that formed in a loamy mantle overlying outwash sand and gravel sediments. These soils are in swales and on broad flats on outwash plains and terraces. Permeability is moderate in the loamy mantle and rapid in the underlying sand and gravel. Slopes are 0 to 2 percent.

These soils have transitional layers between the upper loamy mantle and the IIC horizon. The layers are thicker than is defined for the series. This difference, however, does not alter their usefulness or behavior.

Biscay soils are similar to Mayer soils and are commonly adjacent to Mayer and Talcot soils. Mayer soils are calcareous. They are on slightly convex broad flats and rims of depressions. Talcot soils are very poorly drained, calcareous, and in depressions and low gradient drainageways.

Typical pedon of Biscay loam, 2,580 feet north and 50 feet east of the SW corner of sec. 12, T. 105 N., R. 38 W.:

Ap—0 to 10 inches; black (N 2/0) loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; neutral; abrupt smooth boundary.

A12—10 to 20 inches; black (N 2/0) loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear wavy boundary.

B1g—20 to 26 inches; dark gray (5Y 4/1) loam; common coarse prominent yellowish brown (10YR 5/6) and common fine faint olive (5Y 4/3) mottles; moderate medium angular blocky structure parting to weak fine subangular blocky; friable; few black (N 2/0) worm casts; about 6 percent coarse fragments; neutral; clear irregular boundary.

B2g—26 to 32 inches; grayish brown (2.5Y 5/2) sandy clay loam; many fine distinct yellowish brown (10YR 5/6) and many fine distinct olive (5Y 5/4) mottles; weak fine subangular blocky structure; friable; about 15 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

IIB3g—32 to 39 inches; grayish brown (2.5Y 5/2) gravelly sandy loam; common coarse distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; slight effervescence; mildly alkaline; clear wavy boundary.

IICg—39 to 60 inches; grayish brown (2.5Y 5/2) gravelly coarse sand; common coarse distinct yellowish brown (10YR 5/6) mottles; single grain; loose; slight effervescence; mildly alkaline.

Thickness of the solum and depth to loamy sand or coarser texture and free carbonates are 20 to 40 inches. A few pedons have a calcareous A1 horizon and a noncalcareous B horizon. The mollic epipedon is 16 to 24 inches thick.

The A horizon is neutral in color or has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1. It is loam, clay loam, or sandy clay loam. The A horizon is mildly alkaline to slightly acid. The Bg horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It typically is loam but ranges to sandy clay loam or light clay loam with gravelly loam, sandy loam, or sandy clay loam in the lower part. The Bg horizon is neutral or mildly alkaline. The lower part does not have free carbonates in some pedons. The IICg horizon is coarse sand, loamy coarse sand, loamy sand, or sand and contains 5 to 50 percent gravel. It is mildly alkaline or moderately alkaline.

Blue Earth series

The Blue Earth series consists of very poorly drained soils. These soils have moderately slow permeability. They formed in coprogenous earth (limnic materials) that mantles glacial lacustrine sediment or till. The soils are on lake basins and backwater areas adjacent to lakes. Slopes are less than 1 percent.

Blue Earth soils are similar to Lura soils and are commonly adjacent to Canisteo soils. Lura soils formed in clayey alluvium from glacial sediment and are in depressions. Canisteo soils are poorly drained and formed in loamy glacial till. They are on slight rises along the edges of and inside lake basins and depressions.

Typical pedon of Blue Earth mucky silt loam, 2,150 feet west and 50 feet north of the SE corner of sec. 29, T. 107 N., R. 37 W.:

Lcop—0 to 11 inches; black (10YR 2/1) mucky silt loam, dark gray (5Y 4/1) dry; weak fine granular structure; very friable; few snail shells and fragments of snail shells; strong effervescence; mildly alkaline; abrupt smooth boundary.

Lco2—11 to 21 inches; black (10YR 2/1) mucky silt loam, gray (5Y 5/1) dry; few coarse prominent dark brown (7.5YR 3/2) mottles and coatings in root channels; weak coarse subangular blocky structure; very friable; common small snail shells and fragments of snail shells; violent effervescence; mildly alkaline; clear wavy boundary.

Lco3—21 to 31 inches; black (10YR 2/1) mucky silt loam, gray (5Y 5/1) dry; common coarse prominent dark brown (7.5YR 3/2) mottles on faces of peds; weak coarse prismatic structure; very friable; many snail shells and fragments of snail shells and few clam shell fragments; strong effervescence; mildly alkaline; clear wavy boundary.

Lco4—31 to 44 inches; very dark gray (N 3/0) mucky silt loam, gray (5Y 5/1) dry; few fine distinct very dark grayish brown (2.5Y 3/2) mottles; massive; friable; strong effervescence; mildly alkaline; abrupt wavy boundary.

IIC—44 to 60 inches; very dark gray (5Y 3/1) silt loam, gray (5Y 5/1) dry; few fine distinct very dark grayish brown (2.5Y 3/2) mottles; massive; friable; strong effervescence; mildly alkaline.

Thickness of the coprogenous earth and the depth to glacial till or glacial lacustrine sediment are 30 to 80 inches or more. The coprogenous earth contains 0 to 25 percent coarse fragments that consist of whole and fragmented snail and clam shells. A layer of sapric material as much as 16 inches thick overlies the coprogenous earth in some pedons. It has hue of 10YR, value of 2 or 3, and chroma of 1. This kind of soil is recognized as a separate phase, namely Blue Earth muck.

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

Canisteo series

The Canisteo series consists of poorly drained, calcareous, moderately permeable soils. These soils formed in loamy glacial till. They are on broad flats and narrow rims of depressions in glacial moraines and glacial till plains. Slopes are 0 to 2 percent.

Canisteo soils are similar to Jeffers soils and are commonly adjacent to Glencoe and Webster soils. Jeffers soils contain gypsum. They are in positions on the landscape similar to Canisteo soils. Glencoe soils are very poorly drained and have a mollic epipedon that is more than 24 inches thick. They are in depressions and low gradient drainageways. Webster soils are poorly drained and are on broad flats.

Typical pedon of Canisteo clay loam 100 feet south and 900 feet east of the NW corner of sec. 32, T. 106 N., R. 35 W.:

Ap—0 to 10 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; violent effervescence; moderately alkaline; abrupt smooth boundary.

A12—10 to 21 inches; black (N 2/0) clay loam, dark gray (N 4/0) dry; weak fine subangular blocky structure; friable; about 4 percent coarse fragments; violent effervescence; moderately alkaline; clear wavy boundary.

Blg—21 to 32 inches; dark gray (5Y 4/1) clay loam; weak fine subangular blocky structure; common olive (5Y 5/3) worm casts; about 4 percent coarse fragments; violent effervescence; moderately alkaline; clear wavy boundary.

B2g—32 to 40 inches; olive gray (5Y 5/2) clay loam; few fine distinct light olive brown (2.5Y 5/6) mottles; moderate fine subangular blocky structure; friable; few olive gray (5Y 4/2) worm casts; about 6 percent coarse fragments; few 5- to 10-millimeter diameter soft masses of carbonates; violent effervescence; moderately alkaline; clear irregular boundary.

Clg—40 to 48 inches; olive gray (5Y 5/2) clay loam; common coarse distinct light olive brown (2.5Y 5/6) mottles; weak coarse angular blocky structure; friable; few olive gray (5Y 4/2) worm casts; about 8 percent coarse fragments; few 5- to 10-millimeter diameter soft masses of carbonates; violent effervescence, moderately alkaline; clear wavy boundary.

C2g—48 to 60 inches; olive gray (5Y 5/2) clay loam; common coarse prominent yellowish brown (10YR 5/6) mottles; massive; firm; about 8 percent coarse fragments; few 5- to 10-millimeter diameter soft masses of carbonates in upper part; violent effervescence; moderately alkaline.

The solum is 20 to 45 inches thick. The mollic epipedon is 14 to 24 inches thick.

The A horizon is neutral in color or has hue of 10YR, value of 2 or 3, and chroma of 1. It typically is clay loam or loam but ranges to silt loam in a few pedons. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is clay loam or loam and is mildly alkaline or moderately alkaline. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 to 4. It is clay loam or loam.

Clarion series

The Clarion series consists of well drained, moderately permeable soils. These soils formed in calcareous, loamy glacial till. They are on knolls, hilltops, and side slopes of glacial moraines and on glacial till plains. Slopes are 2 to 12 percent.

Clarion soils are commonly adjacent to Swanlake, Nicollet, and Webster soils. Swanlake soils have more convex, steeper slopes and are calcareous. Nicollet soils are moderately well drained and somewhat poorly drained. Webster soils are poorly drained and are on broad flats.

Typical pedon of Clarion loam, 2 to 4 percent slopes, 1,200 feet south and 150 feet west of the NE corner of sec. 30, T. 107 N., R. 34 W.:

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; neutral; abrupt smooth boundary.

A12—8 to 14 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; common dark brown (10YR 3/3) worm casts; about 5 percent coarse fragments; neutral; clear wavy boundary.

BI—14 to 21 inches; dark brown (10YR 3/3) loam, brown (10YR 4/3) dry; weak fine subangular blocky structure; friable; common black (10YR 2/1) worm casts; about 5 percent coarse fragments; neutral; clear irregular boundary.
B22—21 to 30 inches; brown (10YR 4/3) loam; weak medium subangular blocky structure; friable; few very dark grayish brown (10YR 3/2) worm casts; about 3 percent coarse fragments; slightly acid; clear wavy boundary.
B23ca—30 to 43 inches; yellowish brown (10YR 5/4) loam; weak coarse angular blocky structure parting to weak fine subangular blocky; friable; about 2 percent coarse fragments; about 18 percent diffuse carbonates; violent effervescence; moderately alkaline; clear wavy boundary.
Clca—43 to 53 inches; light olive brown (2.5Y 5/4) loam; few coarse prominent yellowish brown (10YR 5/6) and few coarse faint pale yellow (2.5Y 7/4) mottles; weak coarse angular blocky structure; friable; about 18 percent diffuse and common 2- to 5-millimeter diameter soft masses and many fine threads of carbonates; moderately alkaline; clear wavy boundary.
C2—53 to 60 inches; olive brown (2.5Y 4/4) loam; common coarse prominent yellowish brown (10YR 5/6) mottles; massive; friable; about 8 percent coarse fragments; about 12 percent diffuse and threads of carbonates; strong effervescence; moderately alkaline.

Thickness of the solum and depth to free carbonates are 18 to 50 inches. The mollic epipedon is 10 to 20 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is loam or clay loam and is slightly acid or neutral. The B horizon has hue of 10YR, value of 3 to 5, and chroma of 3 or 4. It is loam or clay loam. The upper part of the B horizon is slightly acid or neutral, and the lower part is mildly alkaline or moderately alkaline. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 4.

Clarion Variant

Clarion Variant consists of well drained soils. These soils have moderately slow permeability. They formed in a mantle of loamy lacustrine sediment and underlying, calcareous, loamy glacial till. These soils are on knolls in glacial lake plains and till plains. Slopes are 2 to 6 percent.

Clarion Variant soils are similar to Ransom soils and are commonly adjacent to Ransom and Rushmore soils. Ransom soils formed in similar sediment but are moderately well drained and somewhat poorly drained. They are on broad, low rises. Rushmore soils formed in similar material but are poorly drained. They are on broad flats.

Typical pedon of Clarion Variant loam, 2 to 6 percent slopes, 2,600 feet south and 1,400 feet east of the NW corner of sec. 15, T. 105 N., R 36 W.:

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; very friable; about 2 percent coarse fragments; common dark brown (10YR 3/3) worm casts; slightly acid; abrupt smooth boundary.
A3—10 to 18 inches; very dark gray (10YR 3/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; very friable; about 3 percent coarse fragments; common dark brown (10YR 3/3) worm casts; slightly acid; clear irregular boundary.
B21—18 to 24 inches; dark brown (10YR 4/3) silt loam; weak fine angular blocky structure parting to weak fine subangular blocky, very friable; common dark gray (10YR 3/1) worm casts; medium acid; clear irregular boundary.
B22—24 to 30 inches; dark yellowish brown (10YR 4/4) silt loam; weak fine prismatic structure parting to weak fine subangular blocky; very friable; medium acid; clear wavy boundary.
IIB23ca—30 to 38 inches; dark yellowish brown (10YR 4/4) loam; few coarse faint yellowish brown (10YR 5/6) mottles; weak medium angular blocky structure; friable; about 5 percent coarse fragments; about 20 percent diffuse, threads of, and common 1- to 5-millimeter diameter soft masses of carbonates; violent effervescence; moderately alkaline; clear wavy boundary.
IIB3ca—38 to 46 inches; olive brown (2.5Y 4/4) loam; common coarse distinct yellowish brown (10YR 5/6) mottles; weak medium angular blocky structure; friable; about 6 percent coarse fragments; about 16 percent diffuse and threads of carbonates; common masses of iron and manganese oxides; violent effervescence; moderately alkaline; clear wavy boundary.
IIC—46 to 60 inches; olive brown (2.5Y 4/4) loam; common coarse distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 8 percent coarse fragments; about 10 percent diffuse and threads of carbonates; common masses of iron and manganese oxides; strong effervescence; mildly alkaline.

The solum is 30 to 50 inches thick. The mollic epipedon is 12 to 20 inches thick. Thickness of the loamy lacustrine mantle and depth to glacial till are 20 to 40 inches. Depth to free carbonates is 16 to 36 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is loam with a high content of silt or silt loam with a high content of fine sand. The A horizon is medium acid to neutral. The B horizon in the lacustrine sediment has hue of 10YR, value of 3 to 5, and chroma of 2 to 4. It is silt loam with a high content of sand, clay loam, or loam with a high content of silt. The B horizon is medium acid to neutral. The IIB horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 or 4. It is silt loam, loam, or clay loam; and some pedons are stratified. The IIB horizon is mildly alkaline or moderately alkaline. The IIC horizon has hue of 2.5Y, value of 4 or 5, and chroma of 2 to 4. It is loam or clay loam. It is mildly alkaline or moderately alkaline.

Coland series

The Coland series consists of poorly drained soils. These soils have moderately slow permeability. They formed in loamy alluvial sediment on bottom lands. Slopes are 0 to 2 percent.

Coland soils are similar to Millington soils and are commonly adjacent to Millington and Spillville soils. Millington soils are calcareous throughout. They are on slightly convex broad flats. Spillville soils are moderately well drained and somewhat poorly drained. They are on irregularly shaped, low rises.

Typical pedon of Coland clay loam, occasionally flooded, 1,500 feet north and 200 feet west of the SE corner of sec. 11, T. 106 N., R. 36 W.:

A11—0 to 12 inches; black (N 2/0) clay loam, very dark gray (N 3/0) dry; moderate medium angular blocky structure parting to moderate fine subangular blocky; friable; about 2 percent coarse fragments; slightly acid; abrupt wavy boundary.

A12—12 to 21 inches; black (N 2/0) clay loam, very dark gray (N 3/0) dry; moderate medium angular blocky structure parting to moderate fine subangular blocky; friable; about 2 percent coarse fragments; slightly acid; clear wavy boundary.

A13—21 to 29 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to weak fine subangular blocky; friable; about 2 percent coarse fragments; slightly acid; clear wavy boundary.

A14—29 to 42 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; few coarse prominent strong brown (7.5YR 5/6) mottles; weak medium prismatic structure; friable; about 2 percent coarse fragments; slightly acid; clear wavy boundary.

AC—42 to 55 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; massive; friable; about 2 percent coarse fragments; neutral; clear wavy boundary.

C—55 to 60 inches; olive gray (5Y 5/2) clay loam; many coarse prominent strong brown (7.5YR 5/6) mottles; massive; friable; about 5 percent coarse fragments; common dark oxides of iron and manganese; neutral.

Thickness of the solum and the mollic epipedon is 36 to 48 inches or more. Depth to free carbonates is 48 inches or more.

The A horizon is neutral in color or has hue of 10YR, value of 2 or 3, and chroma of 1. It typically is clay loam but ranges to silty clay loam or loam. The A horizon typically is slightly acid or neutral but ranges to mildly alkaline below 30 inches in some pedons. The C horizon is neutral in color or has hue of 5Y or 2.5Y, value of 2 to 5, and chroma of 1 or 2. It typically is loam or clay loam, but it has silty or sandy strata with or without gravel in some pedons. The C horizon is slightly acid to mildly alkaline.

Crippin series

The Crippin series consists of somewhat poorly drained, moderately permeable soils. These soils formed in calcareous, loamy glacial till. They are on broad rises on glacial till plains and moraines. Slopes are 1 to 3 percent.

Crippin soils are similar to Jeffers Variant soils and are commonly adjacent to Nicollet and Webster soils. Jeffers Variant soils have a gypsic horizon in the upper part of the solum. They are on slightly convex rises adjacent to shallow, closed depressions. Nicollet soils are moderately well drained to somewhat poorly drained and are on broad, low rises. Webster soils are poorly drained and are on broad flats.

Typical pedon of Crippin clay loam, from an area of Nicollet-Crippin clay loams, 1,300 feet north and 1,000 feet west of the SE corner of sec. 21, T. 107 N., R. 36 W.:

Ap—0 to 10 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; neutral; abrupt smooth boundary.

A12—10 to 17 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; common black (N 2/0) worm casts; about 3 percent coarse fragments; strong effervescence; mildly alkaline; clear irregular boundary.

Blca—17 to 23 inches; very dark grayish brown (2.5Y 3/2) clay loam; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; about 20 percent diffuse carbonates; violent effervescence; moderately alkaline; clear wavy boundary.

B2ca—23 to 31 inches; olive brown (2.5Y 4/4) loam; few fine distinct brown (10YR 5/3) mottles; weak fine subangular blocky structure; about 25 percent diffuse and few 5- to 10-millimeter diameter soft masses of carbonates; violent effervescence; moderately alkaline; clear wavy boundary.

C1ca—31 to 46 inches; olive brown (2.5Y 4/4) loam; many fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak fine subangular blocky; about 8 percent coarse fragments; about 25 percent diffuse and many 5- to 10-millimeter diameter soft masses of carbonates; violent effervescence; moderately alkaline; clear wavy boundary.

C2—46 to 60 inches; light olive brown (2.5Y 5/4) loam; many coarse distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 8 percent coarse fragments; strong effervescence; moderately alkaline.

The solum is 20 to 48 inches thick. The mollic epipedon is 14 to 24 inches thick. Depth to free carbonates is 0 to 10 inches.

The A horizon is neutral in color or has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is loam or clay loam, and it is neutral to moderately alkaline. The B horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 1 to 4. It is loam or clay loam. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4.

Delft series

The Delft series consists of poorly drained soils. These soils have moderately slow permeability. They formed in loamy alluvium derived from glacial till and the underlying glacial till. These soils are on toe slopes and in narrow draws of glacial moraines and till plains. Slopes are 1 to 3 percent.

Delft soils are similar to Glencoe soils and are commonly adjacent to Clarion and Webster soils. Glencoe soils are very poorly drained and have slopes with less gradient. They are in depressions and low gradient drainageways. Clarion soils are well drained and have plane to slightly convex slopes on steeper areas. Webster soils are poorly drained and are on broad flats.

Typical pedon of Delft clay loam, from an area of Webster-Delft clay loams, 700 feet west and 700 feet south of the NE corner of sec. 34, T. 107 N., R. 37 W.:

Ap—0 to 12 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; mildly alkaline; abrupt smooth boundary.

A12—12 to 29 inches; black (N 2/0) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 10 percent coarse fragments; mildly alkaline; clear wavy boundary.

Blg—29 to 34 inches; dark gray (5Y 4/1) silt loam; weak fine prismatic structure parting to weak fine subangular blocky; friable; common black (5Y 2/1) worm casts; about 5 percent coarse fragments; mildly alkaline; clear wavy boundary.

B2g—34 to 46 inches; olive gray (5Y 5/2) clay loam; common fine distinct light olive brown (2.5Y 5/4) and few coarse prominent dark brown (7.5YR 4/4) mottles; weak coarse prismatic structure parting to weak fine subangular blocky; friable; about 5 percent coarse fragments; slight effervescence; mildly alkaline; abrupt wavy boundary.

Cg—46 to 60 inches; olive gray (5Y 5/2) loam; many coarse prominent yellowish brown (10YR 5/6) mottles; weak fine prismatic structure parting to weak medium angular; friable about 8 percent carbonates disseminated throughout; about 6 percent coarse fragments; strong effervescence; mildly alkaline.

The solum is 30 to 55 inches thick. Thickness of the mollic epipedon and depth to free carbonates is 24 to 36 inches. Coarse fragments comprise about 1 to 5 percent of the solum and about 0 to 10 percent of the C horizon. The B horizon contains about 0 to 20 percent free carbonates and the C horizon about 5 to 20 percent free carbonates.

The A horizon is neutral in color or has hue of 10YR, 2.5Y, or 5Y, value of 2 or 3; and chroma of 1. It is loam or clay loam and, less commonly, silty clay loam with a high content of sand. The A horizon is mildly alkaline to medium acid. The B horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is loam, clay loam, or silt loam with a high content of sand. The B horizon is slightly acid to mildly alkaline. The C horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 2 to 4. It is silt loam, loam, clay loam, or sandy loam; and it is mildly alkaline or moderately alkaline.

Dickman series

The Dickman series consists of well drained soils that have moderately rapid permeability. These soils formed in glacial outwash consisting of a loamy mantle and underlying sandy sediment. They are on glacial outwash plains and glacial terraces. Slopes are 0 to 12 percent.

Dickman soils are similar to Estherville soils and are commonly adjacent to Estherville and Linder soils. Estherville and Linder soils have a sandy and gravelly IIC horizon. Linder soils are somewhat poorly drained.

Typical pedon of Dickman sandy loam, 0 to 2 percent slopes, 2,480 feet west and 50 feet south of the NE corner of sec. 36, T. 105 N., R. 38 W.:

Ap—0 to 9 inches; very dark brown (10YR 2/2) sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.

A3—9 to 15 inches; very dark brown (10YR 2/2) sandy loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; very friable; medium acid; clear wavy boundary.

B2—15 to 25 inches; dark yellowish brown (10YR 3/4) loamy sand; single grain; loose; medium acid; clear wavy boundary.
B3—25 to 38 inches; dark brown (10YR 4/3) sand; single grain; loose; medium acid; clear wavy boundary.
C1—38 to 49 inches; yellowish brown (10YR 5/4) sand; single grain; loose; slightly acid; clear wavy boundary.
C2—49 to 60 inches; brown (10YR 5/3) sand; single grain; loose; slightly acid.

The solum is 30 to 50 inches thick. The loamy mantle is 12 to 24 inches thick. Depth to free carbonates is more than 60 inches. The mollic epipedon is 10 to 16 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is fine sandy loam or sandy loam, and it is slightly acid or medium acid. The B horizon has hue of 10YR, value of 3 or 4 in the upper part and 4 or 5 in the lower part, and chroma of 3 or 4. It is loamy sand, loamy fine sand, sandy loam, or fine sandy loam in the upper part and fine sand or sand in the lower part. The B horizon is medium acid or slightly acid. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 3 or 4. It is fine sand or sand and commonly is stratified. The C horizon is medium acid to neutral.

Estherville series

The Estherville series consists of well drained soils that have moderately rapid permeability in the upper part and rapid permeability in the underlying material. These soils formed in glacial outwash sediments over gravelly sand sediment. They are on broad, narrow ridgetops and knolls on glacial outwash plains and terraces. Slopes are 0 to 25 percent.

The Estherville soils are similar to Salida soils and are commonly adjacent to Dickman and Linder soils. Salida soils are excessively drained and can have a thinner loamy mantle. They have convex slopes. Dickman soils have a sandy IIC horizon. Linder soils are somewhat poorly drained. They are on low rises on broad flats.

Typical pedon of Estherville sandy loam, 2 to 6 percent slopes, 500 feet west and 100 feet south of the NE corner of sec. 6, T. 105 N., R. 36 W.:

Ap—0 to 9 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; very friable; medium acid; abrupt smooth boundary.
A3—9 to 13 inches; very dark gray (10YR 3/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; very friable; medium acid; clear wavy boundary.
B2—13 to 19 inches; dark brown (10YR 3/3) sandy loam, dark brown (10YR 3/3) dry; weak coarse subangular blocky structure; friable; about 6 percent gravel; slightly acid; abrupt wavy boundary.
B3—19 to 27 inches; dark brown (7.5YR 3/4) loamy coarse sand; single grain; loose; about 8 percent gravel; slightly acid; abrupt wavy boundary.
IIC—27 to 60 inches; mixed grayish brown (10YR 5/2) yellowish brown (10YR 5/4) gravelly coarse sand; single grain; loose about 20 percent gravel; slight effervescence; mildly alkaline.

Thickness of the solum and depth to sand, gravel, and free carbonates are 15 to 30 inches. The mollic epipedon is 9 to 20 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is sandy loam or loam and is neutral to medium acid. The B horizon has hue of 10YR and value and chroma of 3 or 4. It is sandy loam or loam in the upper part and loamy sand or loamy coarse sand in the lower part. The B horizon is medium acid to neutral. The IIC horizon is coarse sand and very coarse sand and contains 10 to 25 percent gravel. It is neutral or mildly alkaline. The IIC horizon typically is calcareous, but the upper few inches are leached in some pedons. Some parts of the IIC horizon are weakly cemented by carbonates and iron and manganese oxides in some pedons.

Everly series

The Everly series consists of well drained soils. These soils have moderately slow permeability. They formed in calcareous, loamy glacial till. These soils are on summits and side slopes in glacial moraines and on glacial till plains. Slopes are 2 to 6 percent.

These soils are outside the defined range of the Everly series because the solum is thicker and has more coarse fragments and the B21 horizon is more acid. This difference does not alter their usefulness or behavior.

Everly soils are similar to Germantown soils and are commonly adjacent to Letri and Wilmonton soils. Germantown soils have quartzite bedrock beginning at a depth of 20 to 40 inches. Letri soils are poorly drained and are on broad flats. Wilmonton soils are moderately well drained and somewhat poorly drained and are on broad, low rises.

Typical pedon of Everly clay loam, 2 to 6 percent slopes, 50 feet north and 50 feet east of the SW corner of sec. 10, T. 107 N., R. 37 W.:

Ap—0 to 11 inches; black (10YR 2/1) clay loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; about 1 percent coarse fragments; slightly acid; abrupt smooth boundary.
A12—11 to 17 inches; black (10YR 2/1) clay loam, very dark grayish brown (10YR 3/2) dry; moderate medium prismatic structure parting to moderate

medium angular blocky; friable; common very dark grayish brown (10YR 3/2) worm casts; about 2 percent coarse fragments; slightly acid; clear irregular boundary.

B1—17 to 21 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium prismatic structure parting to moderate medium angular blocky; friable; common coarse very dark grayish brown (10YR 3/2) worm casts; about 4 percent coarse fragments; medium acid; clear wavy boundary.

B21—21 to 28 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium prismatic structure parting to moderate medium angular blocky; friable; few very dark grayish brown (10YR 3/2) worm casts; about 5 percent coarse fragments; medium acid; clear wavy boundary.

B22—28 to 36 inches; yellowish brown (10YR 5/4) clay loam; few fine faint yellowish brown (10YR 5/6) mottles; moderate coarse prismatic structure parting to moderate medium angluar blocky; friable; about 5 percent coarse fragments; neutral; clear wavy boundary.

IIB3ca—36 to 46 inches; light olive brown (2.5Y 5/4) loam; few coarse prominent yellowish red (5YR 4/6) mottles; weak coarse angular blocky structure; firm; about 8 percent coarse fragments; about 18 percent carbonates in many coarse threads and common 5- to 10-millimeter diameter soft masses; few 1- to 3-millimeter diameter concretions of iron and manganese oxides; violent effervescence; moderately alkaline; clear wavy boundary.

IIC—46 to 60 inches; light olive brown (2.5Y 5/4) loam; many coarse distinct yellowish brown (10YR 5/6) mottles; massive; firm; about 8 percent coarse fragments; about 15 percent coarse threads of carbonates; violent effervescence; mildly alkaline.

The solum is 24 to 42 inches thick. Depth to free carbonates and the IIC horizon is 18 to 36 inches, although the upper few inches of underlying material are leached in places. The mollic epipedon is 10 to 20 inches thick. A 0- to 4-inch thick sandy or coarse-loamy lag line with or without gravel is at the base of the solum in some pedons.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is clay loam or loam with a high content of silt or silty clay loam, and it is strongly acid to neutral. The B horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. It is clay loam or loam and strongly acid to neutral. The IIC horizon has hue of 10YR or 2.5Y. It is loam or clay loam and is mildly alkaline or moderately alkaline.

Germantown series

The Germantown series consists of moderately deep, well drained soils. These soils have moderately slow permeability. They formed in calcareous, loamy glacial till. These soils are on ridges and knolls in glacial moraines and glacial till plains that are underlain by quartzite bedrock. Slopes are 1 to 6 percent.

Germantown soils are similar to Everly soils and are commonly adjacent to bedrock outcrops and Wilmonton soils. Everly soils do not have bedrock at a depth less than 60 inches. Bedrock outcrops are quartzite and are on the most sloping areas of ridges, knolls, and water courses. Wilmonton soils are moderately well drained and somewhat poorly drained. They do not have bedrock at a depth less than 60 inches. They are in slightly concave areas between ridges and knolls.

Typical pedon of Germantown clay loam, 1 to 6 percent slopes, 2,400 feet north and 1,200 feet east of the SW corner of sec. 12, T. 107 N., R. 36 W.:

Ap—0 to 8 inches; very dark brown (10YR 2/2) clay loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; medium acid; abrupt smooth boundary.

A3—8 to 14 inches; very dark gray (10YR 3/1) clay loam, dark brown (10YR 3/3) dry; moderate medium prismatic structure parting to moderate fine subangular blocky; friable; about 3 percent coarse fragments; many very dark brown (10YR 3/2) worm casts; medium acid; clear irregular boundary.

B2—14 to 19 inches; olive brown (2.5Y 4/4) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium prismatic structure parting to moderate fine subangular blocky; friable; about 3 percent coarse fragments; common very dark brown (10YR 2/2) worm casts; slightly acid; clear wavy boundary.

B3ca—19 to 27 inches; olive brown (2.5Y 4/4) loam; few coarse distinct yellowish brown (10YR 5/6) mottles; strong coarse angular blocky structure parting to strong coarse subangular blocky; friable; about 5 percent coarse fragments; about 18 percent diffuse and common 5- to 10-millimeter diameter soft masses of carbonates; violent effervescence; mildly alkaline; abrupt wavy boundary.

C—27 to 36 inches; olive brown (2.5Y 4/4) loam; few coarse distinct yellowish brown (10YR 5/6) mottles; massive; firm; about 8 percent coarse fragments; about 10 percent diffuse carbonates; many 1- to 3-millimeter diameter masses of oxides of iron and manganese; violent effervescence; mildly alkaline; abrupt smooth boundary.

IIR—36 inches; pinkish red hard Sioux quartzite bedrock.

Thickness of the solum and depth to bedrock are 20 to 40 inches. Depth to free carbonates is 18 to 36 inches. The mollic epipedon is 7 to 16 inches thick. The lower part of the B horizon or the C horizon, or both, contains 15 to 25 percent diffuse and few to many soft masses of carbonates in most pedons.

The A horizon has hue of 10YR, value of 2, and chroma of 1 or 2. It is clay loam or loam and medium acid to neutral. The B horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 to 4. It typically is clay loam or loam, but the lower few inches are sandy or gravelly in some pedons. The B horizon is medium acid to neutral in the upper part and neutral to moderately alkaline in the lower part. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 4. It is mildly alkaline or moderately alkaline.

Glencoe series

The Glencoe series consists of very poorly drained soils. These soils have moderately slow permeability. They formed in loamy sediment derived from glacial till. These soils are in low gradient drainageways and depressions on glacial moraines and till plains. Slopes are less than 1 percent.

Glencoe soils are similar to Delft soils and are commonly adjacent to Canisteo and Webster soils. Delft soils are poorly drained and have greater slopes. They are on toe slopes and narrow upland draws. Canisteo soils are poorly drained and calcareous. They are on broad flats and rims of depressions. Webster soils are poorly drained and are on broad flats.

Typical pedon of Glencoe clay loam, 1,300 feet east and 50 feet south of the NW corner of sec. 31, T. 107 N., R. 36 W.:

Ap—0 to 8 inches; black (N 2/0) clay loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure; friable; neutral; abrupt smooth boundary.

A12—8 to 25 inches; black (N 2/0) clay loam, very dark gray (N 3/0) dry; few fine faint very dark gray (5Y 3/1) mottles; weak fine subangular blocky structure; friable; neutral; clear wavy boundary.

A13—25 to 34 inches; black (5Y 2/1) clay loam, very dark gray (5Y 3/1) dry; many coarse faint very dark gray (5Y 3/1) mottles; weak coarse blocky structure parting to weak fine subangular blocky; friable; traces of coarse fragments; neutral; clear wavy boundary.

A3g—34 to 44 inches; very dark gray (5Y 3/1) clay loam, dark gray (5Y 4/1) dry; many coarse faint, olive gray (5Y 5/2) mottles; weak, coarse, blocky structure parting to weak fine subangular blocky; friable; traces of coarse fragments; neutral; clear wavy boundary.

B2g—44 to 49 inches; olive gray (5Y 4/2) clay loam; many coarse faint light olive gray (5Y 6/2) mottles; few coarse faint very dark gray (5Y 3/1) organic stains; weak coarse prismatic structure parting to weak fine subangular blocky; friable; traces of coarse fragment; neutral; clear wavy boundary.

Cg—49 to 60 inches; olive gray (5Y 5/2) clay loam; common, medium, prominent, yellowish brown (10YR 5/6) mottles; massive; about 5 percent coarse fragments; friable; slight effervescence; mildly alkaline.

Thickness of the solum and depth to free carbonates are 36 to 60 inches. The mollic epipedon is 24 to 46 inches thick.

The A horizon is neutral in color or has hue of 10YR to 5Y, value of 2 or 3, and chroma of 1. It is clay loam, silty clay loam, or loam and is slightly acid to mildly alkaline. The Bg horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is clay loam, silty clay loam, or loam and is neutral or mildly alkaline. The Cg horizon has hue of 5Y or 2.5Y, value of 4 to 6, and chroma of 2 to 4. It is loam or clay loam.

Grogan series

The Grogan series consists of well drained soils. These soils have moderately rapid permeability. They formed in calcareous, glacial lacustrine sediment. These soils are on ridges in lacustrine mantled glacial till plains, glacial moraines, and glacial lake plains. Slopes are 1 to 8 percent.

These soils have more sand and less silt than the defined range for the series, but this difference does not alter their usefulness or behavior.

Grogan soils are similar to Truman soils and are commonly adjacent to Clarion Variant and Ransom soils. Truman soils are fine-silty. They are in positions on the landscape similar to Grogan soils. Ransom soils are moderately well drained and somewhat poorly drained and are fine-silty. They are on broad, low rises. Clarion Variant soils are fine-loamy and are on knolls.

Typical pedon of Grogan fine sandy loam, 1 to 8 percent slopes, 1,320 feet south and 50 feet west of the NE corner of sec. 14, T. 108 N., R. 36 W.:

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

A12—7 to 16 inches; very dark gray (10YR 3/1) fine sandy loam, dark brown (10YR 3/3) dry; common dark brown (10YR 3/3) worm casts; weak fine subangular blocky structure; very friable; slightly acid; clear irregular boundary.

B21—16 to 25 inches; dark yellowish brown (10YR 4/4) fine sandy loam; weak fine subangular blocky structure parting to single grain; very friable; slightly acid; clear wavy boundary.

B22—25 to 34 inches; dark yellowish brown (10YR 4/4) fine sandy loam; single grain; loose; slightly acid; clear wavy boundary.

B3—34 to 42 inches; yellowish brown (10YR 5/4) fine sandy loam; many fine faint brownish yellow (10YR 6/8) mottles; single grain; loose; slightly acid; clear wavy boundary.

C1—42 to 49 inches; yellowish brown (10YR 5/4) very fine sand with strata of gray (10YR 5/1) silt loam; many coarse faint brownish yellow (10YR 6/8) mottles; weak coarse platy structure; friable; neutral; abrupt smooth boundary.

C2—49 to 60 inches; pale brown (10YR 6/3) silt loam; many coarse faint yellowish brown (10YR 5/6) and few coarse prominent yellowish red (5Y 4/6) mottles; massive; friable; strong effervescence; mildly alkaline.

The solum is 20 to 45 inches thick. Depth to free carbonates is 20 to 50 inches. The mollic epipedon is 10 to 18 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 to 3. It is fine sandy loam or loam and is slightly acid or neutral. The B horizon has hue of 10YR, value of 4 or 5, and chroma of 3 to 5. It is fine sandy loam, loam, very fine sandy loam, or loamy very fine sand. The B horizon is slightly acid or neutral in the upper part and neutral or mildly alkaline in the lower part. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 3 to 6. It is stratified very fine sandy loam or loamy very fine sand and silt loam; it is mildly alkaline or moderately alkaline. A IIC horizon of glacial till is at a depth of 50 inches or more in some pedons.

Guckeen series

The Guckeen series consists of somewhat poorly drained, slowly permeable soils. These soils formed in a mantle of clayey, glacial lacustrine sediment that overlies loamy glacial till. They are on broad, low rises in glacial lake plains and till plains. Slopes are 1 to 3 percent.

Guckeen soils are similar to Kingston soils and are commonly adjacent to Lura and Marna soils. Kingston soils are fine-silty. They are in positions on the landscape similar to Guckeen soils. Lura soils are very poorly drained and have a thicker mollic epipedon. They are in shallow, closed depressions. Marna soils formed in similar material but are poorly drained. They are on broad flats and low gradient drainageways.

Typical pedon of Guckeen silty clay loam, 2,500 feet east and 50 feet north of the SW corner of sec. 17, T. 105 N., R. 37 W.:

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

A12—8 to 15 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; friable; few very dark grayish brown (2.5Y 3/2) worm casts; slightly acid; clear wavy boundary.

A13—15 to 21 inches; black (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; friable; common very dark grayish brown (2.5Y 3/2) worm casts; slightly acid; clear wavy boundary.

B1—21 to 27 inches; dark grayish brown (2.5Y 4/2) silty clay; strong fine and medium subangular blocky structure; firm; few very dark grayish brown (2.5Y 3/2) worm casts; medium acid; clear irregular boundary.

B2—27 to 34 inches; olive gray (2.5Y 5/2) silty clay, common coarse distinct yellowish brown (10YR 5/6) mottles; moderate medium prismatic structure parting to moderate fine subangular blocky; firm; neutral; clear wavy boundary.

IIC1ca—34 to 42 inches; olive gray (5Y 5/2) stratified silt loam and very fine sand; common coarse prominent yellowish brown (10YR 5/6) mottles; massive; friable; about 5 percent coarse fragments; about 17 percent diffuse and common 5- to 10-millimeter diameter soft masses of carbonates; violent effervescence; moderately alkaline; clear wavy boundary.

IIC2—42 to 60 inches; olive brown (2.5Y 5/4) clay loam, many coarse distinct yellowish brown (10YR 5/6) mottles; massive; firm; about 5 percent coarse fragments; about 10 percent diffuse carbonates; strong effervescence; mildly alkaline.

Thickness of the solum and depth to free carbonates are 24 to 44 inches. The depth to stratified lag line or glacial till is 20 to 40 inches. The mollic epipedon is 12 to 24 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1. It is silty clay, silty clay loam, clay loam, or clay and is neutral to medium acid. The upper part of the B horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2. It is slightly acid or medium acid. The lower part of the B horizon has hue of 2.5Y, value of 4 or 5, and chroma of 2 to 4. It is slightly acid or neutral. The B horizon is clay, silty clay, silty clay loam, or clay loam. The IIC horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 to 4. It typically is loam or clay loam, except for coarser textured layers in the upper part in some pedons. The IIC horizon is mildly alkaline or moderately alkaline.

Jeffers series

The Jeffers series consists of poorly drained soils. These soils have moderately slow permeability. They formed in calcareous, loamy glacial till. These soils are on rims of depressions, and on low rises of glacial moraines and till plains. Slopes are 0 to 2 percent.

Jeffers soils are similar to Canisteo soils and are commonly adjacent to Glencoe and Letri soils. Canisteo soils do not have gypsum and underlying, firm glacial till. They are in positions on the landscape similar to Jeffers soils. Glencoe soils are very poorly drained and have a thicker mollic epipedon. They are in low gradient drainageways and shallow depressions. Letri soils do not have free carbonates in all parts. They are on broad flats.

Typical pedon of Jeffers clay loam, 1,500 feet east and 1,500 feet north of the SW corner of sec. 23, T. 107 N., R. 37 W.:

Ap—0 to 11 inches; black (2.5Y 2/1) clay loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure; very friable; about 2 percent coarse fragments; about 13 percent diffuse carbonates; about 5 percent gypsum powder in root channels and coatings on faces of peds and few free 1- to 5-millimeter long crystals; strong effervescence; mildly alkaline; abrupt smooth boundary.

A12—11 to 16 inches; very dark gray (2.5Y 3/1) clay loam, dark gray (2.5Y 4/1) dry; weak fine subangular blocky structure; very friable; common very dark grayish brown disseminated carbonates; about 3 percent gypsum powder in root channels and coatings on faces of peds and few 1- to 5-millimeter long crystals; strong effervescence; mildly alkaline; abrupt irregular boundary.

B1g—16 to 20 inches; dark gray (2.5Y 4/1) clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very friable; common olive brown (2.5Y 4/4) and very dark grayish brown (2.5Y 3/2) worm casts; about 5 percent coarse fragments; about 14 percent diffuse carbonates; about 1 percent gypsum powder in root channels and coatings on faces of peds; violent effervescence; mildly alkaline; clear wavy boundary.

B2gca—20 to 24 inches; dark gray (2.5Y 4/1) clay loam; common medium faint grayish brown (2.5Y 5/2) mottles; weak fine subangular blocky structure; very friable; many olive gray (5Y 5/2) worm casts; about 8 percent coarse fragments; about 16 percent diffuse and common 5- to 10-millimeter in diameter, soft masses of carbonates; about 2 percent gypsum powder in root channels and coating on faces of peds and few 1- to 5-millimeter long crystals; violent effervescence; mildly alkaline; clear wavy boundary.

B3ca—24 to 30 inches; grayish brown (2.5Y 5/2) clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; very friable; few grayish brown (2.5Y 5/2) worm casts; about 10 percent coarse fragments; about 20 percent diffuse and common 5- to 10-millimeter diameter soft masses of carbonates; about 1 percent gypsum powder and few 1- to 5-millimeter long crystals in 5- to 10-millimeter diameter nests; violent effervescence; mildly alkaline; clear wavy boundary.

IIC1ca—30 to 38 inches; grayish brown (2.5Y 5/2) loam; many medium and coarse distinct yellowish brown (10YR 5/6) mottles; massive; firm; about 10 percent coarse fragments; about 23 percent diffuse and few 5- to 10-millimeter diameter soft masses of carbonates; strong effervescence; mildly alkaline; clear wavy boundary.

IIC2ca—38 to 60 inches; light olive brown (2.5Y 5/4) loam; many medium faint grayish brown (2.5Y 5/2) and few medium distinct yellowish brown (10YR 5/6) mottles; massive; firm; about 10 percent coarse fragments; about 17 percent diffuse and few 5- to 10-millimeter diameter, soft masses of carbonates; few 1- to 5-millimeter diameter, dark soft masses of iron and manganese oxides; strong effervescence; mildly alkaline.

The solum is 26 to 40 inches thick. The mollic epipedon is 14 to 24 inches thick. The calcium carbonate equivalent is 5 to 25 percent, and a calcic horizon is below a depth of 16 inches. Gypsum comprises 1 to 5 percent of the solum. The solum and the IIC horizon are mildly alkaline or moderately alkaline.

The A horizon has value of 2 or 3 and chroma of 1. The B horizon has hue of 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is loam or clay loam. The IIC horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 2 to 4. It is loam or clay loam.

Jeffers Variant

The Jeffers Variant consists of somewhat poorly drained soils. These soils have moderately slow permeability. They formed in calcareous, loamy glacial till. These soils are on rises adjacent to depressions in glacial moraines and till plains. Slopes are 2 to 4 percent.

Jeffers Variant soils are similar to Crippin soils and are commonly adjacent to Glencoe and Jeffers soils. Crippin soils are in similar positions on the landscape but do not have gypsum. Glencoe soils are very poorly drained, have a thicker mollic epipedon, and do not have carbonates and gypsum in the sola. They are in low gradient drainageways and shallow depressions. Jeffers soils are poorly drained and contain more carbonates and less gypsum in the solum. They are on slightly convex slopes on broad flats and rims of depressions.

Typical pedon of Jeffers Variant, 2 to 4 percent slopes, 1,250 feet north and 100 feet west of the SE corner of sec. 30, T. 107 N., R. 36 W.:

Ap—0 to 12 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; weak fine and very fine subangular blocky structure; friable; about 2 percent coarse fragments; about 6 percent diffuse carbonates; about 4 percent diffuse powder and common 1- to 3- millimeter long crystals of gypsum; strong effervescence; mildly alkaline; abrupt smooth boundary.

A3cs—12 to 16 inches; black (2.5Y 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and very fine subangular blocky structure; friable; many dark grayish brown (2.5Y 4/3) worm casts; about 3 percent coarse fragments; about 8 percent diffuse carbonates; about 18 percent diffuse powder and 1- to 3-millimeter long crystals of gypsum; strong effervescence; mildly alkaline; clear irregular boundary.

B21gcs—16 to 21 inches; dark grayish brown (2.5Y 4/2) loam, dark grayish brown (2.5Y 4/3) dry; few fine faint grayish brown (2.5Y 5/2) mottles; weak fine and very fine subangular blocky structure; friable; many dark grayish brown (2.5Y 3/2) worm casts; about 5 percent coarse fragments; about 12 percent diffuse carbonates; about 18 percent diffuse powder and many 1- to 3-millimeter long crystals of gypsum; violent effervescence; mildly alkaline; clear irregular boundary.

B22gca—21 to 29 inches; dark grayish brown (2.5Y 4/2) loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; common olive brown (2.5Y 4/4) and light olive brown (2.5Y 5/4) worm casts; about 7 percent coarse fragments; about 18 percent diffuse carbonates; about 5 percent diffuse gypsum powder; violent effervescence; mildly alkaline; abrupt wavy boundary.

B3ca—29 to 35 inches; olive brown (2.5Y 4/4) loam; common coarse distinct grayish brown (10YR 5/4) and few coarse prominent dark brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; friable; about 5 percent coarse fragments; about 20 percent diffuse and few 5- to 10-millimeter diameter soft masses of carbonates; violent effervescence; mildly alkaline; abrupt wavy boundary.

Cgca—35 to 60 inches; grayish brown (2.5Y 5/2) loam; common coarse prominent dark brown (7.5YR 4/4) mottles; massive; friable; about 4 percent coarse fragments; about 15 percent diffuse and 1- to 3-millimeter diameter soft masses of carbonates; violent effervescence; mildly alkaline.

The solum is 24 to 40 inches thick. The mollic epipedon is 10 to 18 inches thick. Gypsum comprises 1 to 15 percent of the upper part of the A horizon. It comprises 5 to 30 percent of the lower part of the A horizon and the upper part of the B horizon.

The A horizon is neutral in color or has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1. It is clay loam or loam and is mildly alkaline or moderately alkaline. The B horizon has hue of 2.5Y, value of 4 or 5, and chroma of 2 to 4. It is loam or clay loam and is mildly alkaline or moderately alkaline. The Cca horizon has hue of 2.5Y, value of 4 or 5, and chroma of 2 to 4. It is loam, clay loam, or silt loam and is mildly alkaline or moderately alkaline.

Kingston series

The Kingston series consists of moderately well drained, moderately permeable soils. These soils formed in silty, glacial lacustrine sediment on glacial lake plains. They are on low rises on glacial lake plains and till plains. Slopes are 1 to 3 percent.

Kingston soils are similar to Ransom soils and are commonly adjacent to Ransom, Rushmore, and Truman soils. Ransom soils are moderately well drained and somewhat poorly drained and have horizons that formed in glacial till at a depth less than 40 inches. They are in positions on the landscape similar to Kingston soils. Rushmore soils are poorly drained and have horizons that formed in glacial till within a depth of 40 inches. They are in swales. Truman soils are well drained and formed in silty, glacial lacustrine sediment. They are on knolls.

Typical pedon of Kingston silt loam, 2,000 feet south and 100 feet west of the NE corner of sec. 23, T. 105 N., R. 36 W.:

Ap—0 to 12 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; very friable; neutral; abrupt smooth boundary.

A12—12 to 20 inches; very dark gray (10YR 3/1) silt loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; very friable; many black (10YR 2/1) worm casts; neutral; clear irregular boundary.

B21—20 to 32 inches; dark grayish brown (2.5Y 4/2) silt loam; weak fine subangular blocky structure; very friable; common very dark grayish brown (2.5Y 3/2) worm casts; weak effervescence; neutral; clear wavy boundary.

B22ca—32 to 38 inches; olive brown (2.5Y 4/4) silt loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak coarse platy structure; very friable; about 18 percent diffuse and few 1- to 3-millimeter diameter soft masses of carbonates; violent effervescence; mildly alkaline; clear wavy boundary.

C1ca—38 to 43 inches; light olive brown (2.5Y 5/4) silt loam; few fine and medium distinct yellowish brown (10YR 5/6) mottles; massive; very friable; about 20 percent diffuse and common 5- to 10-millimeter diameter soft masses of carbonates; violent effervescence; mildly alkaline; clear wavy boundary.

C2—43 to 60 inches; light olive brown (2.5Y 5/4) silt loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; very friable; strong effervescence; mildly alkaline; abrupt wavy boundary.

Thickness of the solum and depth to free carbonates are 20 to 40 inches. The mollic epipedon is 12 to 24 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1. It is silt loam, silty clay loam, or loam and high in content of very fine sand. The A horizon is slightly acid or neutral. The B horizon has hue of 10YR or 2.5Y, value of 3 or 4 in the upper part and 4 or 5 in the lower part and chroma of 2 in the upper part and 2 to 4 in the lower part. It is silt loam or silty clay loam. The upper part of the B horizon is slightly acid or neutral, and the lower part is neutral or mildly alkaline. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 to 4. It is silt loam or silty clay loam and mildly alkaline or moderately alkaline.

Letri series

The Letri series consists of poorly drained soils. These soils have moderately slow permeability. They formed in calcareous, loamy glacial till. These soils are in swales and on broad flats of glacial moraines and glacial till plains. Slopes are 0 to 2 percent.

Letri soils are similar to Rushmore soils and are commonly adjacent to Everly and Wilmonton soils. Rushmore soils are fine-silty. They are in positions on the landscape similar to Letri soils. Everly soils are well drained and are on convex side slopes and hilltops on glacial moraines and glacial till plains. Wilmonton soils are moderately well drained and somewhat poorly drained and are on low rises.

Typical pedon of Letri clay loam, 1,520 feet south and 500 feet east of the NW corner of sec. 29, T. 106 N., R. 38 W.:

Ap—0 to 12 inches; black (N 2/0) clay loam, very dark brown (10YR 2/2) dry; weak fine subangular blocky structure; friable; many olive gray (5Y 4/2) worm casts in the lower part; about 3 percent coarse fragments; strong effervescence in a few parts; neutral; clear irregular boundary.

A3—12 to 19 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; many olive gray (5Y 4/2) worm casts in the lower part; about 3 percent coarse fragments; neutral; clear irregular boundary.

B21g—19 to 26 inches; olive gray (5Y 4/2) clay loam; weak fine subangular blocky structure; friable; many olive gray (5Y 3/2) worm casts; thin stone line in lower part with about 40 percent coarse fragments; about 5 percent coarse fragments in other parts; about 12 percent diffuse carbonates; violent effervescence; mildly alkaline; clear irregular boundary.

IIB22gca—26 to 33 inches; olive gray (5Y 5/2) loam; few fine distinct olive yellow (2.5Y 6/6) and gray (5Y 6/1) mottles; moderate medium angular blocky structure; friable; common olive gray (5Y 3/2) worm casts; about 7 percent coarse fragments; about 24 percent diffuse and many 5- to 10- millimeter diameter soft masses of carbonates; violent effervescence; mildly alkaline; clear wavy boundary.

IIClgca—33 to 47 inches; olive gray (2.5Y 5/2) loam; many coarse prominent yellowish red (10YR 5/6) mottles; strong coarse angular blocky structure; firm; about 8 percent coarse fragments; about 17 percent diffuse and few 5- to 10-millimeter diameter soft masses of carbonates; violent effervescence; mildly alkaline; clear wavy boundary.

IIC2ca—47 to 60 inches; light brownish gray (2.5Y 6/2) loam; many coarse prominent yellowish red (10YR 4/5) mottles; massive; firm; about 6 percent coarse fragments; about 20 percent diffuse carbonates; violent effervescence; mildly alkaline.

The solum is 20 to 36 inches thick. Depth to free carbonates is 16 to 30 inches, and the mollic epipedon is 12 to 24 inches thick. The upper mantle is 30 inches or less thick. The stone line is absent in some pedons.

The A horizon is neutral in color or has hue of 10YR, 2.5Y, or 5Y; value of 2 or 3; and chroma of 1. Chroma of 2 or hue of 5Y is also included. It is silty clay loam or clay loam and is slightly acid to mildly alkaline. They are neutral to moderately alkaline. The IIC horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to 4. It is clay loam or loam and mildly alkaline or moderately alkaline.

Linder series

The Linder series consists of somewhat poorly drained soils. Permeability is moderate or moderately rapid in the solum and rapid in the underlying material. These soils formed in glacial outwash material consisting of a loamy mantle and underlying sandy and gravelly sediments. They are on low rises in glacial outwash plains and terraces. Slopes are 0 to 2 percent.

Linder soils are similar to Biscay soils and are commonly adjacent to Biscay and Estherville soils. Biscay soils formed in similar sediments and are poorly drained. They are in swales; on broad flats; and in narrow, upland draws. Estherville soils formed in similar sediments and are well drained. They are on raised, broad flats; narrow ridge tops; and knolls.

Typical pedon of Linder loam, 2,630 feet south and 10 feet east of the NW corner of sec. 31, T. 106 N., R. 36 W.:

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

A3—10 to 16 inches; very dark brown (10YR 2/2) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; slightly acid; clear wavy boundary.

B2—16 to 23 inches; dark grayish brown (2.5Y 4/2) sandy loam; weak coarse angular blocky structure; friable; common very dark grayish brown (10YR 3/2) worm casts; about 2 percent coarse fragments; slightly acid; clear wavy boundary.

B3—23 to 33 inches; dark grayish brown (2.5Y 4/2) loamy sand; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine angular blocky structure; friable; common very dark grayish brown (10YR 3/2) worm casts; about 2 percent coarse fragments; neutral; clear wavy boundary.

IIC1—33 to 40 inches; dark brown (10YR 4/3) sand; single grain; loose; about 5 percent coarse fragments; neutral; clear wavy boundary.

IIC2—40 to 60 inches; light olive brown (2.5Y 4/3) sand; single grain; loose; about 7 percent coarse fragments; slight effervescence; mildly alkaline.

The solum is 20 to 42 inches thick. The depth to sandy sediment is 22 to 36 inches. The mollic epipedon is 10 to 20 inches thick.

The A horizon is neutral in color or has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is loam or sandy loam and medium acid to mildly alkaline. The B horizon has hue of 10YR and value of 4 or 5 or hue of 2.5Y, value of 4 or 5, and chroma of 2 or 3. The B horizon is sandy loam, loamy sand, or sand with some gravel. It is slightly acid to mildly alkaline. The IIC horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 4. It is sand or coarse sand with 5 to 50 percent gravel or loamy sand, and it is mildly alkaline or moderately alkaline. It has carbonates throughout some pedons.

Lura series

The Lura series consists of very poorly drained soils. These soils have slow permeability. They formed in glacial lacustrine sediment and are in depressions on glacial lake plains and till plains. Slopes are less than 1 percent.

Lura soils are similar to Barbert soils and are commonly adjacent to Guckeen and Marna soils. Barbert soils formed in similar material but have an albic and an argillic horizon. They are in shallow depressions. Guckeen soils are somewhat poorly drained and have a IIC horizon of glacial till. They are on low rises. Marna soils are poorly drained and have a IIC horizon of glacial till. They are on broad flats in low gradient drainageways and swales.

Typical pedon of Lura silty clay, 800 feet east and 50 feet south of the NW corner of sec. 16, T. 108 N., R. 36 W.:

Ap—0 to 10 inches; black (N 2/0) silty clay, very dark gray (N 3/0) dry; moderate fine angular blocky structure; friable; plastic, sticky; neutral; abrupt smooth boundary.

A12—10 to 20 inches; black (N 2/0) silty clay, very dark gray (N 3/0) dry; moderate fine angular blocky structure; firm; plastic; sticky; neutral; clear smooth boundary.

A13—20 to 27 inches; black (5Y 2/1) clay, very dark gray (5Y 5/3) dry; weak fine prismatic structure parting to moderate fine angular blocky; firm; plastic; sticky; neutral; clear wavy boundary.

A14—27 to 37 inches; black (5Y 2/2) clay, very dark gray (5Y 3/1) dry; many fine faint dark olive gray (5Y 3/2) mottles; weak fine prismatic structure parting to moderate fine angular blocky; firm; plastic, sticky; neutral; clear wavy boundary.

B1g—37 to 43 inches; dark gray (5Y 4/1) clay; many medium faint olive (5Y 4/4) mottles; moderate fine prismatic structure parting to moderate fine angular blocky; firm; many black (5Y 2/2) krotovina; neutral; clear wavy boundary.

B2g—43 to 52 inches; olive gray (5Y 4/2) silty clay; many fine faint olive (5Y 4/4) mottles; moderate coarse prismatic structure; firm; many black (5Y 2/2) krotovina; neutral; clear wavy boundary.

Cg—52 to 60 inches; olive gray (5Y 5/2) silty clay loam; many coarse prominent dark greenish gray (5G 4/1) mottles; massive; firm; common 5- to 10-millimeter diameter dark masses of iron and manganese oxides; neutral.

Thickness of the solum and depth to free carbonates are 40 to 80 inches. The mollic epipedon is 30 to 66 inches. Loam or clay loam glacial till is at a depth of 40 inches or more in some pedons.

The A horizon is neutral in color or has hue of 10YR, 2.5Y, or 5Y; value of 2 in the upper part and 3 in the lower part; and chroma of 1 or less. It is clay, silty clay, or silty clay loam. The A horizon is slightly acid or neutral. The B horizon has hue of 5Y, value of 4, and chroma of 1 or 2. It is silty clay or clay with silty clay loam in the lower part in some pedons. The B horizon is slightly acid or neutral. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is silty clay loam, silty clay, or clay and is neutral or mildly alkaline.

Madelia series

The Madelia series consists of poorly drained soils. These soils have moderate permeability. They formed in silty, glacial lacustrine sediment. These soils are on broad flats on glacial lake plains. Slopes are 0 to 2 percent.

Madelia soils are similar to Rushmore soils and are commonly adjacent to Kingston and Truman soils. Rushmore soils have horizons in loamy glacial till beginning at a depth of less than 40 inches. Kingston soils formed in similar sediment but are moderately well drained. They are on broad, low rises. Truman soils formed in similar sediment but are well drained. They are on knolls.

Typical pedon of Madelia silty clay loam, 2,500 feet east and 60 feet north of the SW corner of sec. 25, T. 105 N., R. 37 W.:

Ap—0 to 7 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

A12—7 to 14 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

A3—14 to 22 inches; very dark gray (10YR 3/1) silt loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; common black (N 2/0) worm casts; slightly acid; clear wavy boundary.

B21g—22 to 26 inches; dark gray (5Y 4/1) silty clay loam; common fine prominent brown (7.5YR 4/4) mottles; moderate fine subangular blocky structure; friable; neutral; clear irregular boundary.

B22g—26 to 33 inches; olive gray (5Y 5/2) silty clay loam; common fine prominent strong brown (7.5YR 5/6) mottles; moderate fine subangular blocky structure; friable; mildly alkaline; clear irregular boundary.

C1g—33 to 48 inches; light olive gray (5Y 6/2) stratified silt loam and olive (5Y 5/3) very fine sand; common medium prominent yellowish brown (10YR 5/6) mottles; massive; friable; violent effervescence; mildly alkaline; clear smooth boundary.

IIC2—48 to 60 inches; light olive brown (2.5Y 5/4) loam; high in very fine sands; many medium faint grayish brown (2.5Y 5/2) mottles; massive; friable; about 7 percent coarse fragments; violent effervescence; mildy alkaline.

Thickness of the solum and depth to free carbonates are 20 to 40 inches. The mollic epipedon is 14 to 24 inches thick. Loamy glacial till begins at a depth as shallow as 40 inches in some pedons.

The A horizon is neutral in color or has hue of 10YR, value of 2 or 3, and chroma of 1. It is silt loam or silty clay loam and is neutral or slightly acid. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2 but has chroma of 3 only with hue of 5Y. It is silty clay loam or silt loam and slightly acid to mildly alkaline. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 to 4. It is silt loam, silty clay loam, or loam with a high content of very fine sand.

Marna series

The Marna series consists of poorly drained soils. These soils have slow permeability. They formed in clayey, glacial lacustrine sediment and in underlying, loamy glacial till. Marna soils are in shallow swales on glacial lake plains and in drainageways on glacial till plains. Slopes are 0 to 2 percent.

These soils have less clay than the defined range for the series, but this difference does not alter their usefulness or behavior.

Marna soils are similar to Rushmore soils and are commonly adjacent to Guckeen and Lura soils. Rushmore soils contain less clay in the solum. They are in positions on the landscape similar to Marna soils. Guckeen soils are somewhat poorly drained and are on broad, low rises. Lura soils are very poorly drained and have a thicker mollic epipedon. They are in closed depressions.

Typical pedon of Marna silty clay, 700 feet north and 60 feet east of the SW corner of sec. 17, T. 105 N., R. 37 W.:

Ap—0 to 8 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate fine subangular blocky structure; friable; slightly acid; abrupt boundary.

A12—8 to 17 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate fine angular blocky structure; friable; slightly acid; abrupt wavy boundary.

A3—17 to 22 inches; very dark gray (5Y 3/1) silty clay loam, very dark gray (5Y 3/1) dry; moderate fine angular blocky structure; friable; common olive (5Y 4/3) worm casts; slightly acid; clear irregular boundary.

B21g—22 to 27 inches; olive gray (5Y 4/2) silty clay loam; few fine distinct olive (5Y 5/6) mottles; moderate fine angular blocky structure; friable; many black (5Y 2/2) worm casts; neutral; clear irregular boundary.

B22g—27 to 36 inches; olive gray (5Y 5/2) silty clay loam; many fine distinct light olive brown (2.5Y 5/4) mottles; moderate fine prismatic structure parting to moderate fine angular blocky; friable; few black (5Y 2/2) worm casts; neutral; clear wavy boundary.

IIB3g—36 to 48 inches; olive gray (5Y 5/2) clay loam; common coarse distinct light olive brown (2.5Y 5/6) mottles; weak fine prismatic structure parting to **weak medium angular blocky; friable; about 7 per**cent coarse fragments; strong effervescence; mildly alkaline; clear wavy boundary.

IICg—48 to 60 inches; olive gray (5Y 5/2) loam; many coarse prominent yellowish brown (10YR 5/6) mottles; massive; firm; about 8 percent coarse fragments; strong effervescence; mildly alkaline.

Thickness of the solum and depth to free carbonates are 26 to 48 inches. The mollic epipedon is 16 to 24 inches thick. Depth to glacial till is 24 to 40 inches.

The A horizon is neutral in color or has hue of 10YR or 5Y, value of 2 or 3, and chroma of 1. It is silty clay loam, silty clay, or clay and slightly acid or neutral. The B horizon and IIB horizon have hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The B horizon in the upper lacustrine sediment is silty clay loam, silty clay, or clay; and the IIB horizon is loam or clay loam. They are slightly acid to mildly alkaline. The IIC horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is loam or clay loam and mildly alkaline or moderately alkaline.

Mayer series

The Mayer series consists of poorly drained, calcareous soils. These soils have moderate permeability in the upper part and rapid permeability in the underlying material. They formed in glacial outwash consisting of a loamy mantle over sandy and gravelly sediments on glacial outwash plains and terraces. These soils are on broad flats and on rims of depressions. Slopes are 0 to 2 percent.

These soils have transitional layers between the loamy mantle and the IIC material, which are too thick for the defined range of the series. They do not have contrasting layers. This difference, however, does not alter their usefulness or behavior.

Mayer soils are similar to Canisteo soils and are commonly adjacent to Biscay and Talcot soils. Canisteo soils do not have a sandy or gravelly IIC horizon. Biscay soils are poorly drained and formed in similar material but are noncalcareous. They are on broad flats. Talcot soils are very poorly drained and calcareous but have more clay in their sola. They are in shallow depressions and low gradient drainageways.

Typical pedon of Mayer loam, 2,500 feet north and 300 feet west of the SE corner of sec. 7, T. 105 N., R. 37 W.:

Ap—0 to 10 inches; black (N 2/0) loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure; friable; about 10 percent coarse fragments; violent effervescence; mildly alkaline; abrupt smooth boundary.

A12—10 to 17 inches; black (N 2/0) loam, very dark gray (N 3/0) dry; common coarse distinct olive (5Y 4/3) mottles; moderate medium subangular blocky structure; friable; about 10 percent coarse fragments; violent effervescence; mildly alkaline; clear wavy boundary.

B1g—17 to 23 inches; dark olive gray (5Y 4/2) loam; many fine distinct olive (5Y 5/6) mottles; weak medium subangular blocky structure; friable; few black (5Y 2/2) worm casts; about 15 percent coarse fragments; violent effervescence; mildly alkaline; clear wavy boundary.

B2g—23 to 30 inches; olive gray (5Y 5/2) sandy loam; many fine and coarse prominent yellowish brown (10YR 5/6) and few fine distinct olive brown (2.5Y 4/4) mottles; massive; friable; about 15 percent coarse fragments; violent effervescence; mildly alkaline; clear wavy boundary.

IIB3g—30 to 40 inches; olive gray (5Y 5/2) gravelly sandy loam; many fine prominent yellowish brown (10YR 5/6) and few fine faint olive gray (5Y 5/4) mottles; massive; friable; about 20 percent coarse fragments; violent effervescence; mildly alkaline; clear wavy boundary.

IIC—40 to 60 inches; light olive brown (2.5Y 5/3) gravelly loamy sand; many fine prominent yellowish brown (10YR 5/6) mottles; single grain; loose; about 25 percent coarse fragments; violent effervescence; mildly alkaline.

Thickness of the solum and depth to sand and gravel is 20 to 40 inches. The mollic epipedon is 14 to 24 inches thick.

The A horizon is neutral in color or has hue of 10YR, 5Y, or 2.5Y; value of 2 or 3; and chroma of 1. It is loam or silt loam and mildly alkaline or moderately alkaline. The B horizon has hue of 10YR, 2.5Y, or 5Y; value of 4 or 5; and chroma of 1 with hue of 10YR, 1 or 2 with hue of 2.5Y, or 1 to 3 with hue of 5Y; or it is neutral with value of 4 or 5. The upper part of the B horizon is loam or sandy clay loam. The IIB horizon also includes sandy loam or loamy sand with 20 to 50 percent coarse fragments. The IIC horizon has hue of 10YR, 5Y, or 2.5Y; value of 3 to 5; and chroma of 1 to 3. It is gravelly sand or coarse sand; stratified sand, coarse sand, or gravelly loamy sand; or loamy coarse sand. It is mildly alkaline or moderately alkaline. It does not have free carbonates in the upper part in some pedons.

Millington series

The Millington series consists of poorly drained, calcareous soils that formed in loamy alluvial sediment on flood plains. These soils have moderate permeability. Slopes are 0 to 2 percent.

These soils have more gypsum than the defined range for the series, but this difference does not affect their usefulness or behavior.

Millington soils are similar to Coland soils and are commonly adjacent to Coland and Spillville soils. Coland soils are noncalcareous. They are in swales. Spillville soils are moderately well drained and somewhat poorly drained. They are on low rises.

Typical pedon of Millington silty clay loam, 600 feet north and 50 feet west of the SE corner of sec. 16, T. 108 N., R. 36 W.:

A11—0 to 13 inches; black (10YR 2/1) silty clay loam, dark gray (N 4/0) dry; weak medium platy structure parting to weak fine granular; friable; about 2 percent gypsum powder in root channels; strong effervescence; mildly alkaline; clear wavy boundary.

A12g—13 to 30 inches; very dark gray (5Y 3/1) silty clay loam, dark gray (5Y 4/1) dry; weak medium subangular blocky structure; friable; about 5 percent diffuse powder and 1- to 3-millimeter long crystals of gypsum; violent effervescence; moderately alkaline; gradual wavy boundary.

B1g—30 to 40 inches; very dark gray (5Y 3/1) clay loam, dark gray (5Y 4/1) dry; common medium distinct olive (5Y 4/3) mottles; weak fine and medium subangular blocky structure; friable; violent effervescence; moderately alkaline; gradual wavy boundary.

B2g—40 to 48 inches; dark olive gray (5Y 3/2) clay loam, gray (5Y 5/1) dry; common medium faint olive (5Y 4/3) mottles; weak fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; mildly alkaline; gradual smooth boundary.

C—48 to 60 inches; olive (5Y 4/3) clay loam; few fine distinct light olive brown (2.5Y 5/6) mottles; massive; friable; about 3 percent coarse fragments; common 5- to 10-millimeter and many 1- to 3-millimeter diameter soft masses of carbonates; strong effervescence; mildly alkaline.

Thickness of the solum and the mollic epipedon is 30 to 50 inches. The solum and underlying material is calcareous. The solum contains 1 to 15 percent gypsum in powder and crystal forms.

The A horizon is neutral in color or has hue of 10YR, 2.5Y, or 5Y and value of 2 or 3. It is stratified or continuous clay loam, loam, or silty clay loam. Also, it has sandy strata in some pedons. The A horizon is mildly alkaline or moderately alkaline. The B horizon has hue of 2.5Y or 5Y, value of 2 to 4, and chroma of 1 or 2. It has the same range in texture and reaction as the A horizon. The C horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 2 to 4. It is loam or clay loam or is stratified with silty, sandy, and loamy layers. The C horizon is mildly alkaline or moderately alkaline.

Nicollet series

The Nicollet series consists of moderately well drained or somewhat poorly drained soils. These soils have moderate permeability. They formed in calcareous, loamy glacial till. These soils are on low rises in glacial moraines and on glacial till plains. Slopes are 1 to 3 percent.

Nicollet soils are similar to Wilmonton soils and are commonly adjacent to Crippin and Webster soils. Wilmonton soils are in positions on the landscape similar to Nicollet soils but have a firm IIC horizon in glacial till. Crippin soils are somewhat poorly drained and calcareous and are on low, convex rises. Webster soils are poorly drained and are on broad flats.

Typical pedon of Nicollet clay loam, 2,500 feet south and 1,300 feet west of the NE corner of sec. 30, T. 107 N., R. 34 W.:

Ap—0 to 11 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; very friable; about 4 percent coarse fragments; slightly acid; abrupt smooth boundary.

A3—11 to 16 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate medium angular blocky structure parting to weak fine subangular blocky; very friable; about 3 percent coarse fragments; many very dark grayish brown (2.5Y 3/2) worm casts; slightly acid; abrupt irregular boundary.

B21—16 to 28 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine faint grayish brown (2.5Y 5/2) mottles; weak coarse angular blocky structure parting to weak fine and medium subangular blocky; friable; about 2 percent coarse fragments; few very dark grayish brown (2.5Y 3/2) worm casts; slightly acid; clear wavy boundary.

B22g—28 to 37 inches; grayish brown (2.5Y 5/2) loam; common fine distinct light olive brown (2.5Y 5/6) mottles; weak fine and medium prismatic structure parting to weak fine and medium subangular blocky; friable; about 6 percent coarse fragments; slightly acid; abrupt wavy boundary.

C1gca—37 to 52 inches; grayish brown (2.5Y 5/2) loam; many coarse distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 8 percent coarse fragments; few 5- to 10-millimeter diameter white soft masses of carbonates; few 1- to 3-millimeter diameter masses of iron and manganese oxides; strong effervescence; mildly alkaline; abrupt wavy boundary.

C2g—52 to 60 inches; grayish brown (2.5Y 5/2) loam; many coarse distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 8 percent coarse fragments; few threads of carbonates; few masses of iron and manganese oxides; violent effervescence; mildly alkaline.

Thickness of the solum and depth to free carbonates are 20 to 40 inches. The mollic epipedon is 10 to 18 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is loam or clay loam and medium acid to neutral. The B horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 4. It is loam or clay loam. It is medium acid to neutral in the upper part and slightly acid to mildly alkaline in the lower part. The C horizon has hue of 2.5Y or 5Y, value of 5, and chroma of 2 to 4. It has few or common soft masses of calcium carbonate in the upper part.

Normania series

The Normania series consists of moderately well drained soils. They have moderate permeability. These soils formed in shaly, calcareous glacial till. They are on broad, low rises on glacial moraines and till plains. Slopes are 1 to 3 percent.

Normania soils are similar to Nicollet soils and are commonly adjacent to Ves and Webster soils. Nicollet soils have less shale and do not have a calcic horizon. They are in positions on the landscape similar to Normania soils. Ves soils are well drained and have greater slopes. Webster soils are poorly drained and are on broad flats.

Typical pedon of Normania loam, 2,400 feet south and 400 feet west of the NE corner of sec. 13, T. 107 N., R. 34 W.:

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark brown (10YR 2/2) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

A12—9 to 18 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 4 percent coarse fragments; neutral; clear wavy boundary.

B2—18 to 25 inches; olive brown (2.5Y 4/4) loam; weak coarse subangular blocky structure; friable; few black (10YR 2/1) worm casts; about 5 percent coarse shale fragments and small pebbles; strong effervescence; mildly alkaline; clear irregular boundary.

B3ca—25 to 34 inches; light olive brown (2.5Y 5/4) loam; common medium faint grayish brown (2.5Y 5/2) mottles; weak coarse angular blocky structure parting to weak fine subangular blocky; friable; about 6 percent coarse shale fragments and small pebbles; about 18 percent diffuse and few soft masses of carbonates; violent effervescence; moderately alkaline; clear wavy boundary.

C1ca—34 to 48 inches; light olive brown (2.5Y 5/4) loam; many coarse distinct yellowish brown (10YR 5/6) and common fine faint grayish brown (2.5Y 5/2) mottles; massive; friable; about 8 percent coarse shale fragments and small pebbles; about 16 percent diffuse and few soft masses of carbonates; violent effervescence; moderately alkaline; clear wavy boundary.

C2—48 to 60 inches; olive brown (2.5Y 4/4) loam; many coarse distinct yellowish brown (10YR 5/6) and common fine faint grayish brown (2.5Y 5/2) mottles; massive; friable; about 7 percent coarse shale fragments and small pebbles; strong effervescence; mildly alkaline.

The solum is 18 to 40 inches thick. Depth to free carbonates is 18 to 36 inches. The mollic epipedon is 10 to 20 inches thick. Coarse fragments and small pebbles comprise 3 to 8 percent of the solum and the C horizon. The 2- to 5-millimeter part contains 20 to 50 percent shale.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1. It is loam or clay loam and neutral or slightly acid. The B2 horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 to 4. The B horizon is neutral or mildly alkaline. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 to 4. It is mildly alkaline or moderately alkaline.

Ransom series

The Ransom series consists of moderately well drained or somewhat poorly drained soils. These soils have moderately slow permeability. They formed in a 24- to 40-inch mantle of silty, glacial lacustrine sediment over calcareous, loamy glacial till. Ransom soils are on broad, low rises in glacial lake plains and till plains. Slopes are 1 to 3 percent.

Ransom soils are similar to Kingston soils and are commonly adjacent to Rushmore and Clarion Variant soils. Kingston soils are moderately well drained and are in positions on the landscape similar to Ransom soils but are deeper to glacial till. Rushmore soils are poorly drained and are on broad flats. Clarion Variant soils are well drained and are on knolls. Rushmore and Clarion Variant soils formed in material similar to that of the Ransom soils.

Typical pedon of Ransom silty clay loam, 1,400 feet east and 2,500 feet south of the NW corner of sec. 36, T. 106 N., R. 37 W.:

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

A12—7 to 14 inches; very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) dry; moderate medium angular blocky structure parting to moderate fine subangular blocky; friable; neutral; clear wavy boundary.

B1—14 to 19 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; moderate medium angular blocky structure parting to moderate fine subangular blocky; friable; many very dark brown (10YR 2/2) worm casts; neutral; clear wavy boundary.

B21—19 to 28 inches; olive brown (2.5Y 4/4) silty clay loam; few fine distinct grayish brown (2.5Y 5/2) mottles; common very dark brown (10YR 2/2) worm casts; moderate medium angular blocky structure parting to moderate fine subangular blocky; friable; neutral; clear wavy boundary.

B22—28 to 35 inches; olive brown (2.5Y 4/4) silty clay loam; few fine faint grayish brown (2.5Y 5/2) mottles; weak fine subangular blocky structure; friable; strong effervescence; mildly alkaline; clear smooth boundary.

IIC1ca—35 to 49 inches; light olive brown (2.5Y 5/4) loam; many coarse distinct yellowish brown (10YR 5/6) mottles; firm; massive; about 8 percent coarse fragments; strong effervescence; moderately alkaline; clear irregular boundary.

IIC2—49 to 60 inches; olive brown (2.5Y 4/4) loam; many coarse distinct yellowish brown (10YR 5/6) mottles; massive; firm; about 6 percent coarse fragments; strong effervescence; moderately alkaline.

Thickness of the solum and depth to free carbonates are 22 to 40 inches. The mollic epipedon is 14 to 22 inches thick. Depth to glacial till is 24 to 40 inches. A stone line 1 to 4 inches thick that contains up to 20 percent coarse fragments is at the base of the upper mantle in some pedons.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is silty clay loam or silt loam. The B horizon and IIB horizon have hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 to 4. The IIB horizon, if present, is loam, clay loam, or silty clay loam with a high content of sand. The B horizon is neutral or slightly acid, and the IIB horizon is neutral or mildly alkaline. The IIC horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 3 to 5. It is loam or clay loam and mildly alkaline or moderately alkaline.

Romnell series

The Romnell series consists of poorly drained soils. These soils have moderately slow permeability. They formed in calcareous, loamy glacial till in broad depressions on glacial moraines and glacial till plains. Slopes are 0 to 2 percent.

Romnell soils are similar to Glencoe soils and are commonly adjacent to Glencoe and Letri soils. Glencoe soils are very poorly drained and do not have gypsum. They are in depressions and low gradient drainageways. Letri soils are poorly drained, have a thinner mollic epipedon, do not have gypsum, and have a firm IIC horizon of glacial till. They are on broad flats.

Typical pedon of Romnell clay loam, 2,300 feet west and 30 feet south of the NE corner of sec. 3, T. 108 N., R. 38 W.:

Ap—0 to 10 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; about 1 percent coarse fragments; about 1 percent gypsum powder in root channels and coatings on faces of peds; neutral; abrupt smooth boundary.

A12—10 to 18 inches; very dark gray (N 3/0) silt loam, gray (N 5/0) dry; weak fine and medium platy structure; friable; about 2 percent coarse fragments; about 1 percent gypsum powder in root channels and coatings of faces of peds; neutral; abrupt smooth boundary.

B1—18 to 22 inches; very dark gray (5Y 3/1) clay loam, dark gray (5Y 4/1) dry; weak fine subangular blocky structure; friable; about 1 percent coarse fragments; about 1 percent gypsum powder in root channels and coatings on faces of peds; neutral; abrupt wavy boundary.

B21g—22 to 27 inches; very dark gray (5Y 3/1) clay loam, dark gray (5Y 4/1) dry; many coarse distinct olive (5Y 4/3) mottles; weak coarse prismatic structure parting to weak fine angular blocky; friable; about 2 percent coarse fragments; about 1 percent gypsum powder in root channels and coatings on faces of peds; neutral; abrupt wavy boundary.

B22tgcs—27 to 33 inches; olive gray (5Y 4/2) clay loam; common fine prominent yellowish brown (10YR 5/6) mottles; moderate coarse prismatic structure parting to moderate very fine angular blocky; thin discontinuous clay films on faces of peds; firm; about 5 percent coarse fragments; about 6 percent gypsum powder in root channels and coatings on faces of peds and few 1- to 5-millimeter long gypsum crystals; neutral; abrupt wavy boundary.

B3gcacs—33 to 43 inches; gray (5Y 5/1) clay loam; few fine prominent yellowish brown (10YR 5/6) mottles; moderate coarse prismatic structure parting to moderate fine angular blocky; firm; about 5 percent coarse fragments; about 17 percent diffuse and common 5- to 10-millimeter diameter soft masses of carbonates; about 3 percent gypsum powder in root channels and few 5- to 10-millimeter diameter nests of 1- to 5-millimeter long gypsum crystals; strong effervescence; mildly alkaline; abrupt wavy boundary.

Cgca—43 to 60 inches; gray (5Y 5/1) clay loam; few medium distinct olive brown (2.5Y 4/6) and common medium distinct light olive brown (2.5Y 5/6) mottles; massive; firm; about 8 percent coarse fragments; about 18 percent diffuse and many 1- to 5-millimeter diameter, soft masses of carbonates; about 3 percent 1- to 5-millimeter long gypsum crystals in 5- to 10-millimeter diameter nests; strong effervescence; mildly alkaline.

Thickness of the solum and depth to free carbonates are 30 to 55 inches. The mollic epipedon is 24 to 40 inches thick.

The A horizon is neutral in color or has hue of 5Y or 2.5Y, value of 1 to 3, and chroma of 1 or 2. It is clay loam or silty clay loam. The B horizon has hue of 2.5Y or 5Y, value of 2 to 5, and chroma of 1 or 2. It is clay loam or silty clay loam in the upper part and loam, clay loam, or silty clay loam in the lower part. Also, it has coarser textured subhorizons in some pedons. The B horizon is neutral to moderately alkaline. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is loam or clay loam and is mildly alkaline or moderately alkaline.

Rushmore series

The Rushmore series consists of poorly drained soils. These soils have moderately slow permeability. They formed in a mantle of silty lacustrine sediment over calcareous, loamy glacial till. These soils are in swales and on broad flats on glacial lake plains and till plains. Slopes are 0 to 2 percent.

Rushmore soils are similar to Letri and Madelia soils and are commonly adjacent to Lura and Ransom soils. Letri soils are fine-loamy. They are in areas where the mantle contains more sand and coarse fragments and less silt. Madelia soils can have loamy glacial till at greater depths. Lura soils are very poorly drained and have more clay and a thicker mollic epipedon. They are in shallow, closed depressions. Ransom soils are moderately well drained and somewhat poorly drained and are on broad, low rises.

Typical pedon of Rushmore silty clay loam, 600 feet west and 250 feet south of the NE corner of sec. 17, T. 105 N., R. 37 W.:

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

A12—8 to 15 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; few very dark grayish brown (2.5Y 3/2) worm casts; neutral; clear wavy boundary.

A3g—15 to 19 inches; very dark gray (5Y 3/1) silty clay loam, very dark gray (10YR 3/1) dry; common fine distinct dark grayish brown (2.5Y 4/2) mottles and worm casts; weak fine subangular blocky structure; friable; neutral; clear irregular boundary.

B21g—19 to 25 inches; olive gray (5Y 5/2) silty clay loam; many fine faint olive (5Y 5/3) mottles; weak fine subangular blocky structure; friable; strong effervescence; mildly alkaline; clear wavy boundary.

B22—25 to 31 inches; olive (5Y 5/3) silty clay loam; many medium prominent yellowish brown (10YR 5/6) and many fine faint olive (5Y 5/6) mottles; weak fine subangular blocky structure; friable; strong effervescence; mildly alkaline; clear wavy boundary.

IIC1ca—31 to 49 inches; olive brown (2.5Y 4/4) loam; many coarse prominent yellowish brown (10YR 5/6) mottles; massive; firm; about 10 percent coarse fragments; violent effervescence; mildly alkaline.

IIC2—49 to 60 inches; olive brown (2.5Y 5/4) loam; many coarse distinct yellowish brown (10YR 5/6) mottles; massive; firm; about 10 percent coarse fragments; strong effervescence; mildly alkaline.

Thickness of the solum and depth to free carbonates are 15 to 36 inches. The mollic epipedon is 14 to 24 inches thick. Coarse fragments comprise 2 to 10 percent of the IIB horizon and IIC horizon. Depth to glacial till is 20 to 40 inches. A 0- to 4-inch thick stone line is at the base of the mantle in some pedons.

The A horizon is neutral in color or has hue of 10YR, 2.5Y, or 5Y; value of 2 or 3; and chroma of 1 with hue of 10YR or chroma of 1 or 2 with hue of 2.5Y or 5Y. It is slightly acid to mildly alkaline. The B horizon in the upper lacustrine sediment has hue of 2.5Y or 5Y, value of 4 or 5, and dominant chroma of 1 or 2. The IIB horizon is loam or clay loam. It is neutral to moderately alkaline. The IIC horizon has hue of 10YR, 2.5Y, or 5Y; value of 5 or 6; and chroma of 2 to 4. It is loam or clay loam and mildly alkaline or moderately alkaline.

Salida series

The Salida series consists of excessively well drained, very rapidly permeable soils. These soils formed mostly in sandy and gravelly glacial outwash. They are on side slopes and hilltops on glacial outwash plains. Slopes are 2 to 25 percent.

Salida soils are similar to Estherville soils and are commonly adjacent to Storden and Swanlake soils. Estherville soils are well drained, have a thicker loamy mantle, and have carbonates beginning at greater depths. They have less slope. Storden soils do not have a mollic epipedon and formed in glacial till. They are on convex areas on side slopes and hilltops. Swanlake soils have a calcic horizon and formed in glacial till.

Typical pedon of Salida gravelly sandy loam, from an area of Swanlake-Salida complex, 2 to 6 percent slopes, 2,640 feet north and 1,200 feet east of the SW corner of sec. 34, T. 107 N., R. 34 W.:

Ap—0 to 7 inches; very dark gray (10YR 3/1) gravelly sandy loam, very dark grayish brown (10YR 3/2) dry; weak fine granular parting to single grain; very friable; about 40 percent coarse fragments; neutral; abrupt smooth boundary.

B2—7 to 17 inches; dark yellowish brown (10YR 3/4) gravelly loamy coarse sand; single grain; loose; about 50 percent coarse fragments; neutral; clear wavy boundary.

C—17 to 60 inches; dark yellowish brown (10YR 4/5) very gravelly coarse sand; single grain; loose; about 80 percent coarse fragments; slight effervescence; mildly alkaline.

Thickness of the solum is 7 to 20 inches, and depth to free carbonates is 0 to 20 inches. The mollic epipedon is 7 to 14 inches thick. Coarse fragments comprise 35 to 85 percent of the control section.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 to 3. It is gravelly sandy loam, gravelly coarse sandy loam, gravelly loamy sand, gravelly loamy coarse sand, or gravelly coarse sand. It is slightly acid to mildly alkaline. The B horizon has hue of 10YR and value and chroma of 3 or 4. It is gravelly loamy sand, gravelly loamy coarse sand, gravelly coarse sand, or gravelly sand. It is slightly acid to mildly alkaline. The C horizon has hue of 10YR, value of 4 to 6, and chroma of 2 to 6. It is gravelly or very gravelly coarse sand, or it is gravel stratified with sands.

Spicer series

The Spicer series consists of poorly drained, calcareous soils. They have moderate permeability. These soils formed in silty glacial sediment in glacial lake plains. They are on broad flats and rims of depressions. Slopes are 0 to 2 percent.

Spicer soils are similar to Canisteo soils and are commonly adjacent to Kingston and Madelia soils. Canisteo soils formed in glacial till. Kingston soils are moderately well drained and are on broad, low rises. Madelia soils are poorly drained and are on broad flats.

Typical pedon of Spicer silt loam, 1,200 feet west and 2,600 feet south of the NE corner of sec. 15, T. 105 N., R. 36 W.:

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

A12g—10 to 18 inches; black (N 2/0) silt loam, dark grayish brown (2.5Y 5/4) dry; common fine distinct gray (5Y 5/1) mottles; weak fine subangular blocky structure; very friable; common black (N 2/0) worm casts; violent effervescence; moderately alkaline; clear irregular boundary.

B1g—18 to 26 inches; dark grayish brown (2.5Y 4/2) silt loam; few fine distinct gray (5Y 5/1) mottles; weak medium subangular blocky structure; very friable; many black (10YR 2/1) worm casts; violent effervescence; moderately alkaline; clear irregular boundary.

B22g—26 to 35 inches; olive brown (2.5Y 5/2) silt loam; many medium distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; very friable; few black (N 2/0) worm casts; strong effervescence; mildly alkaline; clear wavy boundary.

B3g—35 to 43 inches; grayish brown (2.5Y 5/2) silt loam; many coarse prominent strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; very friable; strong effervescence; mildly alkaline; abrupt wavy boundary.

Cg—43 to 60 inches; gray (5Y 6/1) silt loam; few coarse prominent yellowish brown (10YR 5/6) mottles; massive; friable; strong effervescence; mildly alkaline.

The solum is 22 to 48 inches thick. The mollic epipedon is 12 to 24 inches thick. The solum and the C horizon are silt loam or silty clay loam.

The A horizon is neutral in color or has hue of 10YR, value of 2 or 3, and chroma of 1. The B 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.

Spillville series

The Spillville series consists of moderately well drained to somewhat poorly drained, moderately permeable soils that formed in loamy alluvial sediment. These soils are on flood plains. Slopes are 0 to 2 percent.

Spillville soils are similar to Coland soils and are commonly adjacent to Coland and Millington soils. Coland soils are poorly drained and are in swales. Millington soils are poorly drained and calcareous. They are on broad flats.

Typical pedon of Spillville loam, occasionally flooded, 1,300 feet south and 100 feet east of the NW corner of sec. 9, T. 105 N., R. 36 W.:

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; slightly acid; abrupt smooth boundary.

A12—10 to 22 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; slightly acid; clear wavy boundary.

A13—22 to 34 inches; very dark gray (10YR 3/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; neutral; clear wavy boundary.

A14—34 to 45 inches; very dark gray (10YR 3/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; neutral; clear wavy boundary.

C—45 to 60 inches; very dark gray (10YR 4/1) loam; massive; friable; about 5 percent coarse fragments; slight effervescence; neutral; clear wavy boundary.

The solum is 30 to 56 inches thick. The mollic epipedon is 36 to 56 inches thick. Depth to free carbonates is 40 inches or more.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is loam or silt loam above 36 inches and sandy loam, clay loam, or loam below 36 inches. It is slightly acid or neutral. The C horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 1 or 2. It is slightly acid to mildly alkaline.

Storden series

The Storden series consists of well drained, moderately permeable, calcareous soils. These soils formed in calcareous, loamy glacial till. They are on knolls, hilltops, and side slopes in glacial moraines and glacial till plains. Slopes are 12 to 35 percent.

Storden soils are similar to Swanlake soils and are commonly adjacent to Salida and Swanlake soils. Swanlake soils have a mollic epipedon and a calcic horizon. They are in less sloping areas. Salida soils are excessively drained and are sandy-skeletals.

Typical pedon of Storden loam, 18 to 35 percent slopes, 2,500 feet west and 800 feet south of the NE corner of sec. 4, T. 107 N., R. 37 W.:

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; friable; common light olive brown (2.5Y 5/4) worm casts; about 5 percent coarse fragments; violent effervescence; mildly alkaline; abrupt smooth boundary.

C1—9 to 18 inches; grayish brown (10YR 5/2) loam, very pale brown (10YR 7/4) dry; few coarse faint yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; common light olive brown (2.5Y 5/4) worm casts; about 5 percent coarse fragments; strong effervescence; mildly alkaline; clear wavy boundary.

C2—18 to 60 inches; brown (10YR 5/3) loam; moderate medium angular blocky structure; friable; about 5 percent coarse fragments; strong effervescence; mildly alkaline.

The A horizon and solum are 7 to 10 inches thick. Worm casts composed of A horizon material are common or few to a depth of 16 inches in some pedons.

The Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3 and is mildly alkaline or moderately alkaline. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to 6. It is mildly alkaline or moderately alkaline.

Swanlake series

The Swanlake series consists of well drained, moderately permeable, calcareous soils. These soils formed in loamy glacial till. They are on knolls, hilltops, and side slopes of glacial moraines and on glacial till plains. Slopes are 2 to 12 percent.

Swanlake soils are similar to Storden soils and are commonly adjacent to Clarion, Salida, and Storden soils. Storden soils do not have a mollic epipedon. They are on the most convex part of slopes. Clarion soils are well drained, noncalcareous, and have plane to slightly convex slopes. Salida soils are somewhat excessively drained, do not have a mollic epipedon, and are sandy-skeletals.

Typical pedon of Swanlake loam, 2 to 6 percent slopes, 2,500 feet north and 200 feet east of the SW corner of sec. 16, T. 106 N., R. 36 W.:

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loam, dark brown (2.5Y 5/2) dry; weak fine subangular blocky structure; very friable; about 4 percent coarse fragments; about 2 percent diffuse carbonates; strong effervescence; mildly alkaline; abrupt smooth boundary.

C1ca—9 to 28 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; weak fine subangular blocky structure; very friable; many very dark gray (10YR 3/1) worm casts; about 6 percent coarse fragments; about 22 percent diffuse carbonates; violent effervescence; mildly alkaline; clear irregular boundary.

C2ca—28 to 37 inches; light olive brown (2.5Y 5/4) loam; moderate medium angular blocky structure parting to weak fine subangular blocky; very friable; about 5 percent coarse fragments; about 21 percent diffuse and common 2- to 5-millimeter diameter soft masses of carbonates; violent effervescence; mildly alkaline; clear wavy boundary.

C3ca—37 to 43 inches; light olive brown (2.5Y 5/4) loam; few fine distinct olive (5Y 5/6) and common coarse distinct olive gray (5Y 5/2) mottles; moderate medium angular blocky structure; very friable; about 8 percent coarse fragments; about 22 percent diffuse and few 5- to 10-millimeter diameter soft masses of carbonates; violent effervescence; mildly alkaline; clear wavy boundary.

C4—43 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct yellowish brown (10YR 5/4) and few coarse distinct yellowish red (5Y 5/8) mottles; massive; friable; about 5 percent coarse fragments; about 17 percent diffuse and few 5- to 10-millimeter diameter soft masses and concretions of carbonates; violent effervescence; moderately alkaline.

The solum is 30 to 50 inches thick. The depth to free carbonates is 0 to 7 inches, and the mollic epipedon is 7 to 14 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is loam, sandy loam, or sandy clay loam and contains 0 to 5 percent carbonates. The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 to 5. It is loam or clay loam and is mildly alkaline or moderately alkaline. The C horizon has hue of 2.5Y or 10YR, value of 5 or 6, and chroma of 2 to 6. It is loam or clay loam. It has a 1- to 12-inch thick coarser textured subhorizon in the upper part in some pedons. It is mildly alkaline or moderately alkaline.

Talcot series

The Talcot series consists of very poorly drained soils that are moderately permeable in the solum and rapidly permeable in the underlying material. These soils formed in glacial outwash consisting of a loamy mantle over sand and gravel sediments. They are in depressions and drainageways on glacial outwash plains and terraces. Slopes are 0 to 2 percent.

Talcot soils are similar to Mayer soils and are commonly adjacent to Biscay and Mayer soils. Mayer soils are poorly drained and contain less clay in the solum. They are on rims of depressions and on broad flats. Biscay soils are poorly drained and noncalcareous. They are on broad flats.

Typical pedon of Talcot silty clay loam, 2,000 feet north and 100 feet west of the SE corner of sec. 7, T. 105 N., R. 37 W.:

A1—0 to 11 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate coarse subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; mildly alkaline; clear smooth boundary.

A12—11 to 18 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; friable; about 2 percent coarse fragments; strong effervescence; mildly alkaline; clear smooth boundary.

A3g—18 to 22 inches; very dark gray (5Y 3/1) silty clay loam, dark gray (5Y 4/1) dry; many medium faint olive gray (5Y 5/2) mottles; moderate fine subangular blocky structure; friable; about 3 percent coarse fragments; violent effervescence; mildly alkaline; abrupt wavy boundary.

B2g—22 to 28 inches; olive gray (5Y 4/2) clay loam; many medium faint light olive gray (5Y 6/2) mottles; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; violent effervescence; mildly alkaline; abrupt smooth boundary.

B3—28 to 36 inches; olive (5Y 5/3) loam; many medium faint light olive gray (5Y 6/2) mottles; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; violent effervescence; mildly alkaline; abrupt wavy boundary.

IIC—36 to 60 inches; grayish brown (2.5Y 5/2) stratified coarse sand and olive (5Y 5/6) gravelly coarse sand; single grain; loose; about 30 percent gravel; strong effervescence; mildly alkaline.

Thickness of the solum and depth to the IIC horizon is 24 to 40 inches. The mollic epipedon is 14 to 24 inches thick. The solum typically does not have gravel but some lower horizons contain as much as 10 percent.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or is N 2/0 or N 3/0. It is silty clay loam or clay loam. The B2 horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2 or is N 4/0 or N 5/0. It is clay loam or silty clay loam in most parts. The IIC horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 2 to 6. It is stratified sand or coarse sand and gravel. The IIC horizon has 10 to 35 percent gravel.

Terril series

The Terril series consists of moderately well drained, moderately permeable soils. These soils formed in post glacial, loamy alluvial sediment and are on foot slopes in glacial moraines and glacial till plains. Slopes are 2 to 6 percent.

Terril soils are similar to Delft soils and are commonly adjacent to Clarion, Delft, and Swanlake soils. Delft soils are poorly drained. They are on toe slopes and narrow upland draws. Clarion and Swanlake soils are well drained and are on hilltops, knolls, and side slopes above Terril soils.

Typical pedon of Terril loam, 2 to 6 percent slopes, 2,400 feet north and 1,000 feet west of the SE corner of sec. 36, T. 106 N., R. 37 W.:

A11—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; slightly acid; clear wavy boundary.

A12—10 to 24 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; slightly acid; clear wavy boundary.

B1—24 to 35 inches; very dark grayish brown (10YR 3/2) loam, dark brown (10YR 3/3) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; many (10YR 2/2) worm casts; slightly acid; clear wavy boundary.

B2—35 to 48 inches; brown (10YR 4/3) clay loam; many very dark gray (10YR 3/1) root channels; moderate medium angular blocky structure; friable; about 5 percent coarse fragments; neutral; clear wavy boundary.

B3—48 to 60 inches; olive brown (2.5Y 4/4) loam; common medium faint grayish brown (2.5Y 5/2) mottles; moderate coarse angular blocky structure; friable; about 4 percent coarse fragments; neutral.

The solum is 36 to 60 inches or more thick. The mollic epipedon is 24 to 36 inches thick. Depth to free carbonates and glacial till is 36 inches or more.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is loam or clay loam and is slightly acid or neutral. The B horizon has hue of 10YR or 2.5Y, value of 3, and chroma of 2 or 3 in the upper part and value and chroma of 3 or 4 in the lower part. It is loam or clay loam and slightly acid or neutral.

Truman series

The Truman series consists of well drained, moderately permeable soils. These soils formed in silty, glacial lacustrine sediment and are on knolls and ridges in glacial lake plains. Slopes are 2 to 8 percent.

Truman soils are similar to Kingston soils and are commonly adjacent to Kingston and Madelia soils. Kingston soils are moderately well drained. They are on broad, low rises. Madelia soils are poorly drained. They are on broad, flat areas.

Typical pedon of Truman silt loam, 2 to 8 percent slopes, 2,500 feet south and 500 feet west of the NE corner of sec. 23, T. 105 N., R. 36 W.:

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

A12—9 to 14 inches; very dark grayish brown (10YR 3/2) silt loam, dark brown (10YR 3/3) dry; weak fine subangular blocky structure; friable; neutral; clear wavy boundary.

B1—14 to 20 inches; brown (10YR 4/3) silt loam; weak fine subangular blocky structure; friable; common very dark grayish brown (10YR 3/2) worm casts; neutral; clear wavy boundary.

B21—20 to 30 inches; dark grayish brown (10YR 4/3) silt loam; moderate medium angular blocky structure; friable; common very dark grayish brown (10YR 3/2) worm casts; many fine tubular pores; strong effervescence; mildly alkaline; clear smooth boundary.

B22—30 to 40 inches; dark yellowish brown (10YR 4/4) silt loam; few fine faint yellowish brown (10YR 5/6) mottles; moderate medium angular blocky structure; friable; many dark grayish brown (10YR 4/2) worm casts; violent effervescence; moderately alkaline; clear wavy boundary.

C—40 to 60 inches; light olive brown (2.5Y 5/4) silt loam; few fine faint yellowish brown (10YR 5/6) mottles; massive; friable; violent effervescence; moderately alkaline.

Thickness of the solum and depth to free carbonates are 18 to 56 inches. The mollic epipedon is 10 to 18 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 to 3. It is slightly acid or neutral. The B horizon has hue of 10YR, value of 3 to 5, and chroma of 3 to 6. It is silt loam or silty clay loam. The upper part of the B horizon is neutral or slightly acid, and the lower part is neutral to moderately alkaline. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 4 to 6. It is mildly alkaline or moderately alkaline.

Ves series

The Ves series consists of well drained, moderately permeable soils. These soils formed in calcareous, friable, loamy glacial till that is high in content of shale. They are on side slopes and knolls of glacial moraines and glacial till plains. Slopes are 2 to 6 percent.

Ves soils are similar to Swanlake soils and are commonly adjacent to Normania and Webster soils. Swanlake soils are calcareous throughout. They have convex slopes and are on side slopes and hilltops in glacial moraines and glacial till plains. Normania soils are moderately well drained and are on low rises. Webster soils are poorly drained and are on broad flats.

Typical pedon of Ves loam, 2 to 6 percent slopes, 100 feet west and 1,000 feet north of the SE corner of sec. 4, T. 107 N., R. 34 W.:

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium granular structure; very friable; about 3 percent coarse fragments; neutral; abrupt smooth boundary.

A3—10 to 16 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2); weak fine and medium subangular blocky structure; very friable; many dark brown (10YR 3/3) worm casts; about 3 percent coarse fragments; neutral; clear irregular boundary.

B21—16 to 22 inches; olive brown (2.5Y 4/4) loam, weak fine and medium subangular blocky structure; very friable; common dark brown (10YR 3/3) worm casts; about 3 percent coarse fragments; neutral; clear wavy boundary.

B22—22 to 32 inches; olive brown (2.5Y 4/4) loam; few coarse distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; about 7 percent coarse fragments mostly shale; about 10 percent diffuse carbonates; violent effervescence; mildly alkaline; clear wavy boundary.

B3ca—32 to 40 inches; olive brown (2.5Y 4/4) loam; common coarse distinct yellowish brown (10YR 5/6) mottles; moderate medium angular blocky structure; friable; about 7 percent coarse fragments, mostly shale; about 18 percent diffuse and common 5- to 10-millimeter diameter soft masses of carbonates; violent effervescence; mildly alkaline; clear wavy boundary.

C—40 to 60 inches; olive brown (2.5Y 4/4) loam; common coarse distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 8 percent coarse fragments, mostly shale; about 7 percent diffuse and few 5- to 10-millimeter diameter soft masses of carbonate in the upper part; common 1- to 3-millimeter diameter dark oxides of iron and manganese; strong effervescence; mildly alkaline.

The solum is 18 to 40 inches thick. The depth to free carbonates is 14 to 33 inches. The mollic epipedon is 10 to 20 inches thick. Coarse fragments comprise 3 to 8 percent of the solum and the C horizon. The 2- to 5-millimeter fraction has 20 to 50 percent shale.

The A horizon has hue of 10YR and value of 2 or 3. It is loam or clay loam and slightly acid or neutral. The upper part of the B horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 3 or 4. It is loam or clay loam and neutral or mildly alkaline. The lower part of the B horizon has hue of 2.5Y or 10YR, value of 4 to 6, and chroma of 4. It is loam or clay loam and mildly alkaline or moderately alkaline. The C horizon has hue of 2.5Y, value of 4 or 5, and chroma of 3 or 4. It is mildly alkaline or moderately alkaline.

Webster series

The Webster series consists of poorly drained soils. Permeability is moderate or moderately slow. These soils formed in calcareous, loamy glacial till. They are on flats **and in swales on glacial moraines and glacia till plains.** Slopes are 0 to 2 percent.

Webster soils are similar to Delft and Letri soils and are commonly adjacent to Delft and Glencoe soils. Delft soils have a thicker mollic epipedon and are on toe slopes and narrow upland draws. Letri soils have a firm consistence in the C horizon. Glencoe soils are very poorly drained and have a thicker mollic epipedon. They are in depressions and low gradient drainageways.

Typical pedon of Webster clay loam, in an area of Webster-Delft clay loams, 1,350 feet north and 100 feet east of the SW corner of sec. 3, T. 105 N., R. 34 W.:

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

A12—8 to 15 inches; black (5Y 2/1) clay loam, very dark brown (10YR 2/2) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; many olive (5Y 4/3) worm casts; neutral; clear irregular boundary.

B2g—15 to 25 inches; olive gray (5Y 4/2) clay loam; many fine distinct olive brown (2.5Y 4/4) mottles; weak fine subangular blocky structure; friable; about 4 percent coarse fragments; few very dark gray (5Y 3/1) worm casts; neutral; clear wavy boundary.

B3g—25 to 38 inches; olive gray (5Y 5/2) clay loam; many fine distinct olive brown (2.5Y 4/4) mottles; weak medium angular blocky structure; friable; about 6 percent coarse fragments; violent effervescence; mildly alkaline; clear wavy boundary.

Cg—38 to 60 inches; gray (5Y 5/1) clay loam; many coarse distinct olive brown (2.5Y 4/4) mottles; massive; friable; about 5 percent coarse fragments; violent effervescence; mildly alkaline.

Thickness of the solum and depth to free carbonates are 24 to 50 inches. The mollic epipedon is 14 to 24 inches thick.

The A horizon is N 2/0 or has hue of 10YR, value of 2 or 3, and chroma of 1. It is clay loam or silty clay loam. The B horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is clay loam or silty clay loam. The upper part is neutral, and the lower part is neutral or mildly alkaline. The C horizon has hue of 5Y or 2.5Y, value of 4 to 6, and chroma of 1 to 3. It is loam or clay loam and mildly alkaline or moderately alkaline.

Webster Variant

The Webster Variant consists of poorly drained, moderately permeable soils. These soils formed in a shallow mantle of glacial till over quartzite bedrock. They are in narrow drainageways on glacial moraines and glacial till plains. Slopes are 0 to 2 percent.

Webster Variant soils are similar to Webster soils and are commonly adjacent to Germantown soils and quartzite rock outcrops. Webster soils do not have bedrock at a depth of 60 inches or less. They are on broad flats in areas where glacial till is thicker. Germantown soils are well drained and are on low knolls, hilltops, and side slopes in areas where bedrock is at a depth of 20 to 40 inches. Rock outcrops are on low rises and narrow, rough shelves in swales and dells.

Typical pedon of Webster Variant clay loam, 0 to 2 percent slopes, 1,320 feet west and 50 feet north of the SE corner of sec. 12, T. 107 N., R. 36 W.:

A—0 to 9 inches; black (N 2/0) clay loam; very dark gray (10YR 3/1) dry; weak fine granular structure; friable; slightly acid; clear wavy boundary.

B1—9 to 13 inches; very dark grayish brown (2.5Y 3/2) clay loam, dark grayish brown (10YR 4/2) dry; many fine distinct olive gray (5Y 4/2) mottles; moderate coarse prismatic structure parting to moderate fine subangular blocky; friable; thin discontinuous black clay films on faces of peds; mildly acid; abrupt wavy boundary.

B2—13 to 19 inches; olive gray (5Y 4/2) clay loam; many fine prominent yellowish brown (10YR 5/6) mottles; moderate coarse prismatic structure; firm; thin discontinuous clay films on faces of peds; mildly acid; abrupt wavy boundary.

R—19 inches; pinkish red, hard quartzite bedrock.

Thickness of the solum and depth to bedrock are 10 to 20 inches. The mollic epipedon is 10 to 19 inches thick.

The A horizon is neutral in color or has hue of 10YR, 2.5Y, or 5Y; value of 2 or 3; and chroma of 1 or 2. It is loam or clay loam and strongly acid to slightly acid. The B horizon has hue of 2.5Y or 5Y, value of 3 or 4, and chroma of 2 or 3. It is clay loam or loam and medium acid or slightly acid.

Wilmonton series

The Wilmonton series consists of moderately well drained and somewhat poorly drained soils. These soils have moderately slow permeability. They formed in loamy glacial till on low rises and broad hilltops on glacial moraines and glacial till plains. Slopes are 1 to 3 percent.

Wilmonton soils in this county are outside the defined range of the Wilmonton series because the horizons with firm consistence are too deep. This difference does not affect use and management.

Wilmonton soils are similar to Nicollet soils and are commonly adjacent to Everly and Letri soils. Nicollet soils are in similar positions on the landscape but do not have a firm IIC horizon in loamy glacial till. Letri soils are poorly drained and are on broad flats.

Typical pedon of Wilmonton clay loam, 2,300 feet south and 1,100 feet east of the NW corner of sec. 3, T. 107 N., R. 37 W.:

Ap—0 to 9 inches; black (10YR 2/1) clay loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; medium acid; abrupt smooth boundary.

A12—9 to 17 inches; black (10YR 2/1) clay loam, very dark grayish brown (10YR 3/2) dry; moderate fine and medium angular and subangular blocky structure; friable; many very dark grayish brown (10YR 3/2) worm casts; about 4 percent coarse fragments; medium acid; clear irregular boundary.

A3—17 to 22 inches; very dark grayish brown (10YR 3/1) clay loam, very dark grayish brown (10YR 3/2) dry; moderate fine prismatic structure parting to moderate medium angular and subangular blocky; friable; thin patchy clay films on faces of peds; many olive brown (2.5Y 4/4) worm casts; about 2 percent coarse fragments; medium acid; clear irregular boundary.

B21—22 to 28 inches; olive brown (2.5Y 4/3) clay loam; few fine faint grayish brown (2.5Y 5/2) mottles in lower part; moderate medium angular blocky structure; friable; few very dark grayish brown (10YR 3/2) worm casts; about 1 percent coarse fragments; medium acid; clear irregular boundary.

B22—28 to 37 inches; olive brown (2.5Y 4/4) clay loam; few medium prominent strong brown (7.5YR 5/6) and common fine faint olive yellow (2.5Y 6/6) mottles; moderate coarse prismatic structure parting to moderate medium angular blocky; friable; few thin patchy clay films on faces of peds; about 3 percent coarse fragments; medium acid; clear wavy boundary.

IICca—37 to 60 inches; light olive brown (2.5Y 5/4) loam; many coarse prominent yellowish brown (7.5YR 5/6) mottles; massive; firm; about 6 percent coarse fragments; about 18 percent diffuse carbonates; many 5- to 10-millimeter diameter soft masses of carbonates; violent effervescence; mildly alkaline; clear wavy boundary.

Thickness of the solum and depth to firm glacial till are 20 to 40 inches. Depth to free carbonates is 20 to 40 inches. The mollic epipedon is 14 to 24 inches thick. A lag line is at the boundary of the mantle and the underlying till in some pedons.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is clay loam, silty clay loam, or heavy loam and medium acid to neutral. The upper sediment of the B horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 4. It is clay loam, heavy loam, or silty clay loam and high in content of sand. The B horizon is medium acid to neutral in the upper part and neutral to mildly alkaline in the lower part. The IIB horizon has similar colors and textures but has firm consistence. The IIC horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to 4; and it is mottled. It is loam or clay loam, but coarse textured wedges or seams are in some pedons. It is mildly alkaline or moderately alkaline.

Classification of the soils

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to "Soil taxonomy" (*5*).

The system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 16, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to 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 expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Haplaquolls (*Hapl*, meaning simple horizons, plus *aquoll*, the suborder of Mollisols that have an aquic moisture regime).

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups 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 is thought to typify the great group. An example is Typic Haplaquolls.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine-loamy, mixed, mesic, Typic Haplaquolls.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Formation of the soils

This section discusses the factors of soil formation, relates them to the formation of soils in the survey area, and explains the processes of soil formation.

Factors of soil formation

Soils formed as a result of the interaction of five factors—(1) parent materials; (2) climate; (3) plants and animals; (4) relief; and (5) time. Climate and plants and animals are active factors of soil genesis. Their effect is conditioned by relief and time as they act on parent material. They slowly change the parent material into a natural body that has genetically related horizons. This natural body is known as soil.

Parent material

The soils of Cottonwood County formed in several parent materials. They are glacial till, glacial lacustrine and outwash sediments, post-glacial alluvium, and limnic material.

Glacial till is the parent material of about 80 percent of the soils in Cottonwood County. It is composed of older glacial till that was reworked by substages of the Wisconsin glaciation (*6*).

Glaciers of Late Wisconsin age covered the entire county. They deposited a glacial till that is loam to clay loam with a high content of lime. Storden, Swanlake, Clarion, Nicollet, Crippin, Canisteo, and Webster soils formed in this till. This till is thin in the northern and central parts of the county. In these areas it overlies firmer glacial till that has a higher bulk density. Everly, Wilmonton, Jeffers Variant, Jeffers, Letri, and Romnell soils formed in these areas. These materials are underlain by bedrock on the "red rock ridge." Germantown soils formed in this area.

The glacial till north of the "red rock ridge" has a high lime content and a high content of fine soft shale. Ves and Normania soils formed in this till.

Glacial lacustrine sediment was deposited in glacial lakes. It was washed out of the till by glacial meltwater. It has variable thickness and silty to clayey texture. Clarion Variant, Ransom, and Rushmore soils formed in silty sediment and the underlying glacial till. Guckeen, Marna, and Lura soils formed in clayey sediment and the underlying glacial till. Truman, Kingston, Spicer, and Madelia soils formed entirely in silty sediment. The largest areas of these soils are in Southbrook, Springfield, and Great Bend Townships.

Glacial outwash sediment was washed out of the till by glacial meltwater. It was deposited by glacial streams. It has variable thickness, loamy to sandy texture, and frequently overlies sand and gravel. Estherville, Salida, Dickman, Linder, Biscay, Mayer, and Talcot soils formed in this sediment. The largest areas are along the Des Moines River and its tributaries. Smaller areas are along inactive streams and in the uplands between lakes.

Post-glacial alluvial sediment was deposited by active streams. It has variable thickness and is mostly loamy. Spillville, Coland, and Millington soils formed in this sediment. The largest areas of this parent material are in flood plains.

Limnic material formed in post-glacial lakes and marshes. It consists of accumulations of aquatic organisms and washed-in mineral materials. It is mostly loamy and has appreciable amounts of organic matter in some areas. Blue Earth soil is the principal soil in this material. The largest areas of this soil are in drained lakebeds.

Climate

Climate has had a pronounced effect on soil formation in Cottonwood County. Most of the parent material originated in a climate that produced continental glaciers. The post-glacial climate progressively warmed and stabilized in its present form about 5,000 years ago.

The warming climate is evidenced by successive vegetation types (*7*). The initial post-glacial vegetation was spruce forest. It was rapidly replaced by pine forest and, later, deciduous forest. The deciduous forest remained for a longer time and was replaced by prairie when the climate stabilized in its present form.

The present climate has periods of freezing and thawing. This fractures parent material and soil material and helps keep the soils friable. Precipitation removes soluble and colloidal materials from the upper part of the soil and deposits them in the lower parts. Precipitation has leached carbonates from the surface soil and the upper part of the subsoil of most soils in the county. The amount of leaching and eluviation is greatly modified by relief.

Plants and animals

The native vegetation in Cottonwood County, under the present climate, is tall grass prairie. Some of the common grasses are big bluestem, little bluestem, Canada wildrye, prairie cordgrass, blue grama, sideoats grama, needleandthread, and porcupine grass. Wild flowers such as aster, goldenrod, sunflower, blazing star, wildrose, lily, iris, and violets also grow in the prairie. Reeds, rushes, and sedges grow in marshes. Trees and shrubs are restricted to areas adjacent to streams and lakes.

The prairie vegetation produces organic matter. The organic matter helps to maintain tilth and supplies plants with nitrogen. The amount of organic matter affects the color of the soil. Soils become progressively darker colored as organic matter content increases. Exceptions are soils that have a concentration of lime, such as the calcareous Canisteo and Jeffers soils. These soils have a high organic matter content, but their dark color is masked by the lighter color of the lime.

Animals also affect soil development. Earthworms mix the surface soil, subsoil, and parent material. Some mixing has occurred in nearly all of the county's soils, particularly in Everly and Wilmonton soils. Earthworms are most active in the well drained to poorly drained soils. They are less active in excessively well drained soils and very poorly drained soils. Excessively well drained soils are favored by burrowing rodents. Many areas of the Salida soil and Estherville soils have been modified by their activities.

Man's farming activities have altered most soils. Tillage has partially altered the original structure of the surface soil. The surface soil has become lighter colored in many sloping areas. Tillage has mixed the original dark colored surface with the lighter colored subsoil. Fertilizer and manure applications have increased the fertility level of the soils.

Relief

Cottonwood County has relief ranging from nearly level to very steep. Relief is the most important factor in the formation of different soils in similar parent material. Soils have formed fairly mature profiles and distinct horizons where relief is gentle. There has been little soil formation on steep, convex areas because of excessive runoff. The excessive runoff has reduced leaching of carbonates and created droughty conditions that, in turn, reduce vegetative growth. The Storden soil is an example.

There has been considerable soil formation in some shallow, concave areas because of excessive percolation. The excessive percolation has increased the leaching of carbonates and initiated eluviation of clays. The Barbert soil is an example.

Time

Geologically, all of the soils in the county are young. The soil forming process has been active for 8,000 to 15,000 years (*7*). This has been sufficient time to develop soils in all parent materials except Sioux Quartzite bedrock. The amount of soil profile development is dependent upon the other factors of soil formation. Soils in the flood plains are weakly developed because movement of alluvial parent material disrupts soil profile development.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

Ablation till. Loose permeable till deposited during the final downwasting of glacial ice. Lenses of crudely sorted sand and gravel are common.

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Basal till. Compact glacial till deposited beneath the ice.

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 frequent flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

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 coat, clay skin.

Coarse fragments. Mineral or rock particles up to 3 inches (2 millimeters to 7.5 centimeters) in diameter.

Coarse textured (light textured) soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the bases of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

Complex, soil. A map unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

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.

Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.

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 for 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, as for example in "hillpeats" and "climatic moors."

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Excess lime. Excess carbonates. Excessive carbonates, or lime, restrict the growth of some plants.

Fast intake. The rapid movement of water into the soil.

Favorable. Favorable soil features for the specified use.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fine textured (heavy textured) soil. Sandy clay, silty clay, and clay.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. 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 an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; *November-May*, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered 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. Freezing and thawing of soil moisture. Frost action can damage 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 outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by melt water as it flows from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes by water originating mainly from the melting of glacial ice. Many are interbedded or laminated.

Gleyed soil. A soil having one or more neutral gray horizons as a result of waterlogging and lack of oxygen. The term "gleyed" also designates gray horizons and horizons having yellow and gray mottles as a result of intermittent waterlogging.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table, which is the upper limit of saturation.

Gypsum. Hydrous calcium sulphate.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

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.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Leaching. The removal of soluble material from soil or other material by percolating water.

Light textured soil. Sand and loamy sand.

Limnic material. Includes both organic and inorganic materials either (a) deposited in water through the action of aquatic organisms, such as algae or diatoms, or (b) derived from underwater and floating aquatic plants subsequently modified by aquatic animals.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. Inadequate strength for supporting loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is greater than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous areas. Areas that have little or no natural soil, are too nearly inaccessible for orderly examination, or cannot otherwise be feasibly classified.

Moderately coarse textured (moderately light textured) soil. Sandy loam and fine sandy loam.

Moderately fine textured (moderately heavy textured) soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material mixed with mineral soil material. The content of organic matter is more than 20 percent.

Munsell notation. A designation of color by degrees of the three single variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from the air and water.

Organic matter percent. Organic matter percent-values given in report are based upon the upper 10 inches of the soil.

	Percent
Low	less than 2
Moderate	2 to 4
High	4 to 8
Very high	more than 8

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by water that originated mainly from the melting of glacial ice. Glacial outwash is commonly in valleys on landforms known as valley trains, outwash terraces, eskers, kame terraces, kames, outwash fans, or deltas.

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

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. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are *very slow* (less than 0.06 inch), *slow* (0.06 to 0.20 inch), *moderately slow* (0.2 to 0.6 inch), *moderate* (0.6 to 2.0 inches), *moderately rapid* (2.0 to 6.0 inches), *rapid* (6.0 to 20 inches), and *very rapid* (more than 20 inches).

Phase, soil. A subdivision of a soil series or other unit in the soil classification system based on differences in the soil that affect its management. A soil series, for example, may be divided into phases on the bases of differences in slope, stoniness, thickness, or some other characteristic that affects management. These differences are too small to justify separate series.

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in 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 a semisolid to a plastic state.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under a specified system of management. Productivity is measured in terms of output, or harvest, in relation to input.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock. Soil scientists regard as soil only the part of the regolith that is modified by organisms and other soil-building forces. Most engineers describe the whole regolith, even to a great depth, as "soil."

Relief. The elevations or inequalities of a land surface, considered collectively.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground 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.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel;

sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow refill. The slow filling of ponds, resulting from restricted permeability in the soil.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *very coarse sand* (2.0 millimeters to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.005 to 0.002 millimeter); and *clay* (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stone line. A concentration of coarse fragments in soils that generally marks an old weathering surface. In a cross section, the line may be one fragment or more thick. The line generally overlies material that weathered in place and marks the top of a paleosol. It is ordinarily overlain by recent sediment of variable thickness.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. Refers to all of the A horizon(s).

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 or management.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by 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, silt loam, 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. Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Trace elements. The chemical elements in soils, in only extremely small amounts, essential to plant growth. Examples are zinc, cobalt, manganese, copper, and iron.

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 the limited geographic soil area does not justify creation of a new series.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water. *Water table, apparent.* A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Well graded. Refers to a soil or soil material consisting of particles well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

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ILLUSTRATIONS

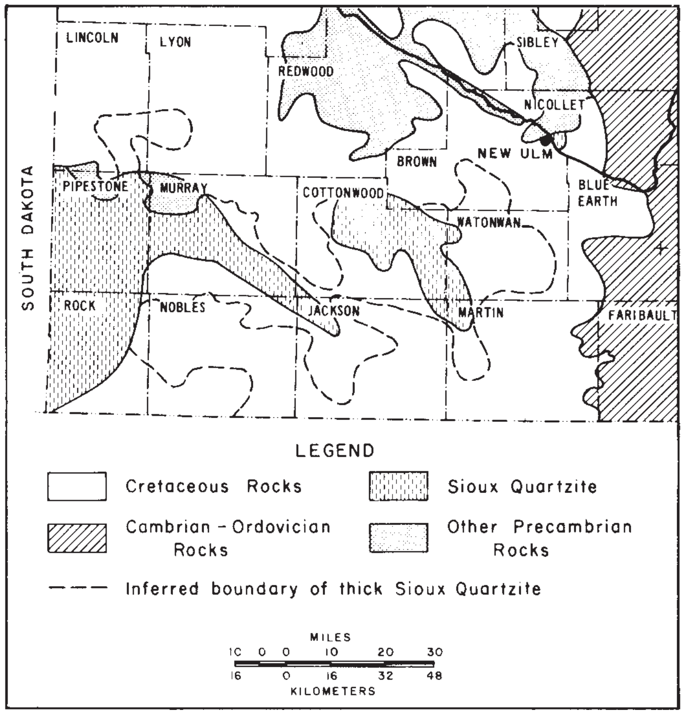

Figure 1.—Generalized geologic map of southwestern Minnesota, showing type and extent of bedrock.

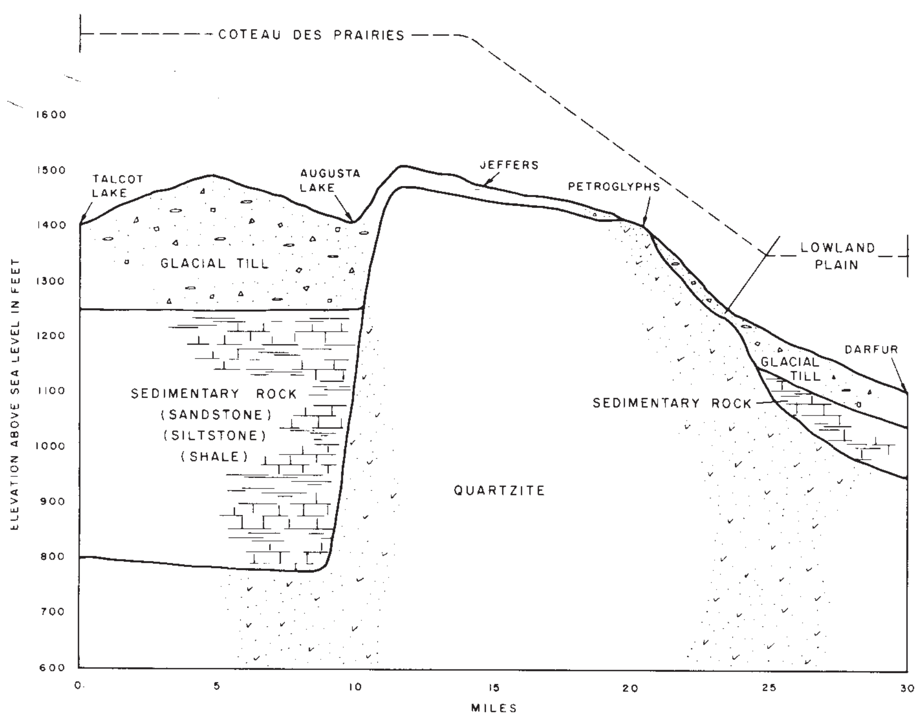

Figure 2.—Cross-sectional, southwest-northeast view of Cottonwood County, showing the relative differences in elevation, thickness of the glacial till, and kinds of underlying bedrock.

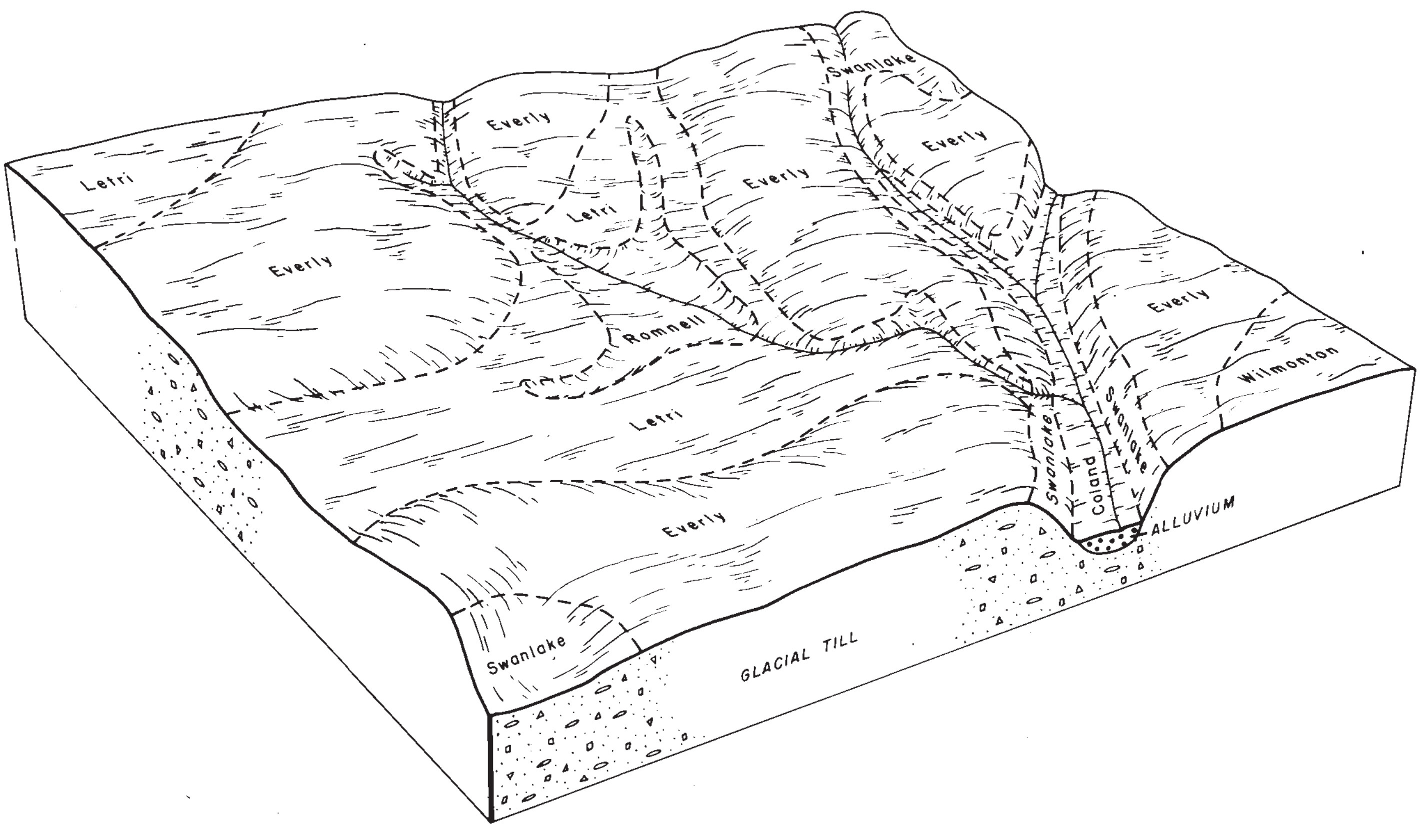

Figure 3.—Relationship of soils, underlying materials, and landforms in the Everly-Letri map unit.

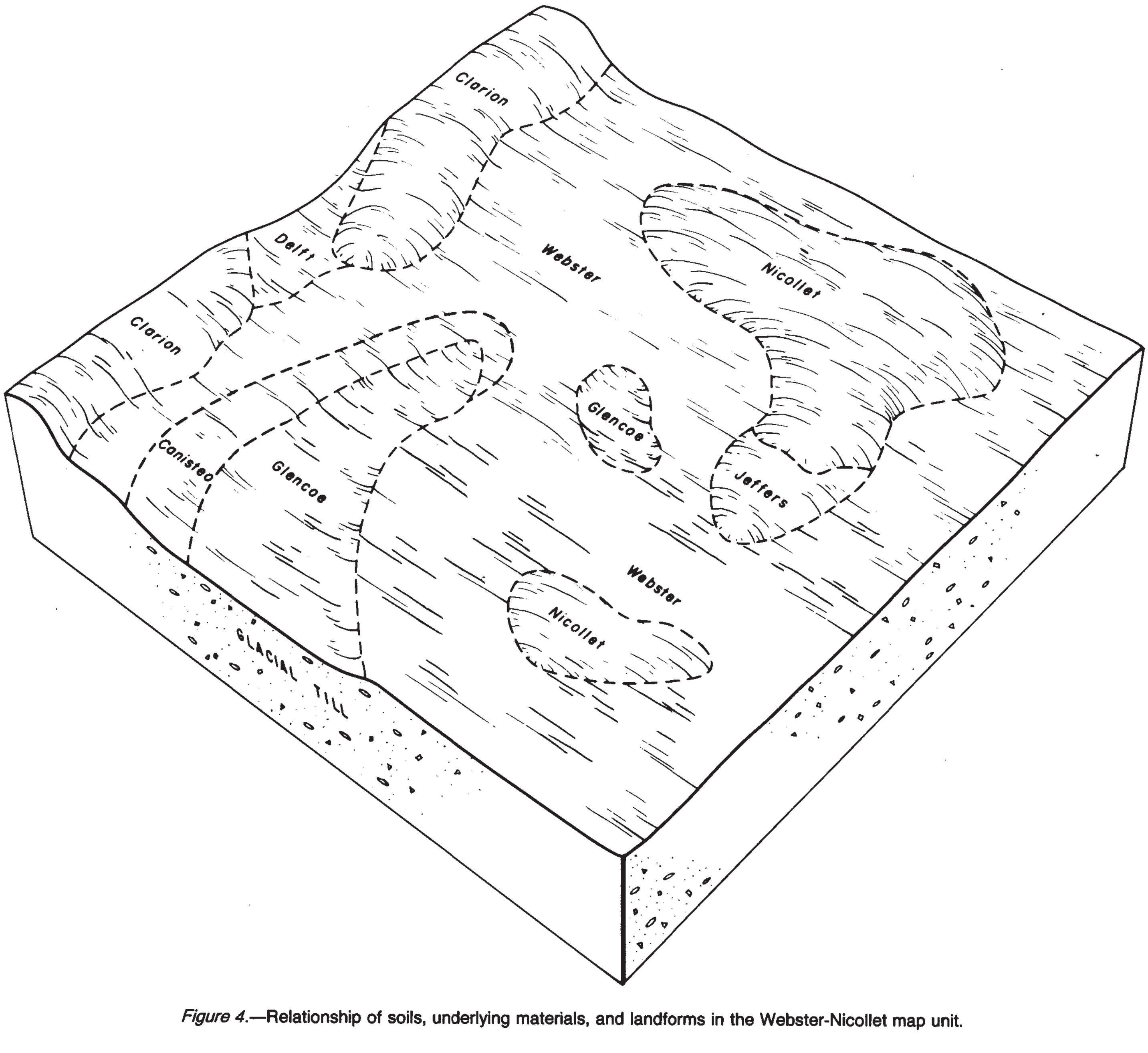

Figure 4.—Relationship of soils, underlying materials, and landforms in the Webster-Nicollet map unit.

Figure 5.—Clarion soils are on the knolls in the background, Webster soils are on the flats in the foreground, and Delft soils are on the toe slopes and draws. The light colored soils on the knolls are Swanlake soils.

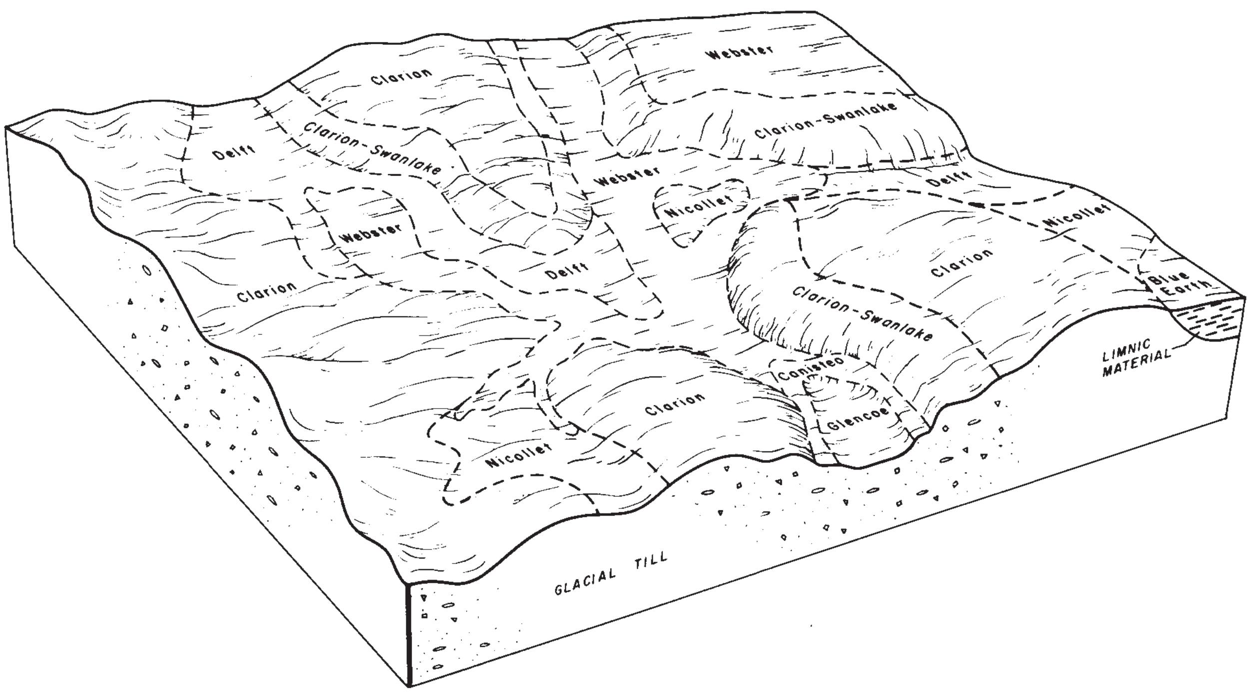

Figure 6.—Relationship of soils, underlying materials, and landforms in the Clarion-Swanlake map unit.

Figure 7.—The result of soil blowing on the Dickman soil under dry farming is shown on the right versus the area under irrigation farming on the left.

Figure 8.—An area of Aquolls and Aquents, ponded. This area is used for wetland wildlife habitat.

TABLES

TABLE 1.--TEMPERATURE AND PRECIPITATION DATA

[Recorded in the period 1951-74 at Windom, Minnesota]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[1]	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	F	F	F	F	F	Units	In	In	In		In
January----	23.0	2.9	13.0	48	-27	0	.51	.15	.79	2	5.8
February---	29.4	9.1	19.2	54	-24	0	.68	.23	1.03	2	6.9
March------	39.6	20.1	29.9	70	-11	26	1.28	.62	1.81	4	9.4
April------	57.6	34.1	45.9	87	15	65	2.65	1.29	3.75	6	2.4
May--------	70.8	46.2	58.5	92	26	278	3.54	1.63	5.09	7	.0
June-------	80.8	56.4	68.6	99	39	558	3.93	2.18	5.35	7	.0
July-------	85.3	61.0	73.2	98	46	719	3.38	1.52	4.88	6	.0
August-----	82.9	59.0	71.0	95	42	651	3.43	2.17	4.56	6	.0
September--	73.5	48.7	61.2	93	29	336	3.36	1.02	5.23	6	.0
October----	63.0	38.3	50.7	87	17	142	1.77	.59	2.71	4	.4
November---	44.0	24.2	34.1	70	-4	0	1.06	.40	1.58	3	2.6
December---	28.9	11.1	20.1	54	-23	0	.81	.30	1.20	3	7.6
Year-----	56.6	34.3	45.5	100	-27	2,775	26.40	21.52	31.21	56	35.1

[1]A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 °F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL
[Recorded in the period 1951-74 at Windom, Minnesota]

Probability	Temperature		
	24 °F or lower	28 °F or lower	32 °F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 2	May 20	May 27
2 years in 10 later than--	April 27	May 14	May 21
5 years in 10 later than--	April 18	May 3	May 10
First freezing temperature in fall:			
1 year in 10 earlier than--	October 8	September 23	September 18
2 years in 10 earlier than--	October 14	September 29	September 22
5 years in 10 earlier than--	October 25	October 11	October 1

TABLE 3.--GROWING SEASON LENGTH
[Recorded in the period 1951-74 at Windom, Minnesota]

Probability	Daily minimum temperature during growing season		
	Higher than 24 °F	Higher than 28 °F	Higher than 32 °F
	Days	Days	Days
9 years in 10	164	131	119
8 years in 10	172	141	127
5 years in 10	189	160	143
2 years in 10	205	179	159
1 year in 10	213	189	167

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
31D	Storden loam, 12 to 18 percent slopes	4,870	1.2
31E	Storden loam, 18 to 35 percent slopes	2,250	0.5
35	Blue Earth mucky silt loam	3,025	0.7
41A	Estherville sandy loam, 0 to 2 percent slopes	7,980	1.9
41B	Estherville sandy loam, 2 to 6 percent slopes	7,475	1.8
41C	Estherville sandy loam, 6 to 12 percent slopes	800	0.2
41D	Estherville sandy loam, 12 to 25 percent slopes	280	0.1
86	Canisteo clay loam	15,275	3.7
94B	Terril loam, 2 to 6 percent slopes	1,375	0.3
101B	Truman silt loam, 2 to 8 percent slopes	2,700	0.7
102B	Clarion loam, 2 to 4 percent slopes	44,850	10.8
110	Marna silty clay loam	3,700	0.9
113	Webster clay loam	28,150	6.8
114	Glencoe clay loam	18,000	4.4
128B	Grogan fine sandy loam, 1 to 8 percent slopes	690	0.2
130	Nicollet clay loam	34,175	8.2
136	Madelia silty clay loam	1,500	0.4
140	Spicer silt loam	780	0.2
149B	Everly clay loam, 2 to 6 percent slopes	24,150	5.8
154	Blue Earth muck	870	0.2
197	Kingston silt loam	2,575	0.6
211	Lura silty clay	3,890	0.9
214	Talcot silty clay loam	3,475	0.8
230	Guckeen silty clay loam	2,100	0.5
241	Letri clay loam	26,490	6.4
247	Linder loam	2,375	0.6
255	Mayer loam	6,225	1.5
269	Millington silty clay loam	2,850	0.7
291	Ransom silty clay loam	3,325	0.8
304	Rushmore silty clay loam	3,175	0.8
313	Spillville loam, occasionally flooded	1,500	0.4
319	Barbert silt loam	200	*
327A	Dickman sandy loam, 0 to 2 percent slopes	2,525	0.6
327B	Dickman sandy loam, 2 to 6 percent slopes	1,300	0.3
327C	Dickman sandy loam, 6 to 12 percent slopes	695	0.2
345	Wilmonton clay loam	23,425	5.7
392	Biscay loam	4,875	1.2
421B	Ves loam, 2 to 6 percent slopes	7,350	1.8
446	Normania loam	3,525	0.9
588B	Clarion Variant loam, 2 to 6 percent slopes	1,410	0.3
589	Romnell clay loam	2,155	0.5
590B	Jeffers Variant clay loam, 2 to 4 percent slopes	1,560	0.4
594	Jeffers clay loam	4,055	1.0
595B	Swanlake loam, 2 to 6 percent slopes	3,700	0.9
595C	Swanlake loam, 6 to 12 percent slopes	21,500	5.2
884	Webster-Delft clay loams	26,125	6.3
885B	Swanlake-Salida complex, 2 to 6 percent slopes	1,050	0.3
885C	Swanlake-Salida complex, 6 to 12 percent slopes	2,275	0.6
886	Nicollet-Crippin clay loams	1,525	0.4
887B	Clarion-Swanlake loams, 3 to 6 percent slopes	5,675	1.4
887C	Clarion-Swanlake loams, 6 to 12 percent slopes	9,625	2.3
961D	Storden-Salida complex, 12 to 25 percent slopes	690	0.2
1029	Pits, gravel	935	0.2
1053	Aquolls and Aquents, ponded	1,500	0.4
1833	Coland clay loam, occasionally flooded	8,725	2.1
1834	Coland clay loam, frequently flooded	4,800	1.2
1835B	Germantown clay loam, 1 to 6 percent slopes	3,500	0.8
1836B	Germantown-Rock outcrop complex, 2 to 6 percent slopes	650	0.2
1837	Webster Variant clay loam	750	0.2
	Water	5,825	1.4
	Total	412,800	100.0

* Less than 0.1 percent.

Table 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield figure indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	Bu	Bu	Ton	AUM*	AUM*
31D------ Storden	50	---	40	3.0	4.5	2.5
31E------ Storden	---	---	---	---	---	1.5
35------ Blue Earth	85	35	---	3.0	4.5	---
41A------ Estherville	40	15	40	2.0	3.0	2.0
41B------ Estherville	35	10	35	2.0	3.0	2.0
41C------ Estherville	25	---	30	1.5	2.5	1.5
41D------ Estherville	---	---	---	---	---	1.0
86------ Canisteo	90	30	70	3.5	5.2	3.0
94B------ Terril	110	40	80	4.5	6.5	3.5
101B------ Truman	90	35	75	4.5	6.5	3.5
102B------ Clarion	105	35	80	4.5	6.5	3.5
110------ Marna	105	35	75	4.0	6.0	3.5
113------ Webster	105	35	80	4.0	6.0	3.5
114------ Glencoe	90	35	70	3.5	5.2	3.0
128B------ Grogan	70	25	65	4.0	6.0	2.8
130------ Nicollet	110	40	80	4.5	6.5	3.5
136------ Madelia	100	35	80	4.5	6.5	3.5
140------ Spicer	90	30	80	4.0	6.0	3.0
149B------ Everly	90	35	75	3.4	5.6	3.3
154------ Blue Earth	85	35	---	3.0	4.5	3.0

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	Bu	Bu	Ton	AUM*	AUM*
197 Kingston	100	35	80	4.5	6.7	3.5
211 Lura	80	30	65	3.5	5.2	3.0
214 Talcot	75	25	65	4.0	6.0	3.3
230 Guckeen	105	35	80	4.5	6.7	3.5
241 Letri	100	35	80	4.5	6.7	3.5
247 Linder	50	20	42	2.5	4.1	2.3
255 Mayer	70	25	60	3.0	5.0	3.2
269 Millington	---	---	---	---	---	3.5
291 Ransom	100	35	80	4.5	6.7	3.5
304 Rushmore	100	35	80	4.5	6.7	3.5
313 Spillville	100	40	80	4.5	6.7	3.5
319 Barbert	75	30	75	3.0	5.0	3.0
327A Dickman	45	20	45	2.5	3.7	1.2
327B Dickman	40	15	40	2.5	3.7	1.2
327C Dickman	35	---	35	2.2	3.5	1.0
345 Wilmonton	100	35	80	4.5	6.7	3.5
392 Biscay	80	30	60	3.5	5.2	3.0
421B Ves	95	35	75	4.2	6.0	3.0
446 Normania	105	35	80	4.5	6.7	3.5
588B Clarion Variant	90	35	75	4.5	6.7	3.0
589 Romnell	90	35	80	4.0	6.0	3.0
590B Jeffers Variant	85	30	70	3.5	5.2	3.0
594 Jeffers	80	25	70	3.5	5.2	3.0

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	Bu	Bu	Ton	AUM*	AUM*
595B----------------------- Swanlake	80	28	65	3.5	5.2	3.0
595C----------------------- Swanlake	70	25	60	3.5	5.2	3.0
884**: Webster-Delft------------	100	35	80	4.0	6.0	3.5
885B**: Swanlake-Salida----------	60	20	55	3.3	4.5	2.5
885C**: Swanlake-Salida----------	50	15	50	3.3	4.0	2.0
886**: Nicollet-Crippin---------	105	35	80	4.5	6.5	3.5
887B**: Clarion-Swanlake---------	90	35	75	4.0	6.0	3.0
887C**: Clarion-Swanlake---------	85	30	71	3.8	5.8	3.0
961D**: Storden-Salida-----------	---	---	---	2.5	3.5	1.5
1029**. Pits	---	---	---	---	---	---
1053**. Aquolls and Aquents	---	---	---	---	---	---
1833----------------------- Coland	90	40	75	4.5	6.7	3.5
1834----------------------- Coland	---	---	---	---	---	3.0
1835B---------------------- Germantown	70	25	70	3.5	5.0	3.0
1836B**: Germantown-Rock outcrop--	---	---	---	---	---	2.0
1837----------------------- Webster Variant	---	---	---	---	---	3.0

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.
** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--			
	8-15	16-25	26-35	>35
31D, 31E. Storden				
35 Blue Earth	Medium purple willow, redosier dogwood, Tatarian honeysuckle.	Russian-olive	Green ash	Eastern cottonwood, golden willow, Siberian elm.
41A, 41B, 41C Estherville	Eastern redcedar, Russian-olive, Siberian crabapple, silver buffaloberry, Tatarian honeysuckle, Siberian peashrub.	Red pine, jack pine, ponderosa pine, Austrian pine, common hackberry, bur oak.	---	---
41D. Estherville				
86 Canisteo	Medium purple willow, redosier dogwood, Tatarian honeysuckle.	Russian-olive	Green ash	Eastern cottonwood, golden willow, Siberian elm.
94B Terril	Tatarian honeysuckle, lilac.	Amur maple, white spruce, Siberian crabapple, northern white-cedar.	Ponderosa pine, eastern white pine, common hackberry, green ash.	Silver maple, eastern cottonwood.
101B Truman	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, Siberian crabapple, Amur maple.	Eastern white pine, green ash, common hackberry.	American elm, eastern cottonwood.
102B Clarion	Tatarian honeysuckle, lilac.	Amur maple, white spruce, Siberian crabapple, northern white-cedar.	Ponderosa pine, eastern white pine, common hackberry, green ash.	Silver maple, eastern cottonwood.
110 Marna	Northern white-cedar, medium purple willow, Tatarian honeysuckle, redosier dogwood.	White spruce, Amur maple, eastern white pine, Siberian crabapple.	Golden willow, green ash, silver maple.	Eastern cottonwood.
113 Webster	Redosier dogwood, northern white-cedar, medium purple willow.	White spruce, Tatarian honeysuckle, Amur maple, eastern white pine, Siberian crabapple.	Green ash, silver maple, golden willow.	Eastern cottonwood.
114 Glencoe	Redosier dogwood, medium purple willow, northern white-cedar, Tatarian honeysuckle.	Siberian crabapple, eastern white pine, Amur maple, white spruce.	Green ash, silver maple, golden willow.	Eastern cottonwood.
128B Grogan	Northern white-cedar, gray dogwood, Tatarian honeysuckle, lilac.	White spruce, Siberian crabapple, Amur maple, eastern redcedar.	Red pine, eastern white pine, green ash, common hackberry.	---
130 Nicollet	Gray dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, Siberian crabapple, Amur maple, eastern redcedar.	Red pine, eastern white pine, green ash, common hackberry.	---

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--			
	8-15	16-25	26-35	>35
136-------------- Madelia	Northern white-cedar, tall purple willow, Tatarian honeysuckle, lilac.	White spruce, Amur maple.	Golden willow, green ash.	Eastern cottonwood.
140-------------- Spicer	Medium purple willow, Tatarian honeysuckle, redosier dogwood.	Russian-olive---------	Green ash-------------	Eastern cottonwood, golden willow, Siberian elm.
149B------------- Everly	Tatarian honeysuckle, lilac.	Amur maple, white spruce, Siberian crabapple, northern white-cedar.	Ponderosa pine, common hackberry, eastern white pine, green ash.	Silver maple.
154-------------- Blue Earth	Medium purple willow, redosier dogwood, Tatarian honeysuckle.	Russian-olive---------	Green ash-------------	Eastern cottonwood, golden willow, Siberian elm.
197-------------- Kingston	Lilac, gray dogwood, Tatarian honeysuckle.	Northern white-cedar, white spruce, Siberian crabapple, Amur maple, eastern redcedar.	Red pine, eastern white pine, green ash, common hackberry.	---
211-------------- Lura	Redosier dogwood, medium purple willow, northern white-cedar, Tatarian honeysuckle.	Siberian crabapple, eastern white pine, Amur maple, white spruce.	Green ash, silver maple, golden willow.	Eastern cottonwood.
214-------------- Talcot	Tatarian honeysuckle, medium purple willow, redosier dogwood.	Russian-olive---------	Green ash-------------	Eastern cottonwood, Siberian elm, golden willow.
230-------------- Guckeen	Gray dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, Siberian crabapple, Amur maple, eastern redcedar.	Red pine, eastern white pine, green ash, common hackberry.	---
241-------------- Letri	Eastern redcedar, lilac, Amur honeysuckle, northern white-cedar.	Black Hills spruce, eastern white pine, Amur maple.	Laurel willow, green ash, silver maple.	Siberian elm, eastern cottonwood.
247-------------- Linder	Tatarian honeysuckle, lilac.	Amur maple, white spruce, Siberian crabapple, northern white-cedar.	Ponderosa pine, common hackberry, green ash, eastern white pine.	Silver maple, eastern cottonwood.
255-------------- Mayer	Medium purple willow, Tatarian honeysuckle, redosier dogwood.	Russian-olive---------	Green ash-------------	Siberian elm, golden willow, eastern cottonwood.
269-------------- Millington	Tatarian honeysuckle, lilac.	Amur maple, white spruce, Siberian crabapple, northern white-cedar.	Common hackberry, ponderosa pine, green ash, eastern white pine.	Eastern cottonwood, silver maple.
291-------------- Ransom	Tatarian honeysuckle	Eastern redcedar, white spruce, Amur maple, Siberian crabapple.	Common hackberry, Russian-olive, green ash, golden willow.	Eastern cottonwood, American elm, silver maple.
304-------------- Rushmore	Northern white-cedar, tall purple willow, redosier dogwood, Tatarian honeysuckle, lilac, eastern redcedar.	White spruce, Amur maple.	Golden willow, green ash, silver maple.	Eastern cottonwood.
313-------------- Spillville	Tatarian honeysuckle, lilac.	Amur maple, white spruce, Siberian crabapple, northern white-cedar.	Common hackberry, ponderosa pine, green ash, eastern white pine.	Eastern cottonwood, silver maple.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- 8-15	16-25	26-35	>35
319------------------- Barbert	Northern white-cedar, redosier dogwood, medium purple willow, Tatarian honeysuckle.	White spruce, Amur maple, eastern white pine, Siberian crabapple.	Golden willow, green ash, silver maple.	Eastern cottonwood.
327A, 327B, 327C-- Dickman	Siberian crabapple, Amur honeysuckle, lilac.	Eastern redcedar, blue spruce, Austrian pine, northern white-cedar, common hackberry, red pine, white spruce, bur oak.	Green ash-------------	---
345------------------- Wilmonton	Tatarian honeysuckle	Northern white-cedar, Black Hills spruce, Siberian crabapple, Amur maple.	Scotch pine, green ash, common hackberry.	---
392------------------- Biscay	Northern white-cedar, redosier dogwood, medium purple willow, Tatarian honeysuckle.	Amur maple, white spruce, eastern white pine.	Silver maple, green ash, black ash, golden willow.	Eastern cottonwood.
421B----------------- Ves	Tatarian honeysuckle, lilac.	Eastern redcedar, northern white-cedar, Black Hills spruce, Amur maple.	Scotch pine, green ash, common hackberry, bur oak.	Silver maple, eastern cottonwood.
446------------------- Normania	Tatarian honeysuckle	Eastern redcedar, northern white-cedar, Black Hills spruce, Amur maple, Siberian crabapple.	Scotch pine, green ash, bur oak, common hackberry.	Eastern cottonwood, silver maple.
588B----------------- Clarion Variant	Gray dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, Siberian crabapple, Amur maple, white spruce.	Eastern white pine, ponderosa pine, green ash, common hackberry.	Eastern cottonwood.
589------------------- Romnell	Northern white-cedar, Tatarian honeysuckle, lilac, medium purple willow.	White spruce, Amur maple.	Silver maple, green ash, golden willow, black ash.	Eastern cottonwood.
590B----------------- Jeffers Variant	Tatarian honeysuckle, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Black Hills spruce, blue spruce, Russian-olive.	Siberian elm, American elm, green ash.	Eastern cottonwood.
594------------------- Jeffers	Medium purple willow, Tatarian honeysuckle, Siberian peashrub, redosier dogwood.	Russian-olive, eastern redcedar, northern white-cedar.	Green ash, American elm, golden willow.	Eastern cottonwood, Siberian elm.
595B, 595C--------- Swanlake	Northern white-cedar, lilac, Tatarian honeysuckle, Siberian peashrub.	White spruce, ponderosa pine, Russian-olive, Siberian crabapple, eastern redcedar.	Green ash, American elm.	Siberian elm.
884*:				
Webster------------	Tatarian honeysuckle, redosier dogwood, northern white-cedar, medium purple willow.	Siberian crabapple, Amur maple, eastern white pine, white spruce.	Green ash, silver maple, golden willow.	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--			
	8-15	16-25	26-35	>35
884*:				
Delft	Lilac, Tatarian honeysuckle, northern white-cedar, medium purple willow.	Amur maple, white spruce.	Green ash, silver maple, golden willow, black ash.	Eastern cottonwood.
885B*, 885C*:				
Swanlake	Northern white-cedar, lilac, Tatarian honeysuckle, Siberian peashrub.	White spruce, ponderosa pine, Russian-olive, Siberian crabapple, eastern redcedar.	Green ash, American elm.	Siberian elm.
Salida	Eastern redcedar, northern white-cedar, Russian-olive, Tatarian honeysuckle.	Common hackberry, bur oak, red pine.	---	---
886*:				
Nicollet	Gray dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, Siberian crabapple, Amur maple, eastern redcedar.	Red pine, eastern white pine, green ash, common hackberry.	---
Crippin	Medium purple willow, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Eastern redcedar, Russian-olive, eastern redcedar.	Silver maple, green ash.	Eastern cottonwood, Siberian elm.
887B*, 887C*:				
Clarion	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Red pine, Norway spruce, common hackberry.	Silver maple, eastern cottonwood.
Swanlake	Northern white-cedar, lilac, Tatarian honeysuckle, Siberian peashrub.	White spruce, ponderosa pine, Russian-olive, Siberian crabapple, eastern redcedar.	Green ash, American elm.	Siberian elm.
961D*:				
Storden.	---	---	---	---
Salida.	---	---	---	---
1029*. Pits	---	---	---	---
1053*. Aquolls and Aquents	---	---	---	---
1833, 1834 Coland	Tatarian honeysuckle, redosier dogwood, northern white cedar, medium purple willow.	Siberian crabapple, Amur maple, eastern white pine, white spruce.	Green ash, silver maple, golden willow.	Eastern cottonwood. silver maple.
1835B Germantown	Siberian crabapple, Tatarian honeysuckle, lilac.	Eastern redcedar, Black Hills spruce, bur oak, northern white-cedar, Scotch pine, common hackberry.	Green ash	---

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--			
	8-15	16-25	26-35	>35
1836B*:				
Germantown	Siberian crabapple, Tatarian honeysuckle, lilac.	Eastern redcedar, Black Hills spruce, bur oak, northern white-cedar, Scotch pine, common hackberry.	Green ash	---
Rock outcrop.				
1837. Webster Variant	---	---	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
31D, 31E: Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
35: Blue Earth	Severe: wetness, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.
41A: Estherville	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
41B: Estherville	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
41C: Estherville	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
41D: Estherville	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
86: Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.
94B: Terril	Slight	Moderate: low strength.	Moderate: low strength.	Moderate: slope, low strength.	Severe: low strength.
101B: Truman	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: frost action, low strength.
102B: Clarion	Slight	Slight	Slight	Slight	Moderate: low strength, frost action.
110: Marna	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: frost action, low strength.
113: Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action, wetness.
114: Glencoe	Severe: wetness, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.
128B: Grogan	Slight	Slight	Slight	Moderate: slope.	Severe: frost action.
130: Nicollet	Moderate: wetness.	Moderate: shrink-swell, low strength.	Moderate: wetness, shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: frost action, low strength.

TABLE 7.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
136 Madelia	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.
140 Spicer	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action, low strength.
149B Everly	Slight	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: low strength, slope, shrink-swell.	Severe: low strength.
154 Blue Earth	Severe: wetness, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.
197 Kingston	Moderate: wetness.	Moderate: shrink-swell, low strength.	Moderate: low strength, wetness, shrink-swell.	Moderate: shrink-swell, low strength.	Severe: frost action, low strength.
211 Lura	Severe: wetness, floods, too clayey.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, low strength.
214 Talcot	Severe: wetness, cutbanks cave, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods, low strength.
230 Guckeen	Severe: wetness.	Severe: low strength.	Severe: wetness.	Severe: low strength.	Severe: frost action, low strength.
241 Letri	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength, wetness.
247 Linder	Severe: cutbanks cave.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.
255 Mayer	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: frost action.
269 Millington	Severe: wetness, floods.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness, low strength.
291 Ransom	Moderate: wetness.	Moderate: shrink-swell, low strength.	Moderate: wetness, shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: frost action, low strength.
304 Rushmore	Severe: wetness.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: frost action, low strength.
313 Spillville	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength, floods.

See footnote at end of table.

TABLE 7.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
319: Barbert	Severe: wetness, floods.	Severe: shrink-swell, wetness, floods.	Severe: shrink-swell, wetness, floods.	Severe: wetness, shrink-swell, floods.	Severe: low strength, wetness, floods.
327A: Dickman	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
327B: Dickman	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
327C: Dickman	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
345: Wilmonton	Moderate: wetness, too clayey.	Moderate: shrink-swell, low strength.	Moderate: wetness, shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength, frost action.
392: Biscay	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
421B: Ves	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action, low strength.
446: Normania	Moderate: wetness.	Moderate: shrink-swell, low strength.	Moderate: wetness, shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: frost action, low strength.
588B: Clarion Variant	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.
589: Romnell	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action, wetness.
590B: Jeffers Variant	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.
594: Jeffers	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.
595B: Swanlake	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action, low strength.
595C: Swanlake	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: frost action, slope, low strength.
884*:					
Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action, wetness.
Delft	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength, wetness.

See footnote at end of table.

TABLE 7.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
885B*:					
Swanlake	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action, low strength.
Salida	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Severe: small stones.
885C*:					
Swanlake	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: frost action, slope, low strength.
Salida	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: small stones.
886*:					
Nicollet	Moderate: wetness.	Moderate: shrink-swell, low strength.	Moderate: wetness, shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: frost action, low strength.
Crippin	Severe: wetness.	Moderate: wetness, shrink-swell, low strength.	Severe: wetness.	Moderate: wetness, shrink-swell, low strength.	Severe: frost action, low strength.
887B*:					
Clarion	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.
Swanlake	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action, low strength.
887C*:					
Clarion	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, low strength, frost action.
Swanlake	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: frost action, slope, low strength.
961D*:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Salida	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1029*.					
Pits	---	---	---	---	---
1053*. Aquolls and Aquents	---	---	---	---	---
1833, 1834 Coland	Severe: floods, wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, low strength.

See footnote at end of table.

TABLE 7.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
1835B------------- Germantown	Severe: depth to rock.	Moderate: depth to rock, shrink-swell, low strength.	Severe: depth to rock.	Moderate: depth to rock, shrink-swell, slope.	Severe: low strength.
1836B*:					
Germantown-------	Severe: depth to rock.	Moderate: depth to rock, shrink-swell, low strength.	Severe: depth to rock.	Moderate: depth to rock, shrink-swell, slope.	Severe: low strength.
Rock outcrop.					
1837-------------- Webster Variant	Severe: depth to rock, wetness.	Severe: depth to rock, wetness.	Severe: depth to rock, wetness.	Severe: depth to rock, wetness.	Severe: depth to rock, low strength, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," and "fair." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
31D Storden	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.	Poor: slope.
31E Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
35 Blue Earth	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness, hard to pack.
41A, 41B** Estherville	Slight	Severe: seepage.	Severe: too sandy, seepage.	Severe: seepage.	Poor: too sandy, seepage.
41C** Estherville	Moderate: slope.	Severe: seepage, slope.	Severe: too sandy, seepage.	Severe: seepage.	Poor: too sandy, seepage.
41D** Estherville	Severe: slope.	Severe: seepage, slope.	Severe: too sandy, seepage.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
86 Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
94B Terril	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
101B Truman	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
102B Clarion	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
110 Marna	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
113 Webster	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
114 Glencoe	Severe: wetness, floods, percs slowly.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
128B Grogan	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
130 Nicollet	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
136 Madelia	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.

TABLE 8.--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
140----------------- Spicer	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
149B---------------- Everly	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
154----------------- Blue Earth	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness, hard to pack.
197----------------- Kingston	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness.	Severe: wetness.	Fair: wetness.
211----------------- Lura	Severe: wetness, percs slowly, floods.	Moderate: excess humus.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness, too clayey, hard to pack.
214----------------- Talcot	Severe: wetness, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Poor: wetness, too sandy, seepage.
230----------------- Guckeen	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey.
241----------------- Letri	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
247----------------- Linder	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, small stones, too sandy.
255----------------- Mayer	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage, too sandy.	Severe: wetness, seepage.	Poor: wetness.
269----------------- Millington	Severe: floods, wetness.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
291----------------- Ransom	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
304----------------- Rushmore	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
313----------------- Spillville	Severe: wetness, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Fair: wetness.
319----------------- Barbert	Severe: percs slowly, wetness, floods.	Severe: wetness.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: wetness, too clayey.
327A, 327B**-------- Dickman	Slight-----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.

See footnotes at end of table.

TABLE 8.--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
327C**: Dickman	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
345: Wilmonton	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey.
392: Biscay	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: wetness, seepage.	Poor: wetness, too sandy, seepage.
421B: Ves	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
446: Normania	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Good.
588B: Clarion Variant	Severe: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
589: Romnell	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
590B: Jeffers Variant	Severe: percs slowly, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness, too clayey.
594: Jeffers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
595B: Swanlake	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
595C: Swanlake	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.	Fair: slope.
884*:					
Webster	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Delft	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
885B*:					
Swanlake	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Salida**	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage, small stones.
885C*:					
Swanlake	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.	Fair: slope.

See footnotes at end of table.

TABLE 8.--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
885C*:					
Salida**	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage, small stones.
886*:					
Nicollet	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Crippin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
887B*:					
Clarion	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
Swanlake	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
887C*:					
Clarion	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.	Fair: slope.
Swanlake	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.	Fair: slope.
961D*:					
Storden	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.	Poor: slope.
Salida**	Severe: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage, slope.	Poor: too sandy, seepage, small stones.
1029*. Pits	---	---	---	---	---
1053*. Aquolls and Aquents	---	---	---	---	---
1833, 1834 Coland	Severe: floods, wetness, percs slowly.	Severe: floods, wetness, seepage.	Severe: floods, wetness, seepage.	Severe: floods, wetness, seepage.	Poor: wetness.
1835B Germantown	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Poor: area reclaim.
1836B*:					
Germantown	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Poor: area reclaim.
Rock outcrop.					
1837 Webster Variant	Severe: depth to rock, wetness.	Severe: depth to rock, wetness.	Severe: depth to rock, wetness.	Severe: depth to rock, wetness.	Poor: area reclaim, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.
** Hazard of ground water pollution.

TABLE 9.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
31D------------------ Storden	Fair: slope, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
31E------------------ Storden	Poor: slope.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
35------------------- Blue Earth	Poor: wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
41A, 41B, 41C--------- Estherville	Good-----------------	Good-----------------	Good-----------------	Poor: area reclaim.
41D------------------ Estherville	Fair: slope.	Good-----------------	Good-----------------	Poor: area reclaim, slope.
86------------------- Canisteo	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
94B------------------ Terril	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
101B----------------- Truman	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
102B----------------- Clarion	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
110------------------ Marna	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
113------------------ Webster	Poor: wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: wetness, too clayey.
114------------------ Glencoe	Poor: wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
128B----------------- Grogan	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
130------------------ Nicollet	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
136------------------ Madelia	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
140------------------ Spicer	Poor: wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
149B----------------- Everly	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.

TABLE 9.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
154 Blue Earth	Poor: wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness, excess humus.
197 Kingston	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
211 Lura	Poor: shrink-swell, low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness, too clayey.
214 Talcot	Poor: wetness.	Good	Unsuited: excess fines.	Poor: wetness.
230 Guckeen	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
241 Letri	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
247 Linder	Fair: wetness.	Good	Unsuited: excess fines.	Good.
255 Mayer	Poor: wetness.	Good	Good	Good.
269 Millington	Poor: wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
291 Ransom	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
304 Rushmore	Poor: wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
313 Spillville	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
319 Barbert	Poor: shrink-swell, wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
327A, 327B Dickman	Good	Fair: excess fines.	Unsuited: excess fines.	Good.
327C Dickman	Good	Fair: excess fines.	Unsuited: excess fines.	Fair: slope.
345 Wilmonton	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
392 Biscay	Poor: wetness.	Good	Good	Good.
421B Ves	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
446 Normania	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
588B Clarion Variant	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.

TABLE 9.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
589: Romnell	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
590B: Jeffers Variant	Fair: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: excess salt, too clayey.
594: Jeffers	Poor: wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
595B: Swanlake	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
595C: Swanlake	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope.
884*:				
Webster	Poor: wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: wetness, too clayey.
Delft	Poor: wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
885B*:				
Swanlake	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Salida	Good	Good	Good	Poor: small stones.
885C*:				
Swanlake	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope.
Salida	Good	Good	Good	Poor: small stones.
886*:				
Nicollet	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Crippin	Fair: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
887B*:				
Clarion	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Swanlake	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
887C*:				
Clarion	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope.
Swanlake	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope.
961D*:				
Storden	Fair: slope, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.

See footnote at end of table.

TABLE 9.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
961D*:				
Salida	Fair: slope.	Good	Good	Poor: small stones, slope.
1029*. Pits	---	---	---	---
1053*. Aquolls and Aquents	---	---	---	---
1833, 1834 Coland	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
1835B Germantown	Poor: low strength, thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: area reclaim, too clayey, small stones.
1836B*:				
Germantown	Poor: low strength, thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: area reclaim, too clayey, small stones.
Rock outcrop.				
1837 Webster Variant	Poor: low strength, thin layer, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness, area reclaim.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
31D, 31E Storden	Slope, seepage.	Favorable	Not needed	Slope	Slope	Slope, erodes easily.
35 Blue Earth	Seepage	Hard to pack, wetness, piping.	Floods, frost action.	Wetness, floods.	Not needed	Wetness.
41A Estherville	Seepage	Seepage	Not needed	Droughty, soil blowing.	Not needed	Droughty.
41B Estherville	Seepage	Seepage	Not needed	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
41C Estherville	Seepage	Seepage	Not needed	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Slope, droughty.
41D Estherville	Seepage	Seepage	Not needed	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
86 Canisteo	Seepage	Wetness	Frost action	Wetness	Not needed	Wetness.
94B Terril	Seepage	Favorable	Not needed	Favorable	Favorable	Favorable.
101B Truman	Seepage	Piping	Not needed	Favorable	Erodes easily	Erodes easily.
102B Clarion	Seepage	Favorable	Not needed	Favorable	Favorable	Favorable.
110 Marna	Favorable	Wetness	Percs slowly, frost action.	Slow intake, wetness, percs slowly.	Not needed	Percs slowly, wetness.
113 Webster	Seepage	Wetness	Frost action	Wetness	Not needed	Wetness.
114 Glencoe	Seepage	Wetness, hard to pack.	Floods, frost action.	Wetness, floods.	Not needed	Wetness.
128B Grogan	Seepage	Piping	Not needed	Favorable	Erodes easily	Erodes easily.
130 Nicollet	Seepage	Wetness	Frost action	Wetness	Not needed	Favorable.
136 Madelia	Seepage	Wetness, piping.	Frost action	Wetness	Not needed	Wetness.
140 Spicer	Seepage	Wetness, piping.	Frost action	Wetness	Not needed	Wetness.
149B Everly	Favorable	Favorable	Not needed	Favorable	Favorable	Favorable.
154 Blue Earth	Seepage	Hard to pack, wetness, piping.	Floods, frost action.	Wetness, floods, soil blowing.	Not needed	Wetness.
197 Kingston	Seepage	Wetness	Frost action	Wetness	Not needed	Erodes easily.

TABLE 10.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
211 Lura	Favorable	Hard to pack, wetness.	Floods, percs slowly, frost action.	Wetness, slow intake, percs slowly.	Not needed	Percs slowly, wetness.
214 Talcot	Seepage	Seepage, wetness.	Frost action, floods.	Wetness, floods.	Not needed	Wetness.
230 Guckeen	Favorable	Favorable	Percs slowly, frost action.	Wetness, percs slowly.	Not needed	Percs slowly, erodes easily.
241 Letri	Favorable	Wetness	Frost action	Wetness	Not needed	Wetness.
247 Linder	Seepage	Seepage, wetness.	Frost action	Wetness, droughty.	Not needed	Favorable.
255 Mayer	Seepage	Seepage, wetness.	Frost action	Wetness	Not needed	Wetness.
269 Millington	Seepage	Wetness	Floods, frost action.	Wetness, floods.	Not needed	Wetness.
291 Ransom	Favorable	Wetness	Frost action	Wetness	Not needed	Favorable.
304 Rushmore	Favorable	Wetness	Frost action	Wetness	Not needed	Wetness.
313 Spillville	Seepage	Favorable	Not needed	Floods	Not needed	Favorable.
319 Barbert	Favorable	Wetness, hard to pack.	Percs slowly, frost action, floods.	Percs slowly, wetness, floods.	Not needed	Wetness, percs slowly.
327A Dickman	Seepage	Seepage	Not needed	Droughty, soil blowing.	Not needed	Droughty.
327B Dickman	Seepage	Seepage	Not needed	Droughty, soil blowing.	Too sandy	Droughty.
327C Dickman	Seepage, slope.	Seepage	Not needed	Slope, droughty, soil blowing.	Too sandy	Droughty, slope.
345 Wilmonton	Favorable	Wetness	Frost action	Wetness	Not needed	Favorable.
392 Biscay	Seepage	Seepage, wetness.	Frost action	Wetness	Not needed	Wetness.
421B Ves	Seepage	Favorable	Not needed	Favorable	Favorable	Favorable.
446 Normania	Seepage	Favorable	Not needed	Favorable	Not needed	Erodes easily.
588B Clarion Variant	Seepage	Piping	Not needed	Favorable	Favorable	Erodes easily.
589 Romnell	Favorable	Wetness	Frost action	Wetness	Not needed	Wetness, erodes easily.
590B Jeffers Variant	Favorable	Piping, wetness.	Frost action, excess salt.	Wetness, excess salt.	Wetness	Erodes easily.
594 Jeffers	Favorable	Wetness	Frost action	Wetness	Not needed	Wetness.
595B Swanlake	Seepage	Favorable	Not needed	Favorable	Favorable	Erodes easily.

TABLE 10.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
595C: Swanlake	Slope	Favorable	Not needed	Slope	Favorable	Slope, erodes easily.
884*:						
Webster	Seepage	Wetness	Frost action	Wetness	Not needed	Wetness.
Delft	Seepage	Wetness	Frost action	Wetness	Not needed	Wetness.
885B*:						
Swanlake	Seepage	Favorable	Not needed	Favorable	Favorable	Erodes easily.
Salida	Seepage	Seepage	Not needed	Droughty, fast intake.	Too sandy	Droughty.
885C*:						
Swanlake	Slope	Favorable	Not needed	Slope	Favorable	Slope, erodes easily.
Salida	Seepage, slope.	Seepage	Not needed	Slope, droughty, fast intake.	Too sandy	Slope, droughty.
886*:						
Nicollet	Seepage	Wetness	Frost action	Wetness	Not needed	Favorable.
Crippin	Seepage	Wetness	Frost action	Wetness	Not needed	Erodes easily.
887B*:						
Clarion	Seepage	Favorable	Not needed	Favorable	Favorable	Favorable.
Swanlake	Seepage	Favorable	Not needed	Favorable	Favorable	Erodes easily.
887C*:						
Clarion	Seepage, slope.	Favorable	Not needed	Slope	Favorable	Slope.
Swanlake	Slope	Favorable	Not needed	Slope	Favorable	Slope, erodes easily.
961D*:						
Storden	Slope, seepage.	Favorable	Not needed	Slope	Slope	Slope, erodes easily.
Salida	Seepage, slope.	Seepage	Not needed	Slope, droughty, fast intake.	Slope, too sandy.	Slope, droughty.
1029*. Pits	---	---	---	---	---	---
1053*. Aquolls and Aquents	---	---	---	---	---	---
1833, 1834: Coland	Seepage	Hard to pack, wetness.	Floods, frost action.	Wetness, floods.	Not needed	Wetness.
1835B: Germantown	Depth to rock	Thin layer	Not needed	Rooting depth	Depth to rock	Depth to rock.
1836B*:						
Germantown	Depth to rock	Thin layer	Not needed	Rooting depth	Depth to rock	Depth to rock.
Rock outcrop.						
1837: Webster Variant	Depth to rock	Thin layer, wetness.	Depth to rock, frost action.	Wetness, rooting depth.	Not needed	Wetness, rooting depth.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
31D: Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
31E: Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
35: Blue Earth	Severe: floods, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
41A: Estherville	Slight	Slight	Moderate: small stones.	Slight	Slight.
41B: Estherville	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
41C: Estherville	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
41D: Estherville	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
86: Canisteo	Severe: wetness.	Moderate: wetness, too clayey.	Severe: wetness.	Moderate: wetness, too clayey.	Moderate: too clayey, wetness.
94B: Terril	Slight	Slight	Moderate: slope.	Slight	Slight.
101B: Truman	Slight	Slight	Moderate: slope.	Slight	Slight.
102B: Clarion	Slight	Slight	Moderate: slope.	Slight	Slight.
110: Marna	Severe: wetness, too clayey.	Severe: too clayey.	Severe: wetness, too clayey.	Severe: too clayey.	Severe: too clayey.
113: Webster	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: wetness.
114: Glencoe	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.	Severe: floods, wetness.
128B: Grogan	Slight	Slight	Moderate: slope.	Slight	Slight.
130: Nicollet	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.
136: Madelia	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: too clayey, wetness.

TABLE 11.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
140-------------------- Spicer	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: wetness.
149B------------------- Everly	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Moderate: slope, too clayey, percs slowly.	Moderate: too clayey.	Moderate: too clayey.
154-------------------- Blue Earth	Severe: floods, wetness, excess humus.	Severe: wetness, excess humus.	Severe: wetness.	Severe: wetness, excess humus.	Severe: wetness, floods.
197-------------------- Kingston	Slight----------	Slight----------	Slight----------	Slight----------	Slight.
211-------------------- Lura	Severe: floods, wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness, floods.	Severe: wetness, too clayey.	Severe: floods, wetness, too clayey.
214-------------------- Talcot	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.
230-------------------- Guckeen	Moderate: wetness, percs slowly, too clayey.	Moderate: wetness, too clayey.	Moderate: wetness, too clayey.	Moderate: too clayey.	Moderate: too clayey.
241-------------------- Letri	Severe: wetness, floods.	Severe: wetness.	Severe: wetness.	Moderate: wetness, too clayey.	Severe: wetness.
247-------------------- Linder	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight----------	Moderate: wetness.
255-------------------- Mayer	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
269-------------------- Millington	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.	Severe: floods, wetness.
291-------------------- Ransom	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Moderate: too clayey, percs slowly.	Moderate: too clayey.	Moderate: too clayey.
304-------------------- Rushmore	Severe: wetness, floods.	Moderate: wetness, too clayey.	Severe: wetness.	Moderate: wetness, too clayey.	Moderate: too clayey, wetness.
313-------------------- Spillville	Severe: floods.	Slight----------	Moderate: floods.	Slight----------	Moderate: floods.
319-------------------- Barbert	Severe: floods, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
327A------------------- Dickman	Slight----------	Slight----------	Slight----------	Slight----------	Slight.
327B------------------- Dickman	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
327C------------------- Dickman	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.

See footnote at end of table.

TABLE 11.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
345 Wilmonton	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.
392 Biscay	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
421B Ves	Slight	Slight	Moderate: slope.	Slight	Slight.
446 Normania	Slight	Slight	Slight	Slight	Slight.
588B Clarion Variant	Moderate: percs slowly.	Slight	Moderate: slope, percs slowly.	Slight	Slight.
589 Romnell	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, too clayey.	Moderate: wetness, too clayey.
590B Jeffers Variant	Moderate: wetness, percs slowly, too clayey.	Moderate: wetness, too clayey.	Moderate: slope, too clayey, wetness.	Moderate: too clayey.	Moderate: too clayey, excess salt, wetness.
594 Jeffers	Severe: wetness.	Moderate: wetness, too clayey.	Severe: wetness.	Moderate: wetness, too clayey.	Moderate: wetness, too clayey.
595B Swanlake	Slight	Slight	Moderate: slope.	Slight	Slight.
595C Swanlake	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
884*:					
Webster	Severe: wetness.	Moderate: wetness, too clayey.	Severe: wetness.	Moderate: wetness, too clayey.	Moderate: wetness, too clayey.
Delft	Severe: wetness.	Moderate: wetness, too clayey.	Severe: wetness.	Moderate: wetness, too clayey.	Moderate: too clayey, wetness.
885B*:					
Swanlake	Slight	Slight	Moderate: slope.	Slight	Slight.
Salida	Moderate: small stones.	Moderate: small stones.	Severe: small stones.	Moderate: small stones.	Severe: small stones, droughty.
885C*:					
Swanlake	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Salida	Moderate: slope, small stones.	Moderate: slope, small stones.	Severe: slope, small stones.	Moderate: small stones.	Severe: small stones, droughty.
886*:					
Nicollet	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.

See footnote at end of table.

TABLE 11.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
886*:					
Crippin	Moderate: too clayey, wetness.	Moderate: too clayey, wetness.	Moderate: too clayey, wetness.	Moderate: too clayey.	Moderate: too clayey.
887B*:					
Clarion	Slight	Slight	Moderate: slope.	Slight	Slight.
Swanlake	Slight	Slight	Moderate: slope.	Slight	Slight.
887C*:					
Clarion	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Swanlake	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
961D*:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Salida	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: slope, small stones.	Severe: slope, small stones, droughty.
1029*. Pits	---	---	---	---	---
1053*. Aquolls and Aquents	---	---	---	---	---
1833 Coland	Severe: floods, wetness.	Moderate: wetness, too clayey.	Severe: wetness.	Moderate: wetness, too clayey.	Moderate: wetness, floods, too clayey.
1834 Coland	Severe: floods, wetness.	Moderate: floods, wetness, too clayey.	Severe: wetness, floods.	Moderate: wetness, too clayey, floods.	Severe: floods.
1835B Germantown	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Moderate: slope, too clayey, depth to rock.	Moderate: too clayey.	Moderate: too clayey, thin layer.
1836B*:					
Germantown	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Moderate: slope, too clayey, depth to rock.	Moderate: too clayey.	Moderate: too clayey, thin layer.
Rock outcrop.					
1837 Webster Variant	Severe: wetness.	Severe: wetness.	Severe: wetness, depth to rock.	Moderate: wetness, too clayey.	Severe: wetness, thin layer.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
31D----------------- Storden	Fair	Good	Good	Fair	Poor	Very poor	Very poor	Fair	Fair	Very poor
31E----------------- Storden	Poor	Fair	Good	Fair	Poor	Very poor	Very poor	Fair	Fair	Very poor
35------------------ Blue Earth	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Poor	Good
41A, 41B, 41C------- Estherville	Fair	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Fair	Very poor
41D----------------- Estherville	Poor	Fair	Fair	Fair	Fair	Very poor	Very poor	Poor	Fair	Very poor
86------------------ Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good
94B----------------- Terril	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor
101B---------------- Truman	Good	Good	Good	Good	Fair	Poor	Very poor	Good	Good	Very poor
102B---------------- Clarion	Good	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor
110----------------- Marna	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good
113----------------- Webster	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good
114----------------- Glencoe	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good
128B---------------- Grogan	Good	Good	Good	Good	Good	Very poor	Very poor	Good	Good	Very poor
130----------------- Nicollet	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor
136----------------- Madelia	Good	Good	Good	Good	Fair	Good	Good	Good	Fair	Good
140----------------- Spicer	Good	Good	Fair	Fair	Poor	Good	Good	Good	Fair	Good
149B---------------- Everly	Good	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor
154----------------- Blue Earth	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Poor	Good
197----------------- Kingston	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor
211----------------- Lura	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good

TABLE 12.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
214: Talcot	Fair	Fair	Fair	Poor	Poor	Good	Good	Fair	Poor	Good
230: Guckeen	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair
241: Letri	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good
247: Linder	Fair	Good	Good	Good	Good	Very poor	Very poor	Good	Good	Very poor
255: Mayer	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good
269: Millington	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good
291: Ransom	Good	Good	Fair	Good	Good	Poor	Poor	Good	Good	Poor
304: Rushmore	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good
313: Spillville	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair
319: Barbert	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good
327A, 327B, 327C: Dickman	Fair	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Fair	Very poor
345: Wilmonton	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor
392: Biscay	Good	Good	Good	Good	Fair	Good	Good	Good	Fair	Good
421B: Ves	Good	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor
446: Normania	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor
588B: Clarion Variant	Good	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor
589: Romnell	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good
590B: Jeffers Variant	Good	Good	Good	Fair	Fair	Poor	Poor	Good	Fair	Poor
594: Jeffers	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good
595B: Swanlake	Good	Good	Good	Fair	Fair	Poor	Very poor	Good	Fair	Very poor
595C: Swanlake	Fair	Good	Good	Fair	Fair	Very poor	Very poor	Fair	Fair	Very poor
884*:										
Webster	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good

See footnote at end of table.

TABLE 12.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
884*:										
Delft	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good
885B*:										
Swanlake	Good	Good	Good	Fair	Fair	Poor	Very poor	Good	Fair	Very poor
Salida	Poor	Poor	Poor	Poor	Poor	Very poor	Very poor	Poor	Poor	Very poor
885C*:										
Swanlake	Fair	Good	Good	Fair	Fair	Very poor	Very poor	Fair	Fair	Very poor
Salida	Poor	Poor	Poor	Poor	Poor	Very poor	Very poor	Poor	Poor	Very poor
886*:										
Nicollet	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor
Crippin	Good	Good	Good	Good	Fair	Fair	Poor	Good	Good	Poor
887B*:										
Clarion	Good	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor
Swanlake	Good	Good	Good	Fair	Fair	Poor	Very poor	Good	Fair	Very poor
887C*:										
Clarion	Fair	Good	Good	Good	Good	Very poor	Very poor	Good	Good	Very poor
Swanlake	Fair	Good	Good	Fair	Fair	Very poor	Very poor	Fair	Fair	Very poor
961D*:										
Storden	Fair	Good	Good	Fair	Poor	Very poor	Very poor	Fair	Fair	Very poor
Salida	Very poor	Poor	Poor	Poor	Poor	Very poor	Very poor	Very poor.	Poor	Very poor
1029*. Pits	---	---	---	---	---	---	---	---	---	---
1053*. Aquolls and Aquents	---	---	---	---	---	---	---	---	---	---
1833 Coland	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good
1834 Coland	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good
1835B Germantown	Fair	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor
1836B*:										
Germantown	Fair	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor
Rock outcrop.										

See footnote at end of table.

TABLE 12.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
1837---------------- Webster Variant	Poor	Fair	Fair	Poor	Poor	Good	Poor	Poor	Poor	Fair

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
31D, 31E----------- Storden	0-9	Loam------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	9-60	Loam------------	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
35----------------- Blue Earth	0-11	Mucky silt loam	OL, ML	A-5	0	95-100	95-100	85-95	80-95	41-50	2-8
	11-44	Mucky silty clay loam, silty clay loam, mucky silt loam.	OL, ML	A-5	0	95-100	80-100	80-95	80-95	41-50	2-8
	44-60	Clay loam, loam, silt loam.	CL, ML	A-6, A-7	0	95-100	90-100	80-100	70-95	35-50	11-20
41A, 41B, 41C, 41D- Estherville	0-13	Sandy loam------	SM, SM-SC, SC	A-2, A-4	0-5	90-100	80-95	50-75	25-50	20-30	2-10
	13-19	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	70-95	40-75	15-45	20-30	2-8
	19-60	Coarse sand, gravelly coarse sand, loamy coarse sand.	SP, SP-SM, SM, GP	A-1	0-10	45-90	40-85	10-40	2-25	---	NP
86----------------- Canisteo	0-21	Clay loam-------	OL, CL	A-7	0	98-100	95-100	85-98	60-90	40-50	15-20
	21-40	Clay loam, loam	CL	A-6, A-7	0	98-100	90-100	85-95	65-85	38-50	25-35
	40-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	60-75	30-40	12-20
94B---------------- Terril	0-24	Loam------------	CL	A-4, A-6	0-5	100	95-100	70-90	60-80	30-40	10-20
	24-60	Clay loam, loam	CL	A-6, A-7	0-5	100	100	85-95	65-85	30-45	15-25
101B--------------- Truman	0-14	Silt loam-------	ML	A-4	0	100	100	95-100	80-98	30-40	5-10
	14-40	Silt loam, silty clay loam.	ML, CL	A-4, A-6, A-7	0	100	100	95-100	80-98	30-45	5-20
	40-60	Silt loam-------	CL, CL-ML	A-4, A-6	0	100	100	95-100	75-95	25-40	4-15
102B--------------- Clarion	0-14	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	14-30	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	30-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
110---------------- Marna	0-17	Silty clay loam	ML	A-7	0	98-100	90-100	90-100	90-100	40-50	15-30
	17-36	Clay, silty clay loam.	CH, MH	A-7	0	98-100	90-100	90-100	85-95	50-80	20-45
	36-60	Clay loam, loam	CL	A-7, A-6	0-5	95-100	90-98	75-95	60-80	35-50	15-25
113---------------- Webster	0-15	Clay loam-------	CL, CH	A-7, A-6	0-5	100	95-100	85-95	70-90	35-60	15-30
	15-38	Clay loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	15-30
	38-60	Loam, sandy loam, clay loam.	CL, ML	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20
114---------------- Glencoe	0-44	Clay loam-------	OL, OH, MH, ML	A-7	0	100	95-100	85-98	75-90	45-60	10-20
	44-49	Loam, clay loam, silty clay loam.	CL	A-7, A-6	0	100	95-100	85-98	75-90	35-50	15-25
	49-60	Loam, clay loam	CL	A-6, A-7	0	98-100	90-98	80-98	70-85	35-50	15-25
128B---------------	0-16	Fine sandy loam	ML	A-4	0	100	100	95-100	50-90	20-40	NP-10
	16-42	Fine sandy loam	ML	A-4	0	100	100	95-100	50-95	20-40	NP-10
	42-60	Stratified very fine sand to silt loam.	ML, CL-ML	A-4	0	100	100	90-100	65-95	20-30	NP-5

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--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	
130---------------- Nicollet	0-16	Clay loam-------	OL, ML, CL	A-6, A-7	0	95-100	95-100	85-98	55-85	35-50	10-25
	16-37	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-95	55-80	35-50	15-25
	37-60	Loam------------	CL, ML	A-6, A-4	0-5	95-100	90-100	75-90	50-75	30-40	5-15
136---------------- Madelia	0-22	Silty clay loam	ML	A-7	0	100	100	100	90-100	40-50	10-20
	22-33	Silty clay loam, silt loam.	CL	A-7, A-6	0	100	100	100	90-100	30-50	10-25
	33-48	Silt loam, loam, very fine sand.	ML, CL	A-6, A-4, A-7	0	100	100	100	60-100	30-50	5-25
	48-60	Loam------------	CL, ML	A-6, A-4	0-5	90-100	85-95	80-90	55-80	30-40	8-15
140---------------- Spicer	0-18	Silt loam-------	OL, ML	A-7, A-6	0	100	100	95-100	90-100	35-50	10-20
	18-43	Silt loam, silty clay loam.	ML	A-7, A-6	0	100	100	95-100	85-100	35-50	10-20
	43-60	Silt loam, silty clay loam.	ML	A-4, A-6	0	100	100	95-100	85-100	30-40	5-12
149B--------------- Everly	0-17	Clay loam-------	CL	A-6, A-7	0	100	95-100	85-95	65-80	30-45	10-20
	17-36	Clay loam, loam	CL	A-6, A-7	0	95-100	95-100	85-95	70-90	35-50	15-25
	36-60	Loam, clay loam	CL	A-6	0-5	90-100	85-95	75-85	60-80	30-40	10-20
154---------------- Blue Earth	0-8	Muck------------	PT	A-8	0	---	---	---	---	---	---
	8-56	Mucky silty clay loam, silty clay loam, mucky silt loam.	OL, ML	A-5	0	95-100	80-100	80-95	80-95	41-50	2-8
	56-60	Clay loam, loam, silty clay loam.	CL, ML	A-6, A-7	0	95-100	90-100	80-100	70-95	35-50	11-20
197---------------- Kingston	0-20	Silt loam-------	ML, OL, CL-ML, CL	A-4	0	100	100	95-100	85-98	25-35	5-10
	20-38	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	95-100	85-98	35-45	12-20
	38-60	Silt loam, silty clay loam.	CL-ML, CL	A-4, A-6	0	100	100	95-100	85-98	25-35	5-12
211---------------- Lura	0-52	Silty clay, clay	OH, MH, CH	A-7	0	100	100	95-100	90-98	50-75	15-40
	52-60	Silty clay, silty clay loam, clay.	CL, CH	A-7	0	100	100	95-100	90-98	40-55	20-30
214---------------- Talcot	0-22	Silty clay loam	CL	A-7	0	100	100	80-90	60-85	40-50	15-25
	22-36	Clay loam, silty clay loam, loam.	CL	A-7	0	95-100	85-100	70-90	60-85	40-50	15-25
	36-60	Stratified loamy sand to gravelly coarse sand.	SP, SP-SM, SW	A-1	0	65-90	50-85	20-50	2-10	---	NP
230---------------- Guckeen	0-21	Silty clay loam	MH, ML, CL, CH	A-7	0	100	95-100	95-100	80-95	40-60	15-25
	21-34	Silty clay, silty clay loam.	MH, ML, CL, CH	A-7	0	100	95-100	95-100	80-95	40-65	15-30
	34-60	Clay loam, silt loam.	CL	A-6, A-7	0	90-100	90-98	85-95	60-75	30-50	10-25

See footnote at end of table.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--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	
241---------------- Letri	0-19	Clay loam-------	CL	A-7	0	95-100	95-100	95-100	80-95	40-50	15-25
	19-26	Clay loam, silty clay loam.	CL	A-7	0	95-100	90-100	85-95	75-85	40-50	15-25
	26-60	Loam, clay loam	CL, ML	A-6, A-7, A-4	0-5	95-100	85-98	85-95	65-75	30-50	7-25
247---------------- Linder	0-16	Loam------------	CL, SC	A-4, A-6	0	100	95-100	80-95	35-80	25-40	8-20
	16-33	Sandy loam, loamy sand.	SC, SM-SC	A-2, A-4	0	95-100	80-100	45-75	30-45	20-30	5-10
	33-60	Sand, gravelly loamy sand, loamy coarse sand.	SP, SP-SM	A-1, A-2	0-5	75-95	50-95	25-50	2-12	---	NP
255---------------- Mayer	0-17	Loam------------	CL, ML	A-6, A-4	0-2	95-100	80-100	70-90	50-85	30-40	5-15
	17-40	Loam, sandy loam, gravelly sandy loam.	CL, SC, ML, SM	A-6, A-4	0-5	90-100	80-100	70-90	40-85	30-40	5-15
	40-60	Gravelly loamy sand, sand, coarse sand.	SP, SW, SP-SM, GP	A-1	0-10	45-90	40-85	20-45	2-10	<20	NP
269---------------- Millington	0-30	Silty clay loam	CL, ML, OL	A-7, A-6	0	100	90-100	90-100	90-100	35-50	11-20
	30-48	Loam, silty clay loam, clay loam.	CL	A-7, A-6	0	95-100	90-100	80-100	70-95	28-50	10-22
	48-60	Stratified sandy clay loam to clay loam.	CL, CL-ML	A-6, A-7, A-4	0	95-100	90-100	80-100	60-95	20-45	5-20
291---------------- Ransom	0-14	Silty clay loam	OL, CL, ML	A-7	0	100	100	95-100	80-95	40-50	10-20
	14-35	Silty clay loam, silt loam.	CL, ML	A-6, A-7	0	95-100	90-100	85-100	75-95	35-50	10-20
	35-60	Silt loam, loam, clay loam.	ML, CL	A-4, A-6	0-5	95-100	85-100	75-95	55-80	30-40	5-15
304---------------- Rushmore	0-19	Silty clay loam	OL, ML, CL	A-7, A-6	0	100	95-100	90-100	85-95	35-50	10-25
	19-31	Silty clay loam	CL	A-7, A-6	0	100	95-100	85-100	85-95	25-45	10-25
	31-60	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	87-97	80-95	55-80	25-45	10-20
313---------------- 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
319---------------- Barbert	0-23	Silt loam-------	ML, OL	A-4, A-7, A-6	0	100	100	90-100	90-100	35-50	5-20
	23-54	Clay, silty clay, silty clay loam.	CH, MH	A-7	0	100	100	90-100	90-100	50-80	20-50
	54-60	Clay loam, loam	CL	A-6, A-7	0	75-100	90-98	65-95	60-80	30-50	10-25
327A, 327B, 327C--- Dickman	0-15	Sandy loam------	SM, SM-SC, SC	A-2, A-4	0	95-100	95-100	55-95	25-40	20-30	2-8
	15-25	Sandy loam, fine sandy loam, loamy sand.	SM, SM-SC, SC	A-2, A-4	0	95-100	95-100	55-95	25-45	15-25	2-8
	25-60	Stratified fine sand to sand.	SP-SM	A-3, A-2	0	95-100	85-95	50-80	5-10	---	NP
345---------------- Wilmonton	0-22	Clay loam-------	CL	A-6, A-7	0	100	92-100	85-97	60-90	30-50	12-25
	22-37	Clay loam, loam	CL	A-6, A-7	0-5	95-100	87-97	80-90	60-80	30-50	15-25
	37-60	Clay loam, loam	CL	A-6	0-5	95-100	87-97	75-85	55-75	25-40	10-25

See footnote at end of table.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
392------------- Biscay	0-20	Loam------------	CL, ML	A-7, A-6	0	95-100	95-100	70-90	50-75	35-50	10-25
	20-32	Loam, sandy clay loam.	CL, ML	A-6, A-7	0	95-100	90-100	70-90	50-75	30-50	10-20
	32-39	Gravelly sandy loam.	SM, SM-SC, SC	A-4	0-5	95-100	70-95	50-80	35-50	15-30	2-10
	39-60	Stratified sand to gravel.	SP, SP-SM, GP, GP-GM	A-1	0-5	45-95	35-90	20-45	2-10	---	NP
421B------------- Ves	0-16	Loam------------	CL, OL	A-6, A-4	0-5	95-100	90-100	80-100	60-80	30-40	7-15
	16-32	Loam, clay loam	CL	A-6	0-5	95-100	90-100	80-95	55-75	30-40	10-20
	32-60	Loam------------	CL, ML	A-6, A-4	0-5	90-100	85-95	80-90	55-80	30-40	7-15
446------------- Normania	0-18	Loam------------	CL	A-6, A-4	0-5	95-100	90-100	80-100	60-80	30-40	8-15
	18-27	Loam, clay loam	CL	A-6, A-4	0-5	95-100	90-100	80-95	55-75	25-40	8-20
	27-60	Loam------------	CL	A-6, A-4	0-5	90-100	85-95	80-90	55-80	30-40	8-15
588B------------- Clarion Variant	0-18	Loam------------	ML, CL, CL-ML	A-6, A-4	0	100	90-100	80-95	65-85	20-40	3-15
	18-30	Loam, silt loam	ML, CL, CL-ML	A-4, A-6	0	100	90-100	80-95	65-85	20-35	3-15
	30-60	Loam, clay loam	CL, ML, CL-ML	A-4, A-6	0-2	90-100	75-95	65-85	50-75	15-30	3-15
589------------- Romnell	0-27	Clay loam-------	CL	A-6, A-7	0	100	95-100	75-90	60-80	30-50	14-25
	27-43	Clay loam, silty clay loam, loam.	CL	A-6, A-7	0	95-100	95-100	75-90	60-80	30-45	14-25
	43-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	70-95	65-85	50-70	30-45	14-25
590B------------- Jeffers Variant	0-16	Clay loam-------	CL	A-4, A-6	0	95-100	90-100	85-95	60-70	30-40	8-15
	16-29	Loam, clay loam, silt loam.	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	75-85	55-70	20-35	3-15
	29-60	Loam, clay loam	ML, CL, CL-ML	A-4, A-6	0	80-100	75-95	65-85	50-60	20-35	3-15
594------------- Jeffers	0-16	Clay loam-------	CL	A-6, A-7	0	95-100	80-100	70-85	60-80	30-45	12-20
	16-30	Clay loam, loam	CL	A-6	0	95-100	80-100	65-85	60-80	25-40	10-18
	30-60	Loam, clay loam	CL	A-6	0-2	90-100	80-95	65-85	60-80	25-40	10-18
595B, 595C--------- Swanlake	0-9	Loam------------	CL-ML, CL	A-4, A-6	0	90-100	85-98	75-90	50-70	20-35	5-15
	9-43	Loam------------	CL-ML, CL	A-4, A-6	0	90-100	85-98	70-90	50-70	20-35	5-15
	43-60	Loam------------	ML, CL, SM, SC	A-4, A-6	0	70-95	65-90	60-85	40-70	20-35	3-15
884*:											
Webster-----------	0-15	Clay loam-------	CL, CH	A-7, A-6	0-5	100	95-100	85-95	70-90	35-60	15-30
	15-38	Clay loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	15-30
	38-60	Loam, sandy loam, clay loam.	CL, ML	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20
Delft-------------	0-12	Clay loam-------	CL	A-6, A-7	0	95-100	80-98	75-90	60-80	30-45	10-20
	12-46	Loam, clay loam, silt loam.	CL	A-6, A-4	0	95-100	80-98	70-90	50-75	25-40	7-15
	46-60	Loam, clay loam	CL, ML, CL-ML	A-6, A-4	0-5	90-100	65-100	55-90	50-85	20-40	3-15
885B*, 885C*:											
Swanlake----------	0-9	Loam------------	CL-ML, CL	A-4, A-6	0	90-100	85-98	75-90	50-70	20-35	5-15
	9-43	Loam------------	CL-ML, CL	A-4, A-6	0	90-100	85-98	70-90	50-70	20-35	5-15
	43-60	Loam------------	ML, CL, SM, SC	A-4, A-6	0	70-95	65-90	60-85	40-70	20-35	3-15

See footnote at end of table.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--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	
885B*, 885C*:											
Salida------------	0-7	Gravelly sandy loam.	SM	A-2, A-1	0-5	85-95	60-75	30-60	12-20	---	NP
	7-17	Gravelly loamy sand, gravelly coarse sand, gravelly loamy coarse sand.	SP, SW	A-1	0-5	50-90	40-60	10-30	0-5	---	NP
	17-60	Very gravelly coarse sand.	SP, SW, GP	A-1	0-5	20-70	10-60	5-30	0-5	---	NP
886*:											
Nicollet----------	0-16	Clay loam-------	OL, ML, CL	A-6, A-7	0	95-100	95-100	85-98	55-85	35-50	10-25
	16-37	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-95	55-80	35-50	15-25
	37-60	Loam------------	CL, ML	A-6, A-4	0-5	95-100	90-100	75-90	50-75	30-40	5-15
Crippin-----------	0-17	Clay loam-------	CL	A-6, A-7	0	95-100	95-100	80-90	60-80	30-45	10-20
	17-31	Loam, clay loam	CL	A-6	0	95-100	90-100	80-90	60-80	30-40	10-20
	31-60	Loam, clay loam	CL, ML	A-4, A-6	0-1	90-100	85-100	75-90	55-80	30-40	5-15
887B*, 887C*:											
Clarion-----------	0-14	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	14-30	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	30-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
Swanlake----------	0-9	Loam------------	CL-ML, CL	A-4, A-6	0	90-100	85-98	75-90	50-70	20-35	5-15
	9-43	Loam------------	CL-ML, CL	A-4, A-6	0	90-100	85-98	70-90	50-70	20-35	5-15
	43-60	Loam------------	ML, CL, SM, SC	A-4, A-6	0	70-95	65-90	60-85	40-70	20-35	3-15
961D*:											
Storden-----------	0-9	Loam------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	9-60	Loam------------	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
Salida------------	0-7	Gravelly sandy loam.	SM	A-2, A-1	0-5	85-95	60-75	30-60	12-20	---	NP
	7-17	Gravelly loamy sand, gravelly coarse sand, gravelly loamy coarse sand.	SP, SW	A-1	0-5	50-90	40-60	10-30	0-5	---	NP
	17-60	Very gravelly coarse sand.	SP, SW, GP	A-1	0-5	20-70	10-60	5-30	0-5	---	NP
1029*. Pits	---	---	---	---	---	---	---	---	---	---	---
1053*. Aquolls and Aquents	---	---	---	---	---	---	---	---	---	---	---
1833, 1834--------- Coland	0-42	Clay loam, loam	CL, CH	A-7	0	100	100	95-100	70-90	45-55	20-30
	42-60	Loam, sandy loam, clay loam	CL, SC	A-4, A-6	0	100	95-100	60-70	40-75	20-40	5-15
1835B-------------- Germantown	0-8	Clay loam-------	CL	A-6, A-7	0-5	95-100	90-98	85-95	60-85	35-45	15-20
	8-27	Clay loam, loam	CL	A-6, A-7	0-5	95-100	90-98	85-95	65-85	35-45	15-20
	27-36	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	85-95	75-95	65-85	50-75	25-40	4-15
	36	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--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	
1836B*:											
Germantown--------	0-8	Clay loam-------	CL	A-6, A-7	0-5	95-100	90-98	85-95	60-85	35-45	15-20
	8-27	Clay loam, loam	CL	A-6, A-7	0-5	95-100	90-98	85-95	65-85	35-45	15-20
	27-36	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	85-95	75-95	65-85	50-75	25-40	4-15
	36	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Rock outcrop.											
1837--------------- Webster Variant	0-9	Clay loam-------	CL	A-6, A-7	0-5	95-100	90-100	85-95	65-85	30-50	15-25
	9-19	Clay loam, loam	CL	A-6, A-7	0-5	95-100	90-100	85-95	60-80	30-50	15-25
	19	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol > 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	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH				
31D, 31E--------- Storden	0-9	0.6-2.0	0.20-0.22	7.4-8.4	Low-----------	0.28	5	4L
	9-60	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37		
35--------------- Blue Earth	0-11	0.6-6.0	0.18-0.24	7.4-8.4	Moderate------	0.28	5	5
	11-44	0.2-0.6	0.18-0.24	7.4-8.4	Low-----------	0.28		
	44-60	0.2-2.0	0.14-0.16	7.4-8.4	Moderate------	0.28		
41A, 41B, 41C, 41D------------- Estherville	0-13	2.0-6.0	0.13-0.18	5.6-7.3	Low-----------	0.20	3-2	3
	13-19	2.0-6.0	0.09-0.14	5.6-7.3	Low-----------	0.20		
	19-60	6.0-20	0.02-0.04	6.6-8.4	Low-----------	0.10		
86--------------- Canisteo	0-21	0.2-2.0	0.18-0.22	7.4-8.4	Moderate------	0.24	5	4L
	21-40	0.6-2.0	0.15-0.19	7.4-8.4	Moderate------	0.32		
	40-60	0.6-2.0	0.14-0.16	7.4-8.4	Low-----------	0.32		
94B-------------- Terril	0-24	0.6-2.0	0.20-0.22	6.1-7.3	Low-----------	0.24	5	6
	24-60	0.6-2.0	0.17-0.19	6.1-7.3	Low-----------	0.24		
101B------------- Truman	0-14	0.6-2.0	0.20-0.23	6.1-7.3	Low-----------	0.32	5	6
	14-40	0.6-2.0	0.18-0.21	6.1-7.8	Moderate------	0.43		
	40-60	0.6-2.0	0.18-0.20	7.4-8.4	Low-----------	0.43		
102B------------- Clarion	0-14	0.6-2.0	0.20-0.22	5.6-7.3	Low-----------	0.28	5	6
	14-30	0.6-2.0	0.17-0.19	5.6-7.8	Low-----------	0.37		
	30-60	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	---		
110-------------- Marna	0-17	0.06-0.2	0.18-0.22	6.1-7.3	High----------	0.28	5	4
	17-36	0.06-0.2	0.13-0.16	6.1-7.3	High----------	0.28		
	36-60	0.2-2.0	0.14-0.19	6.6-8.4	Moderate------	0.28		
113-------------- Webster	0-15	0.6-2.0	0.19-0.21	6.6-7.3	Moderate------	0.24	5	6
	15-38	0.2-2.0	0.16-0.18	6.6-7.8	Moderate------	0.32		
	38-60	0.6-2.0	0.17-0.19	7.4-8.4	Moderate------	0.32		
114-------------- Glencoe	0-44	0.2-0.6	0.18-0.22	6.1-7.8	Moderate------	0.28	5	6
	44-49	0.2-0.6	0.15-0.19	6.6-7.8	Moderate------	0.28		
	49-60	0.2-0.6	0.15-0.19	7.4-7.8	Moderate------	0.28		
128B------------- Grogan	0-16	2.0-6.0	0.22-0.24	5.6-7.3	Low-----------	0.32	5	5
	16-42	2.0-6.0	0.17-0.19	6.1-7.8	Low-----------	0.43		
	42-60	2.0-6.0	0.17-0.19	7.4-8.4	Low-----------	0.43		
130-------------- Nicollet	0-16	0.6-2.0	0.17-0.22	5.6-7.3	Moderate------	0.24	5	6
	16-37	0.6-2.0	0.15-0.19	5.6-7.8	Moderate------	0.32		
	37-60	0.6-2.0	0.14-0.19	7.4-7.8	Low-----------	0.32		
136-------------- Madelia	0-22	0.6-2.0	0.18-0.24	6.1-7.3	Moderate------	0.28	5	6
	22-33	0.6-2.0	0.16-0.22	6.6-7.8	Moderate------	0.28		
	33-48	0.6-2.0	0.16-0.22	7.4-8.4	Low-----------	0.37		
	48-60	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37		
140-------------- Spicer	0-18	0.6-2.0	0.18-0.24	7.4-8.4	Moderate------	0.28	5	5
	18-43	0.6-2.0	0.16-0.22	7.4-8.4	Moderate------	0.28		
	43-60	0.6-2.0	0.16-0.22	7.4-8.4	Low-----------	0.28		
149B------------- Everly	0-17	0.6-2.0	0.17-0.19	5.6-7.3	Moderate------	0.24	5-4	6
	17-36	0.6-2.0	0.15-0.17	6.1-7.3	Moderate------	0.32		
	36-60	0.2-0.6	0.17-0.19	7.4-8.4	Moderate------	0.32		

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH				
154-------------- Blue Earth	0-8	2.0-6.0	0.35-0.48	7.4-8.4	Moderate------	0.28	5	3
	8-56	0.2-0.6	0.18-0.24	7.4-8.4	Low-----------	0.28		
	56-60	0.2-2.0	0.14-0.16	7.4-8.4	Moderate------	0.28		
197-------------- Kingston	0-20	0.6-2.0	0.18-0.24	5.6-7.3	Low-----------	0.28	5	7
	20-38	0.6-2.0	0.16-0.20	5.6-7.8	Moderate------	0.37		
	38-60	0.6-2.0	0.16-0.20	7.4-8.4	Low-----------	0.37		
211-------------- Lura	0-52	0.06-0.2	0.14-0.17	6.1-7.3	High----------	0.32	5	8
	52-60	0.06-0.6	0.11-0.19	6.6-7.8	High----------	0.32		
214-------------- Talcot	0-22	0.6-2.0	0.18-0.22	7.4-8.4	Moderate------	0.28	4	7
	22-36	0.6-2.0	0.17-0.20	7.4-8.4	Moderate------	0.28		
	36-60	6.0-20	0.02-0.04	7.4-8.4	Low-----------	0.15		
230-------------- Guckeen	0-21	0.2-0.6	0.16-0.19	5.6-7.3	Moderate------	0.28	3	7
	21-34	0.06-0.2	0.13-0.16	5.6-7.3	Moderate------	0.28		
	34-60	0.2-0.6	0.15-0.17	6.6-8.4	Moderate------	0.37		
241-------------- Letri	0-19	0.6-2.0	0.18-0.22	6.1-7.8	Moderate------	0.24	5	7
	19-26	0.6-2.0	0.15-0.19	6.1-7.8	Moderate------	0.32		
	26-60	0.2-0.6	0.17-0.19	6.6-8.4	Moderate------	0.32		
247-------------- Linder	0-16	0.6-2.0	0.20-0.22	5.6-7.8	Moderate------	0.24	4	6
	16-33	2.0-6.0	0.15-0.17	6.1-7.8	Low-----------	0.24		
	33-60	6.0-20	0.02-0.04	7.4-8.4	Low-----------	0.10		
255-------------- Mayer	0-17	0.6-2.0	0.20-0.22	7.4-8.4	Low-----------	0.28	4	4L
	17-40	0.6-2.0	0.16-0.19	7.4-8.4	Low-----------	0.28		
	40-60	6.0-20	0.02-0.04	7.4-8.4	Low-----------	0.15		
269-------------- Millington	0-30	0.6-2.0	0.17-0.23	7.4-8.4	Moderate------	0.28	5	6
	30-48	0.6-2.0	0.17-0.20	7.4-8.4	Moderate------	0.28		
	48-60	0.6-2.0	0.14-0.20	7.4-8.4	Moderate------	0.28		
291-------------- Ransom	0-14	0.6-2.0	0.18-0.22	6.6-7.3	Moderate------	0.32	5-4	7
	14-35	0.6-2.0	0.16-0.19	6.6-7.8	Moderate------	0.43		
	35-60	0.2-0.6	0.20-0.22	7.4-8.4	Low-----------	0.43		
304-------------- Rushmore	0-19	0.6-2.0	0.18-0.22	6.1-7.8	Moderate------	0.28	5	7
	19-31	0.6-2.0	0.16-0.19	6.6-8.4	Moderate------	0.37		
	31-60	0.2-0.6	0.14-0.16	7.4-8.4	Moderate------	0.37		
313-------------- Spillville	0-45	0.6-2.0	0.19-0.21	5.6-7.3	Moderate------	0.28	5	6
	45-60	0.6-6.0	0.15-0.18	5.6-7.3	Low-----------	0.28		
319-------------- Barbert	0-23	0.6-2.0	0.22-0.24	5.1-6.5	Moderate------	0.28	5	6
	23-54	0.06-0.2	0.10-0.14	5.1-7.3	High----------	0.28		
	54-60	0.2-0.6	0.15-0.17	6.6-7.8	Moderate------	0.37		
327A, 327B, 327C- Dickman	0-15	2.0-6.0	0.13-0.15	5.6-6.5	Low-----------	0.20	3	3
	15-25	2.0-20	0.12-0.14	5.6-6.5	Low-----------	0.20		
	25-60	6.0-20	0.02-0.07	5.6-7.3	Low-----------	0.15		
345-------------- Wilmonton	0-22	0.6-2.0	0.20-0.26	6.1-7.3	Moderate------	0.28	5	6
	22-37	0.2-0.6	0.15-0.19	6.1-7.8	Moderate------	0.28		
	37-60	0.2-0.6	0.14-0.19	7.4-8.4	Moderate------	0.37		
392-------------- Biscay	0-20	0.6-2.0	0.20-0.22	6.1-7.8	Moderate------	0.28	4	6
	20-32	0.6-2.0	0.17-0.19	6.6-7.8	Moderate------	0.28		
	32-39	2.0-6.0	0.11-0.17	6.6-7.8	Low-----------	0.28		
	39-60	6.0-20	0.02-0.04	6.6-8.4	Low-----------	0.10		
421B------------- Ves	0-16	0.6-2.0	0.20-0.22	6.1-7.8	Moderate------	0.24	5	6
	16-32	0.6-2.0	0.17-0.19	6.6-7.8	Moderate------	0.24		
	32-60	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.24		
446-------------- Normania	0-18	0.6-2.0	0.20-0.23	6.1-7.3	Moderate------	0.24	5	6
	18-27	0.6-2.0	0.17-0.19	6.6-7.8	Moderate------	0.24		
	27-60	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37		

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group
						K	T	
	In	In/hr	In/in	pH				
588B-------------- Clarion Variant	0-18	0.6-2.0	0.20-0.24	6.1-7.3	Low-----------	0.28	5	6
	18-30	0.6-2.0	0.18-0.22	5.6-7.3	Low-----------	0.28		
	30-60	0.2-0.6	0.17-0.19	7.4-8.4	Low-----------	0.37		
589--------------- Romnell	0-27	0.6-2.0	0.17-0.24	6.6-7.8	Moderate------	0.28	5	7
	27-43	0.2-0.6	0.15-0.19	6.6-7.8	Moderate------	0.37		
	43-60	0.2-0.6	0.14-0.19	7.4-8.4	Moderate------	0.37		
590B-------------- Jeffers Variant	0-16	0.6-2.0	0.19-0.22	7.4-7.8	Low-----------	0.28	5	4L
	16-29	0.6-2.0	0.17-0.22	7.4-7.8	Low-----------	0.28		
	29-60	0.2-0.6	0.16-0.22	7.4-7.8	Low-----------	0.37		
594--------------- Jeffers	0-16	0.6-2.0	0.17-0.19	7.4-8.4	Moderate------	0.24	5	6
	16-30	0.6-2.0	0.15-0.19	7.4-8.4	Moderate------	0.32		
	30-60	0.2-0.6	0.14-0.19	7.4-8.4	Moderate------	0.32		
595B, 595C-------- Swanlake	0-9	0.6-2.0	0.18-0.22	7.4-7.8	Low-----------	0.28	5	4L
	9-43	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37		
	43-60	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37		
884*:								
Webster----------	0-15	0.6-2.0	0.19-0.21	6.6-7.3	Moderate------	0.24	5	6
	15-38	0.2-2.0	0.16-0.18	6.6-7.8	Moderate------	0.32		
	38-60	0.6-2.0	0.17-0.19	7.4-8.4	Moderate------	0.32		
Delft------------	0-12	0.2-0.6	0.18-0.20	5.6-7.8	Moderate------	0.24	5	6
	12-46	0.2-0.6	0.19-0.22	6.6-7.8	Low-----------	0.32		
	46-60	0.2-0.6	0.15-0.19	7.4-8.4	Low-----------	0.32		
885B*, 885C*:								
Swanlake---------	0-9	0.6-2.0	0.18-0.22	7.4-7.8	Low-----------	0.28	5	4L
	9-43	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37		
	43-60	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37		
Salida-----------	0-7	2.0-6.0	0.10-0.12	6.1-8.4	Low-----------	0.10	3-2	8
	7-17	>20	0.02-0.04	7.4-8.4	Low-----------	0.10		
	17-60	>20	0.02-0.04	7.4-8.4	Low-----------	0.10		
886*:								
Nicollet---------	0-16	0.6-2.0	0.17-0.22	5.6-7.3	Moderate------	0.24	5	6
	16-37	0.6-2.0	0.15-0.19	5.6-7.8	Moderate------	0.32		
	37-60	0.6-2.0	0.14-0.19	7.4-7.8	Low-----------	0.32		
Crippin----------	0-17	0.6-2.0	0.20-0.22	6.6-8.4	Moderate------	0.28	5	6
	17-31	0.6-2.0	0.17-0.19	7.4-8.4	Moderate------	0.28		
	31-60	0.6-2.0	0.17-0.19	7.9-8.4	Moderate------	0.37		
887B*, 887C*:								
Clarion----------	0-14	0.6-2.0	0.20-0.22	5.6-7.3	Low-----------	0.28	5	6
	14-30	0.6-2.0	0.17-0.19	5.6-7.8	Low-----------	0.37		
	30-60	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	---		
Swanlake---------	0-9	0.6-2.0	0.18-0.22	7.4-7.8	Low-----------	0.28	5	4L
	9-43	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37		
	43-60	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37		
961D*:								
Storden----------	0-9	0.6-2.0	0.20-0.22	7.4-8.4	Low-----------	0.28	5	4L
	9-60	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37		
Salida-----------	0-7	2.0-6.0	0.10-0.12	6.1-8.4	Low-----------	0.10	3-2	8
	7-17	>20	0.02-0.04	7.4-8.4	Low-----------	0.10		
	17-60	>20	0.02-0.04	7.4-8.4	Low-----------	0.10		
1029*. Pits	---	---	---	---	--------------	---	---	---

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH				
1053*. Aquolls and Aquents	---	---	---	---	---	---	---	---
1833, 1834------- Coland	0-42	0.2-0.6	0.20-0.22	6.1-7.3	High----------	0.28	5	7
	42-60	2.0-6.0	0.13-0.17	6.1-7.3	Low-----------	0.28		
1835B------------ Germantown	0-8	0.6-2.0	0.18-0.22	5.6-6.5	Moderate------	0.28	4	6
	8-27	0.2-2.0	0.16-0.19	5.1-8.4	Moderate------	0.28		
	27-36	0.2-2.0	0.17-0.19	7.4-8.4	Low-----------	0.28		
	36	---	---	---	--------------	---		
1836B*:								
Germantown------	0-8	0.6-2.0	0.18-0.22	5.6-6.5	Moderate------	0.28	4	6
	8-27	0.2-2.0	0.16-0.19	5.1-8.4	Moderate------	0.28		
	27-36	0.2-2.0	0.17-0.19	7.4-8.4	Low-----------	0.28		
	36	---	---	---	--------------	---		
Rock outcrop.								
1837------------- Webster Variant	0-9	0.6-2.0	0.17-0.21	5.1-6.5	Moderate------	0.24	2	6
	9-19	0.6-2.0	0.15-0.19	5.1-7.3	Moderate------	0.32		
	19	---	---	---	--------------	---		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--SOIL AND WATER FEATURES

[The definitions of "flooding" and "water table" in the Glossary explain terms such as "rare," "brief," "apparent," and "perched." The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth		Uncoated steel	Concrete
					Ft			In			
31D, 31E---------- Storden	B	None---------	---	---	>6.0	---	---	>60	Moderate----	Low------	Low.
35--------------- Blue Earth	B/D	Common------	Brief-----	Apr-Jun	0-1.0	Apparent	Nov-Jun	>60	High--------	High-----	Low.
41A, 41B, 41C, 41D------------- Estherville	B	None--------	---	---	>6.0	---	---	>60	Low---------	Low------	Low.
86--------------- Canisteo	C/D	None--------	---	---	1.0-3.0	Apparent	Oct-Jul	>60	High--------	High-----	Low.
94B-------------- Terril	B	None--------	---	---	>6.0	---	---	>60	Moderate----	Moderate	Low.
101B------------- Truman	B	None--------	---	---	>6.0	---	---	>60	High--------	Low------	Low.
102B------------- Clarion	B	None--------	---	---	>6.0	---	---	>60	Moderate----	Low------	Low.
110-------------- Marna	D	None--------	---	---	1.0-2.5	Apparent	Nov-Jun	>60	High--------	High-----	Low.
113-------------- Webster	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	>60	High--------	High-----	Low.
114-------------- Glencoe	B/D	Frequent----	Brief to long.	Mar-Jun	0-1.0	Apparent	Oct-Jun	>60	High--------	High-----	Low.
128B------------- Grogan	B	None--------	---	---	>6.0	---	---	>60	High--------	Low------	Low.
130-------------- Nicollet	B	None--------	---	---	2.5-5.0	Apparent	Apr-May	>60	High--------	High-----	Low.
136-------------- Madelia	B/D	None--------	---	---	1.0-2.5	Apparent	Nov-May	>60	High--------	High-----	Low.
140-------------- Spicer	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-May	>60	High--------	High-----	Low.
149B------------- Everly	B	None--------	---	---	>6.0	---	---	>60	Moderate----	Moderate	Moderate.
154-------------- Blue Earth	B/D	Common------	Brief-----	Apr-Jun	0-1.0	Apparent	Nov-Jun	>60	High--------	High-----	Low.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth		Uncoated steel	Concrete
					Ft			In			
197-----Kingston	B	None	---	---	3.0-5.0	Apparent	Apr-May	>60	High	High	Low.
211-----Lura	C/D	Frequent	Brief	Apr-May	0-1.0	Apparent	Nov-May	>60	High	High	Low.
214-----Talcot	B/D	Common	Brief	Apr-Jun	0-1.0	Apparent	Oct-Jul	>60	High	High	Low.
230-----Guckeen	C	None	---	---	2.0-3.5	Apparent	Apr-May	>60	High	High	Low.
241-----Letri	B/D	None	---	---	0.5-2.0	Perched	Apr-Jun	>60	High	High	Low.
247-----Linder	B	None	---	---	3.0-5.0	Apparent	Nov-Jul	>60	High	Moderate	Low.
255-----Mayer	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	>60	High	High	Low.
269-----Millington	B	Frequent	Brief	Apr-Jun	0-2.0	Apparent	Mar-Jul	>60	High	High	Low.
291-----Ransom	B	None	---	---	2.5-5.0	Apparent	Apr-Jun	>60	High	High	Low.
304-----Rushmore	B/D	Rare	---	---	1.0-3.0	Apparent	Nov-Jun	>60	High	High	Low.
313-----Spillville	B	Occasional	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	Moderate	High	Moderate.
319-----Barbert	D	Common	Brief	Apr-May	0-1.0	Perched	Nov-Jun	>60	High	High	Low.
327A, 327B, 327C-----Dickman	A	None	---	---	>6.0	---	---	>60	Low	Low	Moderate.
345-----Wilmonton	B	None	---	---	2.5-5.0	Apparent	Mar-Jun	>60	High	Moderate	Low.
392-----Biscay	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	>60	High	Moderate	Low.
421B-----Ves	B	None	---	---	>6.0	---	---	>60	Moderate	Moderate	Low.
446-----Normania	B	None	---	---	3.0-6.0	Apparent	Mar-Jun	>60	High	Moderate	Low.
588B-----Clarion Variant	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Moderate.
589-----Romnell	B/D	None	---	---	0.5-2.0	Apparent	Nov-Jun	>60	High	High	Low.

See footnote at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth		Uncoated steel	Concrete
					Ft			In			
590B-------------- Jeffers Variant	C	None--------	---	---	1.5-3.0	Apparent	Mar-Jun	>60	High--------	High-----	Low.
594--------------- Jeffers	B/D	None--------	---	---	1.0-2.0	Apparent	Mar-Jun	>60	High--------	High-----	Moderate.
595B, 595C-------- Swanlake	B	None--------	---	---	>6.0	---	---	>60	Moderate----	Low------	Low.
884*: Webster----------	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	>60	High--------	High-----	Low.
Delft------------	B/D	None--------	---	---	1.0-2.0	Apparent	Nov-Jun	>60	High--------	High-----	Low.
885B*, 885C*: Swanlake---------	B	None--------	---	---	>6.0	---	---	>60	Moderate----	Low------	Low.
Salida-----------	A	None--------	---	---	>6.0	---	---	>60	Low---------	Low------	Low.
886*: Nicollet---------	B	None--------	---	---	2.5-5.0	Apparent	Apr-May	>60	High--------	High-----	Low.
Crippin----------	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jun	>60	High--------	High-----	Low.
887B*, 887C*: Clarion----------	B	None--------	---	---	>6.0	---	---	>60	Moderate----	Low------	Low.
Swanlake---------	B	None--------	---	---	>6.0	---	---	>60	Moderate----	Low------	Low.
961D*: Storden----------	B	None--------	---	---	>6.0	---	---	>60	Moderate----	Low------	Low.
Salida-----------	A	None--------	---	---	>6.0	---	---	>60	Low---------	Low------	Low.
1029*. Pits	---	------------	---	---	---	---	---	---	------------	---------	---
1053*. Aquolls and Aquents	---	------------	---	---	---	---	---	---	------------	---------	---
1833, 1834-------- Coland	B/D	Common------	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	High--------	High-----	Low.
1835B------------- Germantown	B	None--------	---	---	>6.0	---	---	20-40	Moderate----	Moderate	Moderate.
1836B*: Germantown-------	B	None--------	---	---	>6.0	---	---	20-40	Moderate----	Moderate	Moderate.
Rock outcrop.											
1837-------------- Webster Variant	D	None--------	---	---	0.5-1.5	Perched	Nov-Jul	<20	High--------	Moderate	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--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
Barbert	Fine, montmorillonitic, mesic Typic Argialbolls
*Biscay	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls
Blue Earth	Fine-silty, mixed (calcareous), mesic Mollic Fluvaquents
Canisteo	Fine-loamy, mixed (calcareous), mesic Typic Haplaquolls
Clarion	Fine-loamy, mixed, mesic Typic Hapludolls
Clarion Variant	Fine-loamy, mixed, mesic Typic Hapludolls
Coland	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Crippin	Fine-loamy, mixed, mesic Aquic Hapludolls
Delft	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Dickman	Sandy, mixed, mesic Typic Hapludolls
Estherville	Coarse-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
*Everly	Fine-loamy, mixed, mesic Typic Hapludolls
Germantown	Fine-loamy, mixed, mesic Udic Haplustolls
Glencoe	Fine-loamy, mixed, mesic Cumulic Haplaquolls
*Grogan	Coarse-silty, mixed, mesic Typic Hapludolls
Guckeen	Fine, montmorillonitic, mesic Aquic Hapludolls
Jeffers	Fine-loamy, mixed (calcareous), mesic Typic Haplaquolls
Jeffers Variant	Fine-loamy, mixed, mesic Aeric Calciaquolls
Kingston	Fine-silty, mixed, mesic Aquic Hapludolls
Letri	Fine-loamy, mixed, mesic Typic Haplaquolls
Linder	Coarse-loamy, mixed, mesic Aquic Hapludolls
Lura	Fine, montmorillonitic, mesic Cumulic Haplaquolls
Madelia	Fine-silty, mixed, mesic Typic Haplaquolls
*Marna	Fine, montmorillonitic, mesic Typic Haplaquolls
*Mayer	Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic Typic Haplaquolls
*Millington	Fine-loamy, mixed (calcareous), mesic Cumulic Haplaquolls
Nicollet	Fine-loamy, mixed, mesic Aquic Hapludolls
Normania	Fine-loamy, mixed, mesic Aquic Haplustolls
Ransom	Fine-silty, mixed, mesic Aquic Hapludolls
Romnell	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Rushmore	Fine-silty, mixed, mesic Typic Haplaquolls
Salida	Sandy-skeletal, mixed, mesic Entic Hapludolls
Spicer	Fine-silty, mixed (calcareous), mesic Typic Haplaquolls
Spillville	Fine-loamy, mixed, mesic Cumulic Hapludolls
Storden	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Swanlake	Fine-loamy, mixed, mesic Entic Hapludolls
Talcot	Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic Typic Haplaquolls
Terril	Fine-loamy, mixed, mesic Cumulic Hapludolls
Truman	Fine-silty, mixed, mesic Typic Hapludolls
Ves	Fine-loamy, mixed, mesic Udic Haplustolls
Webster	Fine-loamy, mixed, mesic Typic Haplaquolls
Webster Variant	Fine-loamy, mixed, mesic Typic Haplaquolls
*Wilmonton	Fine-loamy, mixed, mesic Aquic Hapludolls

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