United States
Department of
Agriculture

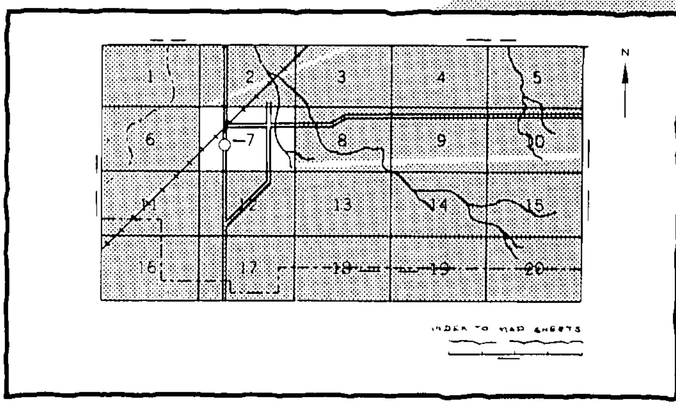
Soil
Conservation
Service

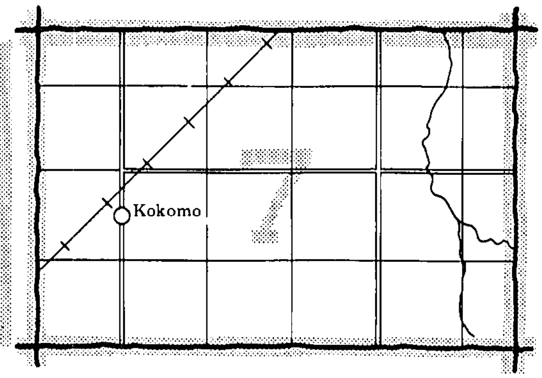
In cooperation with
North Dakota Agricultural
Experiment Station,
North Dakota Cooperative
Extension Service, and
North Dakota State Soil
Conservation Committee

Soil Survey of Nelson County Area North Dakota

HOW TO USE

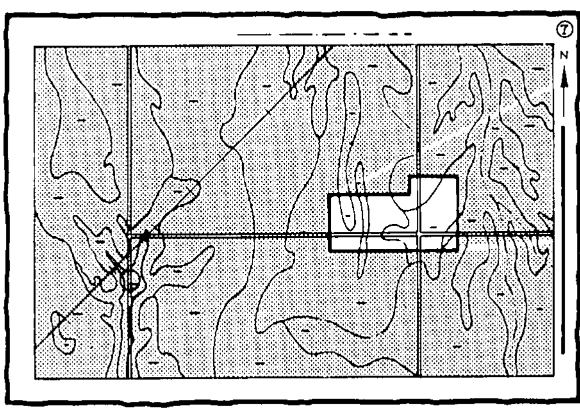
1. Locate your area of interest on the "Index to Map Sheets"

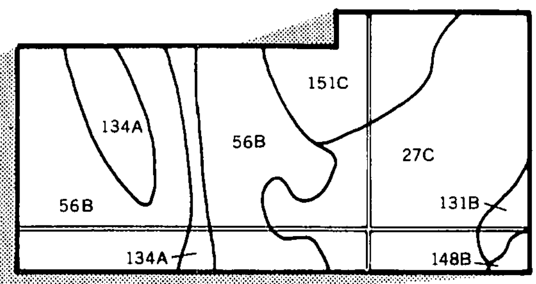




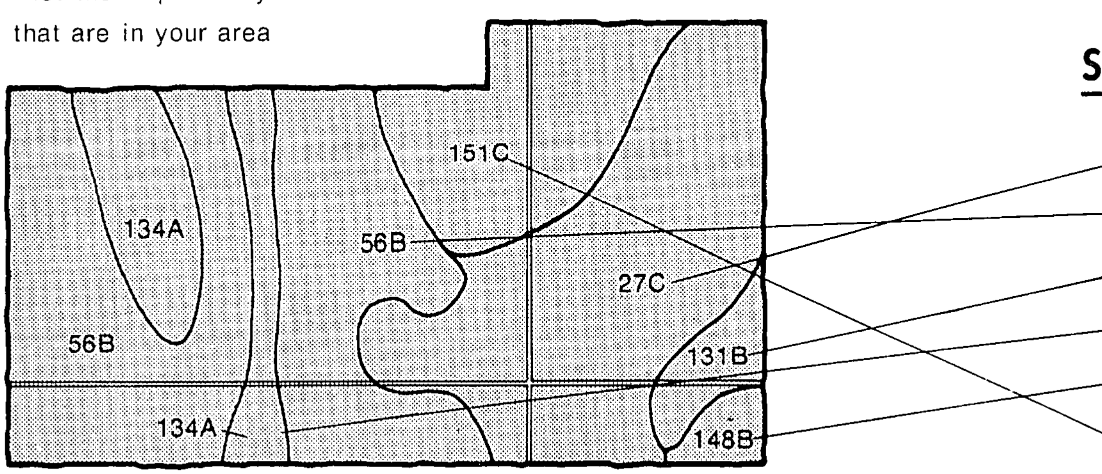
2. Note the number of the map sheet and turn to that sheet.

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





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

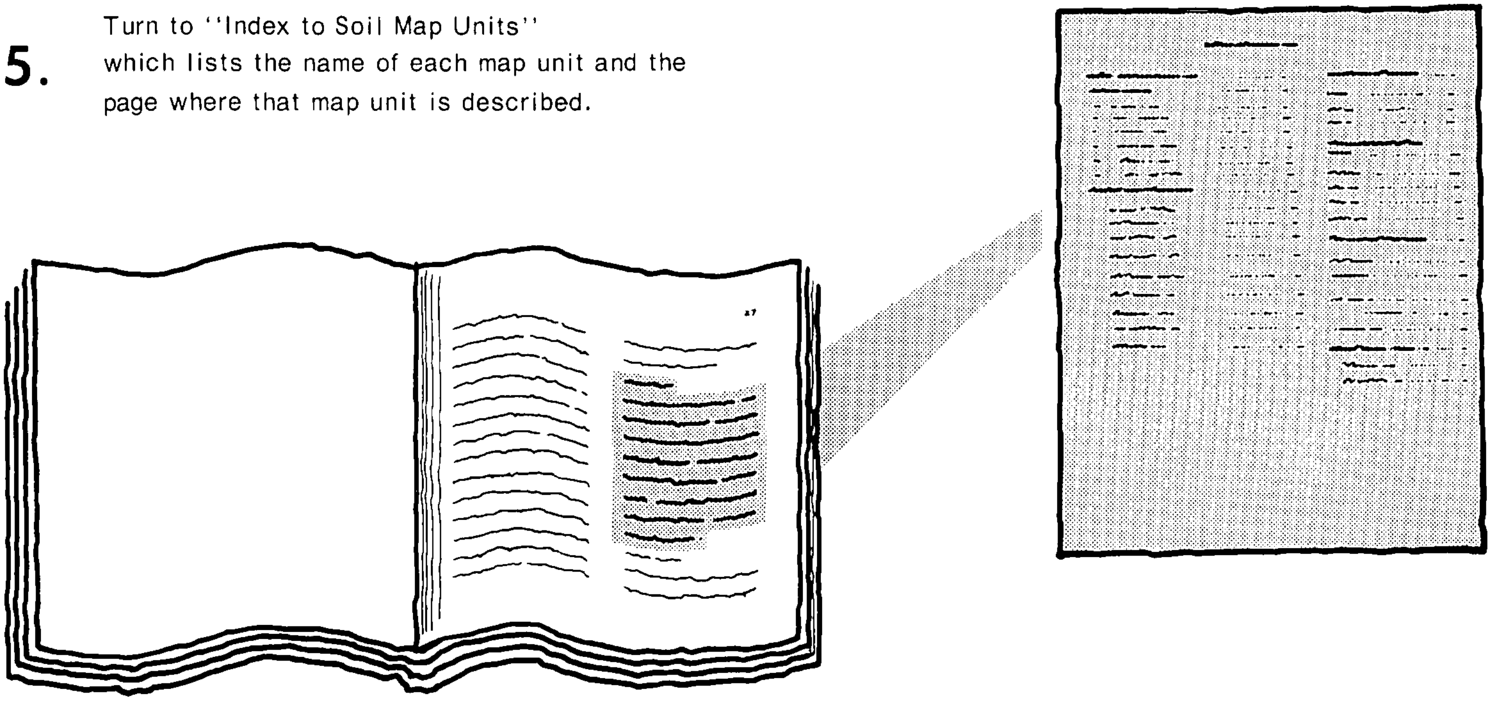


Symbols

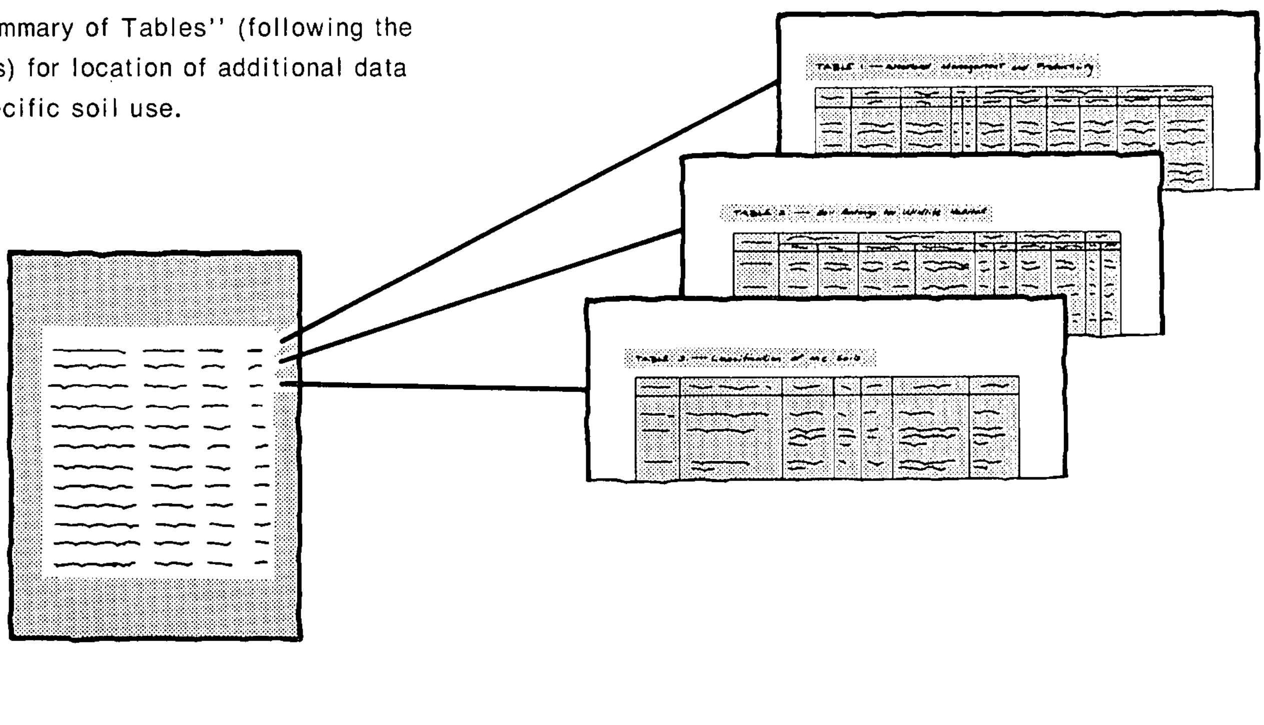
- 27C
- 56B
- 131B
- 134A
- 148B
- 151C

THIS SOIL SURVEY

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



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



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

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

Major fieldwork for this soil survey was completed in 1985. Soil names and descriptions were approved in 1986. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1986. The aerial photobase map on which the soils were delineated was completed in September 1978. This survey was made cooperatively by the Soil Conservation Service, the North Dakota Agricultural Experiment Station, the North Dakota Cooperative Extension Service, and the North Dakota State Soil Conservation Committee. It is part of the technical assistance furnished to the Nelson County Soil Conservation District. Financial assistance was provided by the Nelson County Board of Commissioners and the North Dakota Department of Universities and School Lands.

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

Cover: Windbreaks in an area of Svea-Buse loams, 6 to 9 percent slopes.

Contents

Soil Series

Issued June 1989

Index to Map Units

Summary of Tables

Foreword

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

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

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

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

August J. Dornbusch, Jr.
State Conservationist
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Soil Survey of Nelson County Area, North Dakota

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Fieldwork by Cornelius J. Heidt, Donald E. Moen, Mark W. Morrison, and
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United States Department of Agriculture, Soil Conservation Service,
in cooperation with
North Dakota Agricultural Experiment Station,
North Dakota Cooperative Extension Service, and
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This survey area is in the northeastern part of North Dakota (fig. 1). It makes up 575,360 acres, or about 900 square miles. In 1980, the population of Nelson County was 5,140 and that of Lakota, the county seat and the largest town, was 950. Lakota is in the northwestern part of the survey area. Other major towns are Michigan, Aneta, and Petersburg. The part of the county that is not included in this survey is included in the *Soil Survey of Eddy County and Parts of Benson and Nelson Counties, North Dakota* (*17*).

The survey area is part of the Northern Black Glaciated Plains and the Central Black Glaciated Plains of the Northern Great Plains Spring Wheat Region (*16*). Farming is the main economic enterprise. The principal crops are durum and hard red spring wheat, barley, and sunflowers.

Nearly all of the soils in the survey area are deep. They are suited to cultivated crops and to pasture, range, and hay. Unfavorable soil characteristics lower the potential of some soils for crops. Poor surface drainage is the major management concern on flats and in depressions, especially during wet periods. Soil blowing is a hazard on nearly all of the soils. It is most severe on the sandy and loamy soils on outwash plains.

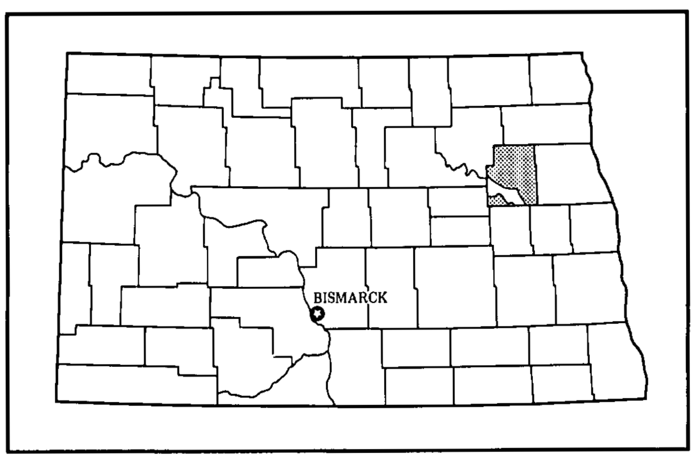

Figure 1.—Location of Nelson County in North Dakota.

On about 38,000 acres, the soils are saline, and on about 16,000 acres, they have an alkali subsoil. The soils that are underlain by sand and gravel in outwash areas have a very low or low available water capacity.

General Nature of the Survey Area

This section provides general information about the survey area. It describes climate; history and development; physiography, relief, and drainage; and the water supply.

Climate

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

The survey area has a subhumid, continental climate. It is usually quite warm in summer. Frequent spells of hot weather and occasional cool days characterize the summer. Temperatures are very cold in winter, when artic air frequently surges over the area. Most precipitation falls during the warm period. It is normally heaviest in late spring and early summer. Winter snowfall is normally not too heavy, and it is blown into drifts, so that much of the ground is free of snow. Blizzards occur several times each year.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Petersburg, North Dakota, in the period 1951 to 1981. 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 7 degrees F, and the average daily minimum temperature is -3 degrees. The lowest temperature on record, which occurred at Petersburg on January 4, 1968, is -39 degrees. In summer the average temperature is 65 degrees, and the average daily maximum temperature is 78 degrees. The highest recorded temperature, which occurred at Petersburg on September 6, 1978, is 102 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 18.3 inches. Of this, about 14 inches, or more than 75 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 12 inches. The heaviest 1-day rainfall during the period of record was 2.96 inches at Petersburg on September 2, 1957. Thunderstorms occur on about 33 days each year. Hail falls in scattered small areas during summer thunderstorms.

The average seasonal snowfall is about 32 inches. The greatest snow depth at any one time during the period of record was 23 inches. On the average, 24 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

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

History and Development

Prior to any permanent settlement in the survey area, the Sioux Indians inhabited the areas around Stump Lake and along the Sheyenne River. A final peace treaty among several Indian tribes was made on the plains near Stump Lake (*10*).

Before the settlers arrived, Stump Lake was a large forested, swampy area. By the time the survey area was settled, the water had risen and supported good populations of fish. For years the settlers gathered firewood from the beach of the lake.

The first permanent settler in the survey area was Francis de Molin. He settled in the county prior to 1867. The first agricultural settlement was established in 1879. The Great Northern Railroad was then being extended west. The first land title in the area was granted at the Grand Forks Land Office in 1882 (*9*).

The county was established in 1883 from parts of Grand Forks, Ramsey, and Foster Counties. It was organized on May 15, 1883, by the first board of county commissioners. The county was named after the Honorable N.E. Nelson, a customs collector at Pembina for many years and the first recorded homesteader in North Dakota (*10*).

The number of farms peaked around 1935 and has since steadily declined. In 1978, there were 716 farms. The average size of these farms was about 900 acres.

One federal highway and four state highways provide access to markets. The county is also served by two railroads.

Physiography, Relief, and Drainage

This survey area is in the Western Lake Section of the Central Lowland Province (*5*). It is made up of five distinctly different physiographic regions—a glacial till plain, a water-planed glacial till plain, an outwash plain, the Stump Lake Basin, and the major stream valleys (*4*). The glacial till plain makes up about 85 percent of the survey area (fig. 2). The elevation of this plain ranges from about 1,300 feet above sea level to about 1,700 feet on Blue Mountain. The plain generally consists of nearly level to gently rolling ground moraines and some hilly end moraines. Isolated kames or eskers and shallow drainageways characterize some areas. Local relief generally ranges from 10 to 40 feet. On end moraines and ice-thrust features, however, it ranges from 25 to 100 feet.

The water-planed till plain is south of the Sheyenne River. It is an area of glacial till that was smoothed by glacial meltwater. This area consists mainly of well drained soils on flats and slight rises and minor areas of somewhat poorly drained and poorly drained soils in drainageways. Local relief ranges from less than 1 foot to 10 feet.

The outwash plain includes level flats and very steep esker ridges, both of which formed from material deposited by meltwater flowing from the glaciers. Local relief on this plain ranges from less than 1 foot to about 100 feet.

The Stump Lake Basin consists of old lake bottoms and shorelines. The bottoms are characterized by poorly drained soils on flats, and the shorelines are characterized by well drained to excessively drained, nearly level to steep soils on abandoned beaches and in areas between the beaches. Local relief ranges from less than 1 foot on the bottoms to as much as 100 feet on the shorelines.

The major stream valleys were cut by glacial meltwater. They are deeply entrenched into shale bedrock. They are characterized by well drained to excessively drained, steep soils on breaks and terraces and poorly drained to well drained, nearly level soils on flood plains. Local relief on the breaks and terraces ranges from 50 to 100 feet.

The natural drainage pattern is poorly defined in most of the survey area, except for the northeast corner and southern part. Runoff flows in poorly defined

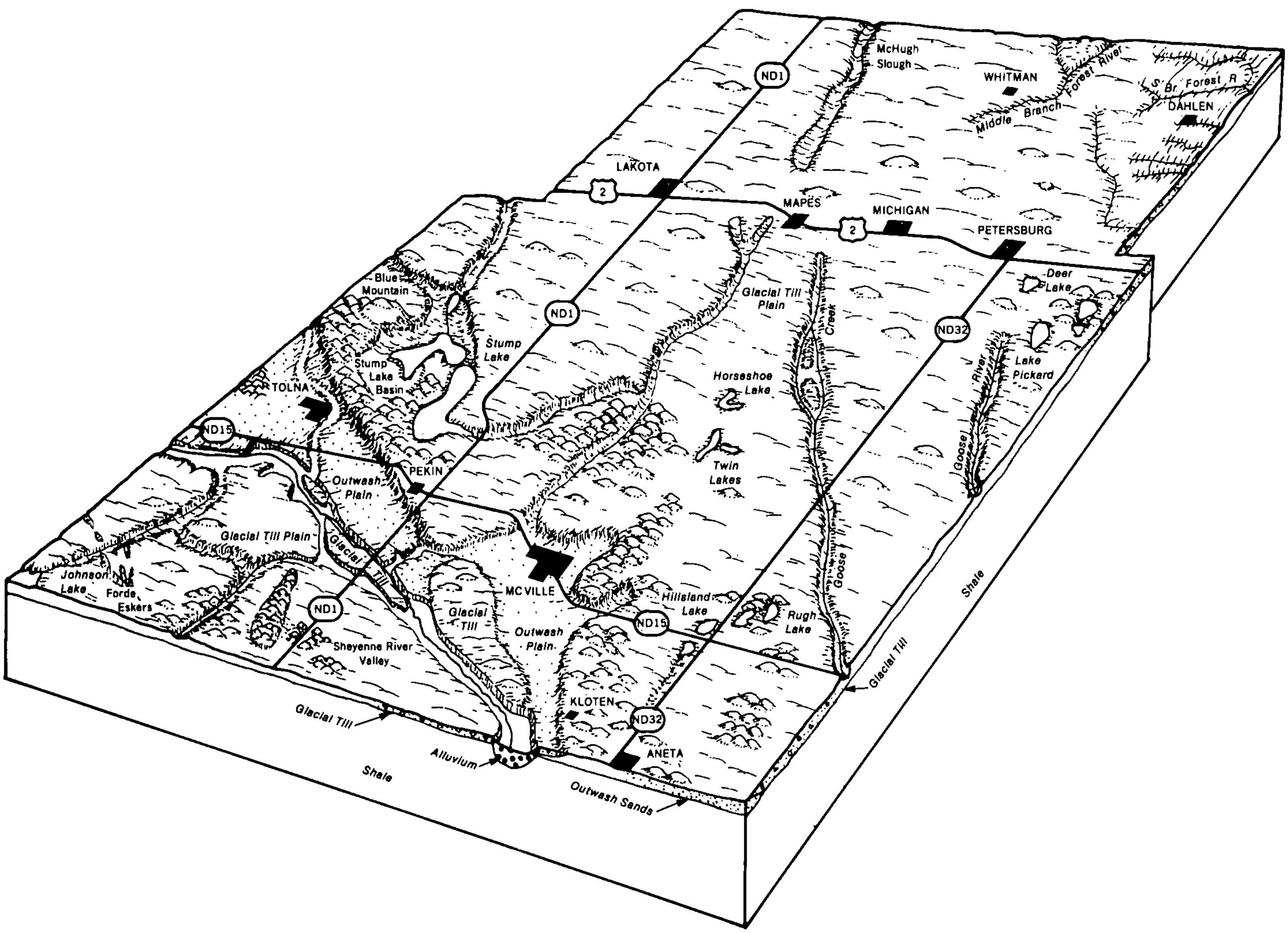

Figure 2.—Physiographic features of Nelson County, North Dakota.

drainageways and accumulates in sloughs or small lakes. Surface water in the northeast corner drains into several small coulees and eventually into the Red River of the North. The area between Petersburg and Aneta is drained by the coulees of the Goose River drainage system. The south-central and southwestern parts of the survey area are drained by the Sheyenne River and its tributaries.

Water Supply

Most of the water in the survey area is from ground water sources. The principal sources of ground water are the McVille and Spiritwood aquifers, which are in glacial drift, and the Pierre and Dakota aquifers, which are in sedimentary rocks.

Of all the aquifers, the McVille aquifer has the greatest potential for development. It can produce well yields of more than 500 gallons per minute in areas south of East Stump Lake, where the water is of good quality.

The Spiritwood aquifer, the largest glacial drift aquifer, is in the southwestern part of the survey area. Parts of the aquifer can yield more than 500 gallons per minute. Generally, the water is of relatively good quality.

The Dakota aquifer probably is the most productive of the two bedrock aquifers. Wells penetrating this aquifer are as deep as 1,300 feet in the survey area. The Pierre aquifer is close to the surface in most of the area. Wells tapping this aquifer can yield as much as 5 gallons per minute, but most yield less. The water is of fair or poor quality (*8*).

Presently, two irrigation systems use water from the Sheyenne River. Rural water districts supply water from the McVille and Fordville aquifers to a large part of this survey area. Water from the Fordville aquifer, which is located in Walsh County, is piped to rural parts of the survey area.

How This Survey Was Made

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

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

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

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

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

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

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

Map Unit Composition

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

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

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

Survey Procedures

The general procedures used to make this survey are described in the Soil Conservation Service's National Soils Handbook and the *Soil Survey Manual* (*14*). *Geology of Nelson and Walsh Counties, North Dakota* (*4*), *Soil Taxonomy* (*15*), *Land Resource Regions and Major Land Resource Areas of the United States* (*16*), *The Major Soils of North Dakota* (*12*), and *Soil Survey Report, County General Soil Maps, North Dakota* (*13*) were among the references used. The procedures used in determining the nature and characteristics of the soils are described under the heading "How This Survey Was Made."

Soil scientists traversed the land on foot, by pickup, or by all-terrain vehicles at an interval close enough for them to locate contrasting soil areas of about 3 to 5 acres. All map units were characterized by transects of representative areas. At least one transect was recorded for each 1,000 acres of a given map unit.

Data collected from the transects were used to determine soil names and establish the range of composition of each map unit. Each map unit was documented by at least two pedon descriptions for each soil series identified in its name. Laboratory data were collected in 1982 and 1983 for all pedons sampled for engineering properties. The analyses were made by the North Dakota State Highway Department. Analyses for engineering properties also were made by the North Dakota State University, Soil Characterization Laboratory.

During the course of the survey, access to a few areas was denied. Soil lines were extended through these areas on the basis of photo interpretation and knowledge of the soils in the surrounding area. The areas that were mapped in this way are as follows: SE1/4 sec. 22, S1/2 sec. 23, S1/2NW1/4 sec. 23, NW1/4NW1/4 sec. 23, SE1/4NW1/4 sec. 24, and NE1/4 sec. 26, all in T. 149 N., R. 57 W.

The composition of each map unit is calculated from data collected through point intercept transects. The soil scientists made these transects by traversing representative areas of each map unit and determining the soil type at set intervals.

The confidence interval (range of composition) is given for complexes in the map unit descriptions and for single-name map units in the following list. The confidence interval was determined from transect data by use of the method described by R.G. Cline (*7*). The confidence interval of the mean was determined at the

90 percent probability level. In other words, there is a 90 percent probability that the true average extent of the named soil in the map unit lies within the range given. Expressing the extent in these terms should give the user a more realistic idea of the distribution of the soils in the map units because it stresses the fact that the composition of a map unit differs among delineations and because soil variability prevents a certain knowledge of the exact composition of the units.

The confidence intervals in the single-name map units in the survey area are listed below. The intervals are expressed in percentage figures, which describe the extent of the named soil at a 90 percent probability level.

2 Parnell silt loam—80 to 90
3 Playmoor silty clay loam, saline—75 to 90
4 Southam silty clay loam—90 to 95
8 Svea loam—85 to 95
10 Svea loam, 1 to 3 percent slopes—85 to 95
15 Borup silt loam—80 to 100
17 Borup silt loam, saline—65 to 90
20 Hamerly loam, 0 to 2 percent slopes—90 to 95
20B Hamerly loam, 2 to 5 percent slopes—75 to 80
22 Vallers loam, 0 to 3 percent slopes—70 to 90
27 Hamar loamy sand—70 to 100
28E Wamduska sandy loam, 9 to 45 percent slopes, extremely stony—65 to 85
29B Maddock loamy sand, 1 to 6 percent slopes—70 to 90
30 Embden fine sandy loam, 0 to 3 percent slopes—65 to 100
31B Egeland sandy loam, 3 to 6 percent slopes—70 to 95
32 Gardena silt loam, 0 to 3 percent slopes—80 to 95
32B Gardena silt loam, 3 to 6 percent slopes—70 to 95
33 Glyndon silt loam—55 to 90
34 LaDelle silt loam—65 to 90
35 LaDelle silt loam, channeled—50 to 70
36B Arvilla sandy loam, 0 to 6 percent slopes—75 to 95
37 Fordville loam—65 to 85
38B Renshaw loam, 1 to 6 percent slopes—75 to 90
39E Sioux loam, 6 to 25 percent slopes—75 to 95
40 Divide loam, 0 to 3 percent slopes—75 to 90
41 Vang loam—80 to 95
42B Brantford loam, 1 to 6 percent slopes—80 to 95
43E Coe gravelly loam, 6 to 25 percent slopes—50 to 65
44B Walsh loam, 1 to 6 percent slopes—80 to 100
44C Walsh loam, 6 to 9 percent slopes—80 to 95
47 Lallie silty clay loam, saline—75 to 95
73 Lamoure silty clay loam—75 to 90

In the detailed map unit descriptions, the paragraph on contrasting inclusions specifies soils having properties that limit farming and soils having properties that do not limit farming. The limiting inclusions do not exceed 15 percent, and no one limiting soil makes up more than 10 percent of the map unit.

General Soil Map Units

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

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

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

The descriptions, names, and delineations of the soils identified on the general soil map of this survey area do not always agree or join with those of the soils identified on the maps of adjoining counties published at an earlier date. Differences result from a better knowledge of soils, modifications in series concepts, and variations in map unit design and in the extent of the soils in the survey areas.

Soil Descriptions

Dominantly Level to Undulating or Gently Sloping, Loamy and Silty Soils on Till Plains

These soils formed in glacial till and alluvium. They make up about 85 percent of the survey area. In most areas surface water flows into marshes and depressions. The soils are used primarily for cultivated crops; however, scattered areas are used for range or hay.

The main concerns in managing the soils for cultivated crops are controlling soil blowing and water erosion and overcoming the wetness of the Tonka and Parnell soils. The principal limitations affecting building site development and septic tank absorption fields are ponding and slow permeability in areas of the Tonka and Parnell soils; wetness and moderately slow permeability in the Hamerly soils; moderately slow permeability and the shrink-swell potential in the Buse, Cresbard, and Barnes soils; and wetness, moderately slow permeability, and the shrink-swell potential in the Svea soils.

1. Hamerly-Svea-Tonka Association

Deep, level to undulating, moderately well drained to poorly drained, medium textured soils

This association consists of soils on slight rises and flats and in swales and shallow depressions on till plains. Scattered marshes, knolls, and drainageways are throughout the association. Slope ranges from 0 to 6 percent.

This association makes up about 28 percent of the survey area. It is about 55 percent Hamerly soils, 15 percent Svea soils, 15 percent Tonka soils, and 15 percent soils of minor extent (fig. 3).

The level to undulating, somewhat poorly drained Hamerly soils are on slight rises and flats. Typically, the surface layer is black loam about 7 inches thick. The subsoil is light yellowish brown, calcareous loam about 14 inches thick. The substratum to a depth of about 60 inches is olive brown and olive gray, mottled loam.

The nearly level and undulating, moderately well drained Svea soils are in swales. Typically, the surface soil is black loam about 11 inches thick. The subsoil is about 27 inches thick. In sequence downward, it is very dark grayish brown clay loam, dark brown loam, dark brown clay loam, and light olive brown, calcareous clay loam. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam.

The level, poorly drained Tonka soils are in shallow depressions. Typically, the surface soil is black silt loam about 10 inches thick. The subsurface layer is dark grayish brown, mottled silt loam about 6 inches thick. The subsoil is mottled clay loam about 23 inches thick. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled loam.

Barnes, Buse, Cresbard, Parnell, Playmoor, and Vallers are the minor soils in this association. The well drained Barnes soils are on rises above the Svea soils. They are noncalcareous in the upper part of the subsoil. The dark color of their surface layer extends to a depth of only 7 to 16 inches. The well drained Buse soils have a calcareous subsoil. They are on knolls above the Svea soils. The moderately well drained Cresbard soils have an alkali subsoil. They are in swales below the Svea soils. The very poorly drained Parnell soils have an accumulation of clay in the subsoil. They are in deep depressions. The poorly drained Playmoor soils are

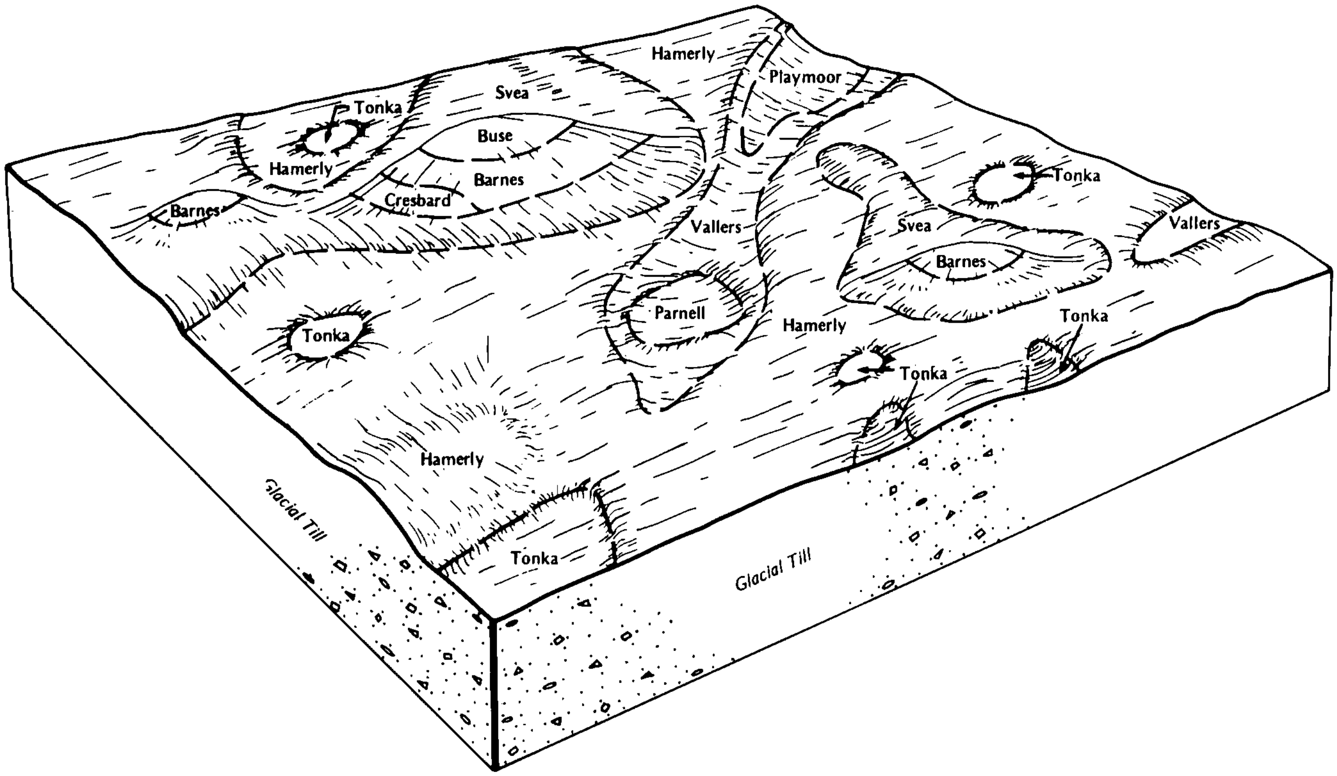

Figure 3.—Typical pattern of soils and parent material in the Hamerly-Svea-Tonka association.

saline. They are in depressions and drainageways. The poorly drained Vallers soils have an accumulation of lime in the subsoil. They are on the rims of depressions.

Most areas are used for cultivated crops; however, some areas of the Tonka soils are used for native hay. This association is well suited to small grain and sunflowers. Controlling soil blowing on the Hamerly soils and overcoming the wetness of the Tonka soils are the main concerns in managing cultivated areas. The productivity index of this association for spring wheat is 73.

The main limitations affecting building site development are wetness, the shrink-swell potential, and ponding. The principal limitations affecting septic tank absorption fields are wetness, slow or moderately slow permeability, and ponding.

2. Svea-Buse-Parnell Association

Deep, level to undulating, moderately well drained, well drained, and very poorly drained, medium textured soils

This association consists of soils on knolls and in swales and deep depressions on till plains. Scattered marshes, flats, and drainageways are throughout the association. Slope ranges from 0 to 6 percent.

This association makes up about 44 percent of the survey area. It is about 35 percent Svea soils, 15 percent Buse soils, 15 percent Parnell soils, and 35 percent soils of minor extent (fig. 4).

The nearly level and undulating, moderately well drained Svea soils are in swales. Typically, the surface soil is black loam about 11 inches thick. The subsoil is about 27 inches thick. In sequence downward, it is very dark grayish brown clay loam, dark brown loam, dark brown clay loam, and light olive brown, calcareous clay loam. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam.

The undulating, well drained Buse soils are on knolls. Typically, the surface layer is black loam about 7 inches thick. The subsoil is light yellowish brown, calcareous clay loam about 13 inches thick. The substratum to a depth of about 60 inches is olive brown and dark grayish brown loam.

The level, very poorly drained Parnell soils are in deep depressions. Typically, the surface soil is black silt loam about 14 inches thick. The subsurface layer is very dark gray silty clay loam about 2 inches thick. The subsoil is about 30 inches thick. It is very dark grayish brown clay loam in the upper part, dark grayish brown silty clay loam in the next part, and olive gray, calcareous, mottled silty

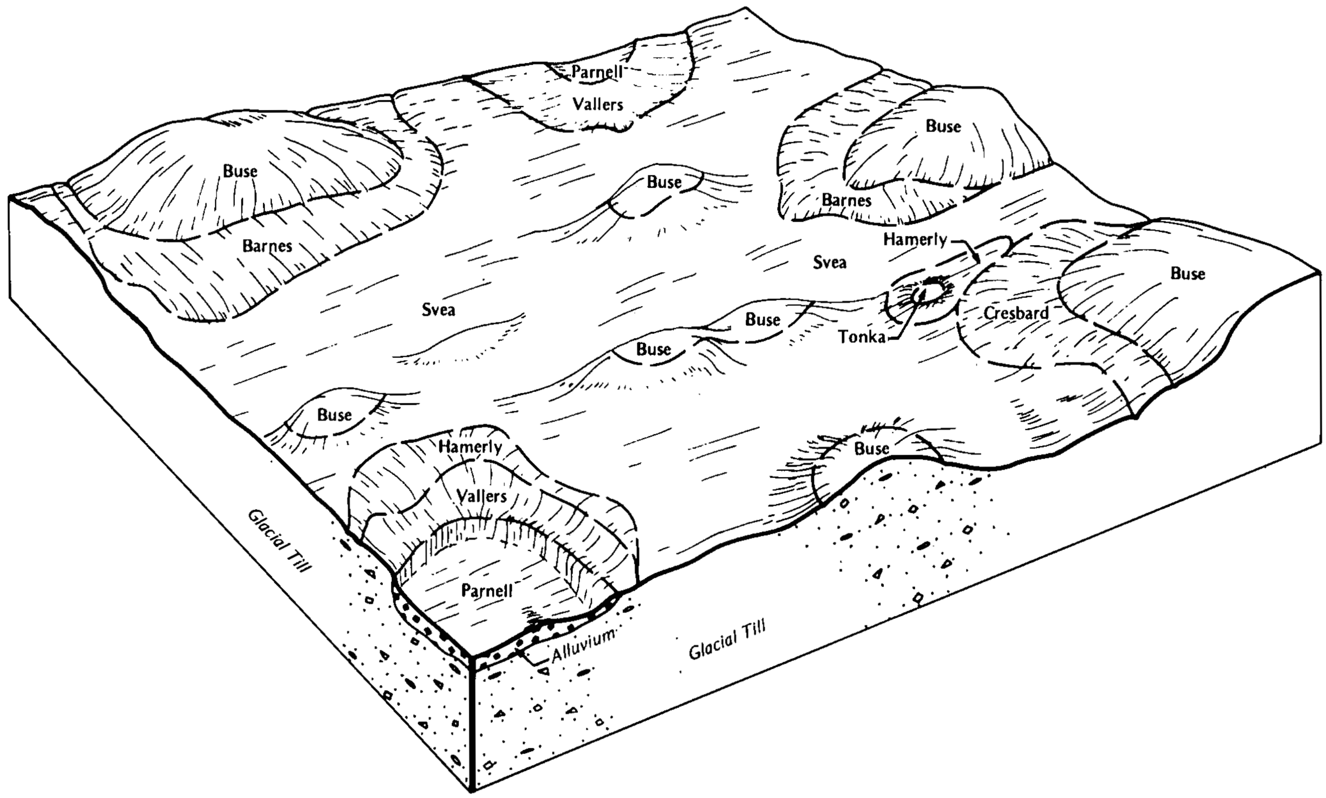

Figure 4.—Typical pattern of soils and parent material in the Svea-Buse-Parnell association.

clay in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled loam.

Barnes, Cresbard, Hamerly, Sioux, Southam, Tonka, and Vallers are the minor soils in this association. The well drained Barnes soils are on rises between the Svea and Buse soils. They are noncalcareous in the upper part of the subsoil. The dark color of their surface layer extends to a depth of only 7 to 16 inches. The moderately well drained Cresbard soils have an alkali subsoil. They are intermingled with areas of the Svea soils. The somewhat poorly drained Hamerly soils have an accumulation of lime in the subsoil. They are on flats below the Svea soils. The excessively drained Sioux soils have a gravelly substratum. They are intermingled with areas of the Buse soils. The very poorly drained Southam soils are continuously ponded. They are in deep depressions. The poorly drained Tonka soils have a light colored subsurface layer that is at least 5 inches thick. They are in shallow depressions. The poorly drained Vallers soils have an accumulation of lime in the subsoil. They are on the rims of depressions.

Most areas are used for cultivated crops, but the Parnell soils generally are used for native hay, range, or wetland wildlife habitat. This association is suited to small grain and sunflowers. Controlling soil blowing on the Buse soils and water erosion on the Buse and Svea soils and overcoming the wetness of the Parnell soils are the main concerns in managing cultivated areas. The productivity index of this association for spring wheat is 60.

The main limitations affecting building site development are wetness, a high shrink-swell potential, and ponding. The principal limitations affecting septic tank absorption fields are wetness, moderately slow or slow permeability, and ponding.

3. Cresbard-Svea Association

Deep, level to undulating, moderately well drained, medium textured soils

This association consists of soils on rises and in swales on till plains. Scattered depressions, flats, and drainageways are throughout the association. Slope ranges from 0 to 6 percent.

This association makes up about 6 percent of the survey area. It is about 45 percent Cresbard soils, 40 percent Svea soils, and 15 percent soils of minor extent (fig. 5).

The alkali Cresbard soils are on rises. Typically, the surface layer is black loam about 7 inches thick. The

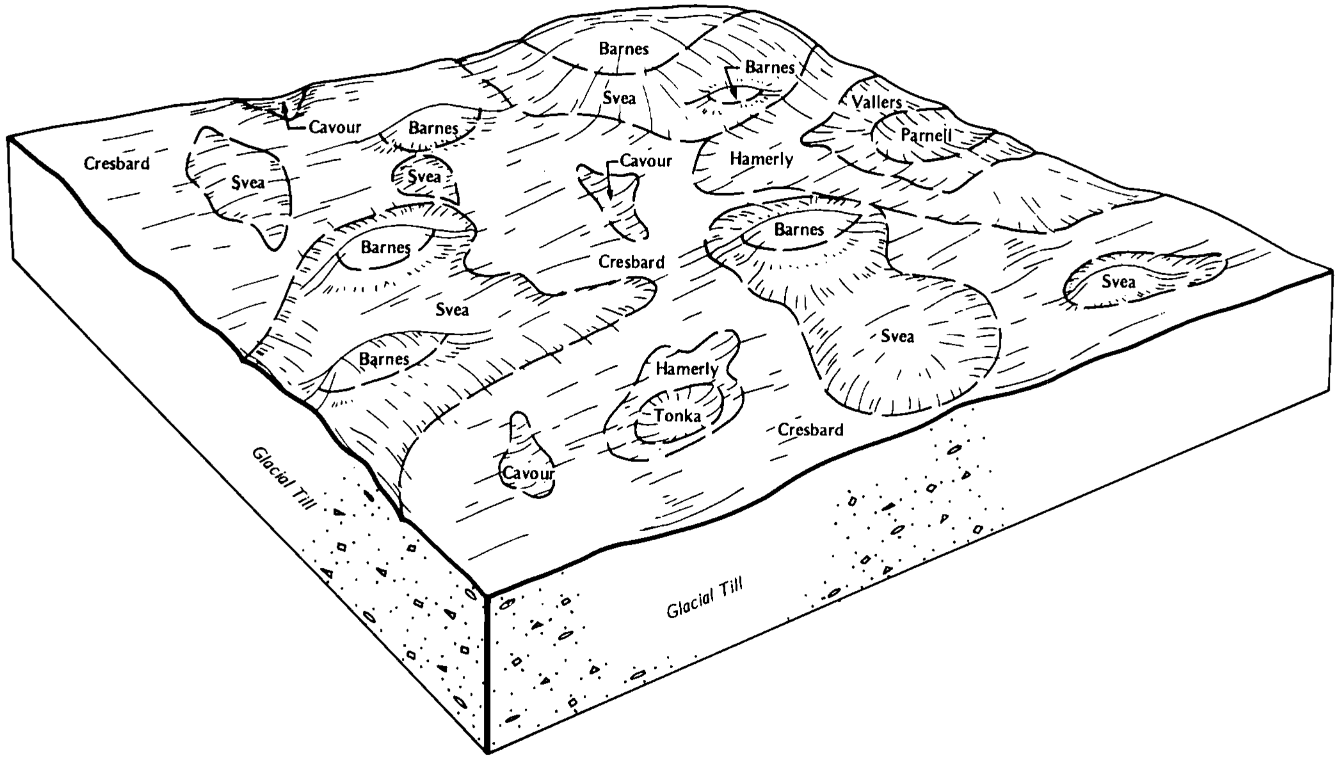

Figure 5.—Typical pattern of soils and parent material in the Cresbard-Svea association.

subsurface layer is very dark brown loam about 2 inches thick. The next layer is very dark brown and black clay loam about 3 inches thick. The subsoil is about 28 inches thick. It is dark grayish brown and very dark grayish brown clay loam in the upper part and light olive brown and olive brown, calcareous loam in the lower part. The upper part of the substratum is light brownish gray and light olive brown, mottled silt loam. The lower part to a depth of about 60 inches is olive brown and grayish brown, mottled loam.

The Svea soils are in swales. Typically, the surface soil is black loam about 11 inches thick. The subsoil is about 24 inches thick. It is very dark gray loam in the upper part, very dark grayish brown and dark brown clay loam in the next part, and light yellowish brown, calcareous loam in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam.

Barnes, Cavour, Hamerly, Parnell, Tonka, and Vallers are the minor soils in this association. The well drained Barnes soils are on rises above the Svea soils. They are noncalcareous in the upper part of the subsoil. The dark color of their surface layer extends to a depth of only 7 to 16 inches. The moderately well drained Cavour soils have an alkali subsoil. They are in swales below the Cresbard soils. The somewhat poorly drained Hamerly soils have an accumulation of lime in the subsoil. They are on flats below the Svea soils. The very poorly drained Parnell soils have an accumulation of clay in the subsoil. They are in deep depressions. The poorly drained Tonka soils have a light colored subsurface layer that is at least 5 inches thick. They are in shallow depressions. The poorly drained Vallers soils have an accumulation of lime in the subsoil. They are on the rims of depressions.

Most areas are used for cultivated crops. This association is well suited to small grain and sunflowers. Overcoming the effect of the dense, alkali subsoil in the Cresbard soils and maintaining tilth and fertility in both of the major soils are the main concerns in managing cultivated areas. The subsoil of the Cresbard soils restricts root development. The productivity index of this association for spring wheat is 77.

The main limitations affecting building site development are wetness and the shrink-swell potential. The principal limitations affecting septic tank absorption fields are moderately slow permeability and wetness.

4. Svea-Buse Association

Deep, nearly level and undulating, moderately well drained and well drained, medium textured soils

This association consists of soils on knolls and in swales on till plains. Scattered drainageways, flats, and depressions are throughout the association. Slope ranges from 1 to 6 percent.

This association makes up about 2 percent of the survey area. It is about 45 percent Svea soils, 35 percent Buse soils, and 20 percent soils of minor extent.

The nearly level, moderately well drained Svea soils are in swales. Typically, the surface soil is black loam about 11 inches thick. The subsoil is about 27 inches thick. In sequence downward, it is very dark grayish brown clay loam, dark brown loam, dark brown clay loam, and light olive brown, calcareous loam. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam.

The undulating, well drained Buse soils are on knolls. Typically, the surface layer is black loam about 7 inches thick. The subsoil is light yellowish brown, calcareous loam about 13 inches thick. The substratum to a depth of about 60 inches is olive brown and dark grayish brown loam.

Barnes, Cresbard, Hamerly, Parnell, Playmoor, and Tonka are the minor soils in this association. The well drained Barnes soils are on rises between the Svea and Buse soils. They are noncalcareous in the upper part of the subsoil. The dark color of their surface layer extends to a depth of only 7 to 16 inches. The moderately well drained Cresbard soils have an alkali subsoil. They are on rises above the Svea soils. The somewhat poorly drained Hamerly soils have an accumulation of lime in the subsoil. They are on flats below the Svea soils. The very poorly drained Parnell soils have an accumulation of clay in the subsoil. They are in deep depressions. The poorly drained Playmoor soils are saline. They are in depressions and drainageways. The poorly drained Tonka soils have a light colored subsurface layer that is at least 5 inches thick. They are in shallow depressions.

Most areas are used for cultivated crops. This association is suited to small grain and sunflowers. Controlling soil blowing and water erosion on the Buse soils and maintaining tilth and fertility in both of the major soils are the main concerns in managing cultivated areas. The productivity index of this association for spring wheat is 67.

The main limitation affecting building site development is the shrink-swell potential. The principal limitations affecting septic tank absorption fields are moderately slow permeability and wetness.

5. Svea-Barnes Association

Deep, level to gently sloping, well drained, medium textured soils

This association consists of soils on low ridges and broad flats and in swales on till plains. Drainageways cross the association at regular intervals. Slope ranges from 0 to 6 percent.

This association makes up about 5 percent of the survey area. It is about 55 percent Svea soils, 25 percent Barnes soils, and 20 percent soils of minor extent.

The level and nearly level Svea soils are on broad flats and in swales. Typically, the surface soil is loam about 17 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is about 19 inches thick. It is very dark grayish brown loam in the upper part, dark grayish brown clay loam in the next part, and light olive brown, mottled, calcareous loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loam.

The nearly level and gently sloping Barnes soils are on low ridges. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 19 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loam.

Buse, Cresbard, Embden, and Gardena are the minor soils in this association. The well drained Buse soils have a calcareous subsoil. They are on knolls. The moderately well drained Cresbard soils have an alkali subsoil. They are on flats. The well drained Embden soils have a fine sandy loam surface soil and subsoil. They are in swales. The moderately well drained Gardena soils have a silt loam surface soil and subsoil. They are on flats.

Most areas are used for cultivated crops. This association is well suited to small grain and sunflowers. Controlling water erosion on the Barnes soils and maintaining tilth and fertility in both of the major soils are the main concerns in managing cultivated areas. The productivity index of this association for spring wheat is 86.

The main limitation affecting building site development is the shrink-swell potential. The principal limitation affecting septic tank absorption fields is moderately slow permeability.

Dominantly Level to Hilly or Moderately Steep, Loamy and Silty Soils on Till Plains, Moraines, and Flood Plains and in Stream Valleys

These soils formed in glacial till, alluvium, and material weathered from shale bedrock. They make up about 12 percent of the survey area. In most areas surface water flows to drainageways; however, a few scattered lakes, marshes, and depressions are throughout these associations. Generally, the gently rolling and rolling areas are used for cultivated crops, hay, or pasture. The hilly areas generally are used for range or wildlife habitat.

The main concerns in managing the soils for cultivated crops are soil blowing on the Buse soils, water erosion on all of the soils, and flooding on the LaDelle soils. The principal limitations affecting building site development and septic tank absorption fields are flooding on the LaDelle soils; the slope, moderately slow permeability, and shrink-swell potential in areas of the Buse, Barnes, and Svea soils; and the slope and depth to bedrock in areas of the Kloten soils.

6. Buse-Svea-Barnes Association

Deep, gently rolling to hilly, well drained and moderately well drained, medium textured soils

This association consists of soils on ridges, on knolls, and in intervening swales. Scattered shallow and deep depressions are throughout the association. Slope ranges from 6 to 25 percent.

This association makes up about 10 percent of the survey area. It is about 30 percent Buse soils, 30 percent Svea soils, 15 percent Barnes soils, and 25 percent soils of minor extent (fig. 6).

The gently rolling to hilly, well drained Buse soils are on knolls and ridges. Typically, the surface layer is very dark gray loam about 8 inches thick. The subsoil is grayish brown, calcareous loam about 14 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

The gently rolling to hilly, moderately well drained and well drained Svea soils are in swales. Typically, the surface soil is black loam about 16 inches thick. The subsoil is about 23 inches thick. It is very dark grayish brown loam in the upper part, olive brown clay loam in the next part, and light olive brown, calcareous clay loam in the lower part. The subsoil is mottled below a depth of 22 inches. The substratum to a depth of about 60 inches is olive brown, mottled loam.

The gently rolling and rolling, well drained Barnes soils are between the knolls and swales. Typically, the surface layer is black loam about 8 inches thick. The subsoil is loam about 15 inches thick. It is dark brown in the upper part and grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loam.

Coe, Hamerly, Parnell, Sioux, Tonka, and Vallers are the minor soils in this association. The excessively drained Coe soils have a very gravelly substratum made up mainly of shale fragments. They are on knolls and

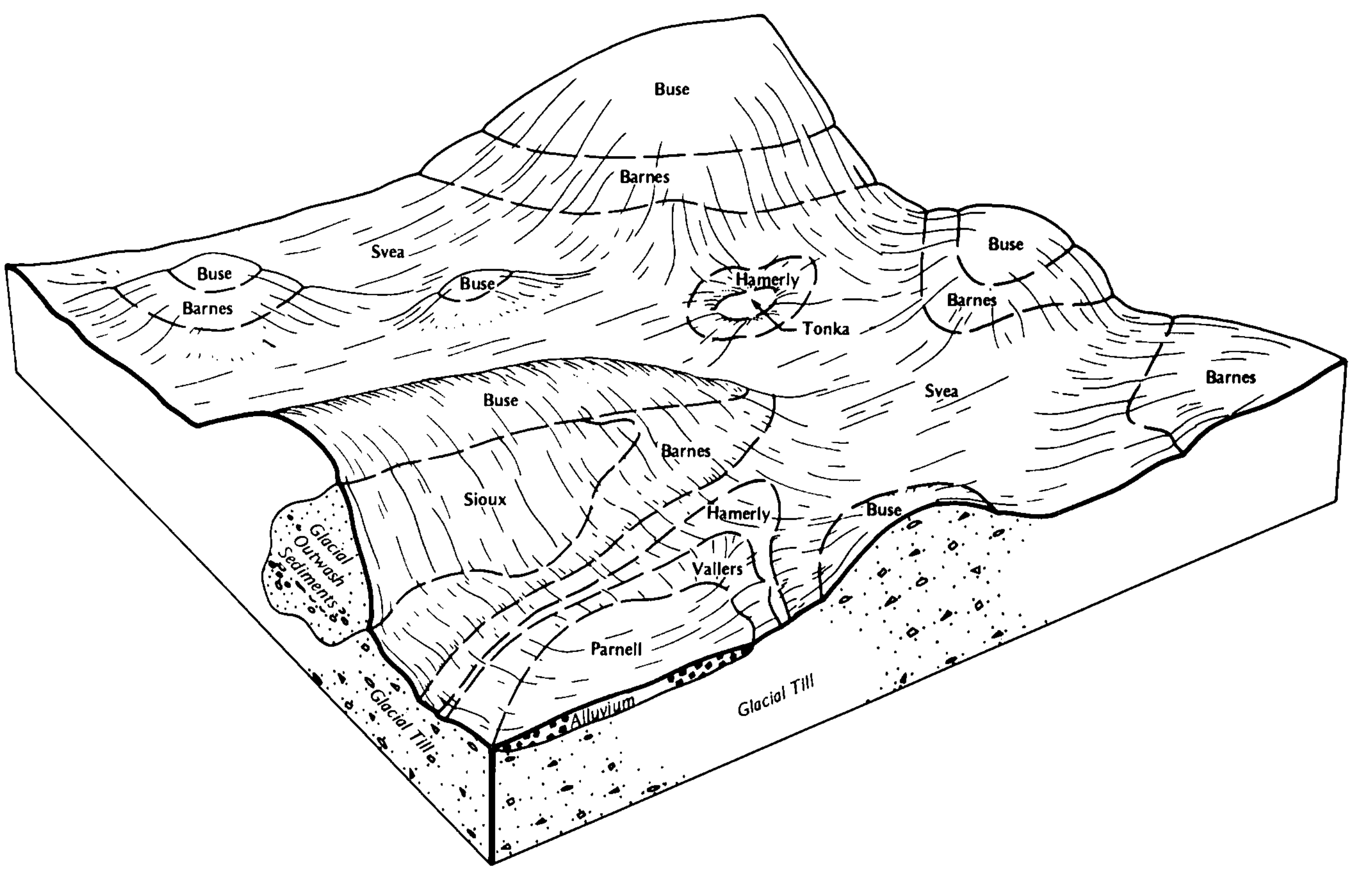

Figure 6.—Typical pattern of soils and parent material in the Buse-Svea-Barnes association.

ridges. The somewhat poorly drained Hamerly soils have an accumulation of lime in the subsoil. They are on flats below the Svea soils. The very poorly drained Parnell soils have an accumulation of clay in the subsoil. They are in deep depressions. The excessively drained Sioux soils have a gravelly substratum made up mainly of granitic fragments. They are on knolls and ridges. The poorly drained Tonka soils have a light colored subsurface layer that is at least 5 inches thick. They are in shallow depressions. The poorly drained Vallers soils have an accumulation of lime in the subsoil. They are on the rims of depressions.

Most areas are used for pasture, hay, range, or cultivated crops. Most of the rolling and hilly areas are used for range or native hay. This association is poorly suited to cultivated crops because of the slope. The gently rolling soils are better suited than the steeper soils. Controlling water erosion on all of the major soils and controlling soil blowing on the Buse soils are the main concerns in managing cultivated areas. The productivity index of this association for spring wheat is 47.

The main limitations affecting building site development are the slope and the shrink-swell potential. The principal limitations affecting septic tank absorption fields are moderately slow permeability and the slope.

7. Kloten-Buse-LaDelle Association

Shallow and deep, level to moderately steep, well drained and moderately well drained, medium textured soils

This association consists of soils on flood plains and on the sides of stream valleys. It makes up about 2 percent of the survey area. It is about 25 percent Kloten soils, 25 percent Buse soils, 25 percent LaDelle soils, and 25 percent soils of minor extent (fig. 7).

The shallow, strongly sloping and moderately steep, well drained Kloten soils are on the middle part of valley sides below the Buse soils. Typically, the surface layer is black loam about 7 inches thick. The substratum is very dark grayish brown very channery loam about 11 inches thick. Below this is dark olive gray shale bedrock.

The deep, strongly sloping and moderately steep, well drained Buse soils are on the summits and upper parts of valley sides. Typically, the surface layer is very dark grayish brown loam about 7 inches thick. The subsoil is calcareous loam about 12 inches thick. It is brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

The deep, level, moderately well drained LaDelle soils are on flood plains. Typically, the surface soil is about 12 inches thick. It is black. It is silt loam in the upper part and silty clay loam in the lower part. The subsoil is black silty clay loam about 17 inches thick. The substratum to a depth of about 60 inches is silty clay loam. It is very dark gray in the upper part and very dark grayish brown in the lower part.

Barnes, Lamoure, Sioux, Svea, and Walsh are the minor soils in this association. The well drained Barnes soils are on convex side slopes. They are noncalcareous in the upper part of the subsoil. The dark color of their surface layer extends to a depth of only 7 to 16 inches. The poorly drained Lamoure soils have sand and gravelly sand in the lower part of the substratum. They are in depressions and oxbows on the flood plains. The excessively drained Sioux soils have a gravelly substratum. They are on terraces. The moderately well drained Svea soils are in swales. The dark color of their surface layer extends to a depth of more than 16 inches. The well drained Walsh soils are loam throughout and have shale fragments in the lower part of the substratum. They are on foot slopes.

Most areas are used for range; however, the LaDelle soils and the minor Svea and Walsh soils are used primarily for cultivated crops. This association generally is poorly suited to cultivated crops because of the slope. In some areas the level to moderately sloping soils are suited to cultivated crops. Water erosion and soil blowing on the Buse soils and flooding on the LaDelle soils are the main concerns in managing cultivated areas. The productivity index of this association for spring wheat is 47.

The main limitations affecting building site development are the depth to bedrock, the slope, the flooding, and the shrink-swell potential. The principal limitations affecting septic tank absorption fields are the flooding, the depth to bedrock, wetness, and moderately slow permeability.

Dominantly Level to Very Steep, Sandy, Silty, and Loamy Soils on Lake Plains and Former Lakeshores

These soils formed in beach sediments, lacustrine sediments, and glacial till. They make up about 1 percent of the survey area. In most areas surface water flows into nearby lakes or marshes or ponds on the surface. The soils are used primarily as range or wildlife habitat; however, scattered areas are used for hay, pasture, or cultivated crops. The soils are best suited to range.

The main concerns in managing the soils for range are maintaining the important native plants and achieving a uniform distribution of grazing. The principal limitations affecting building site development and septic tank absorption fields are rapid permeability, flooding, wetness, slope, the shrink-swell potential, and stoniness.

8. Wamduska-Lallie-Mauvais Association

Deep, level to very steep, excessively drained, poorly drained, and somewhat poorly drained, coarse textured to moderately fine textured soils

This association consists of soils on abandoned beaches on lakeshores and on flats on lake plains. The

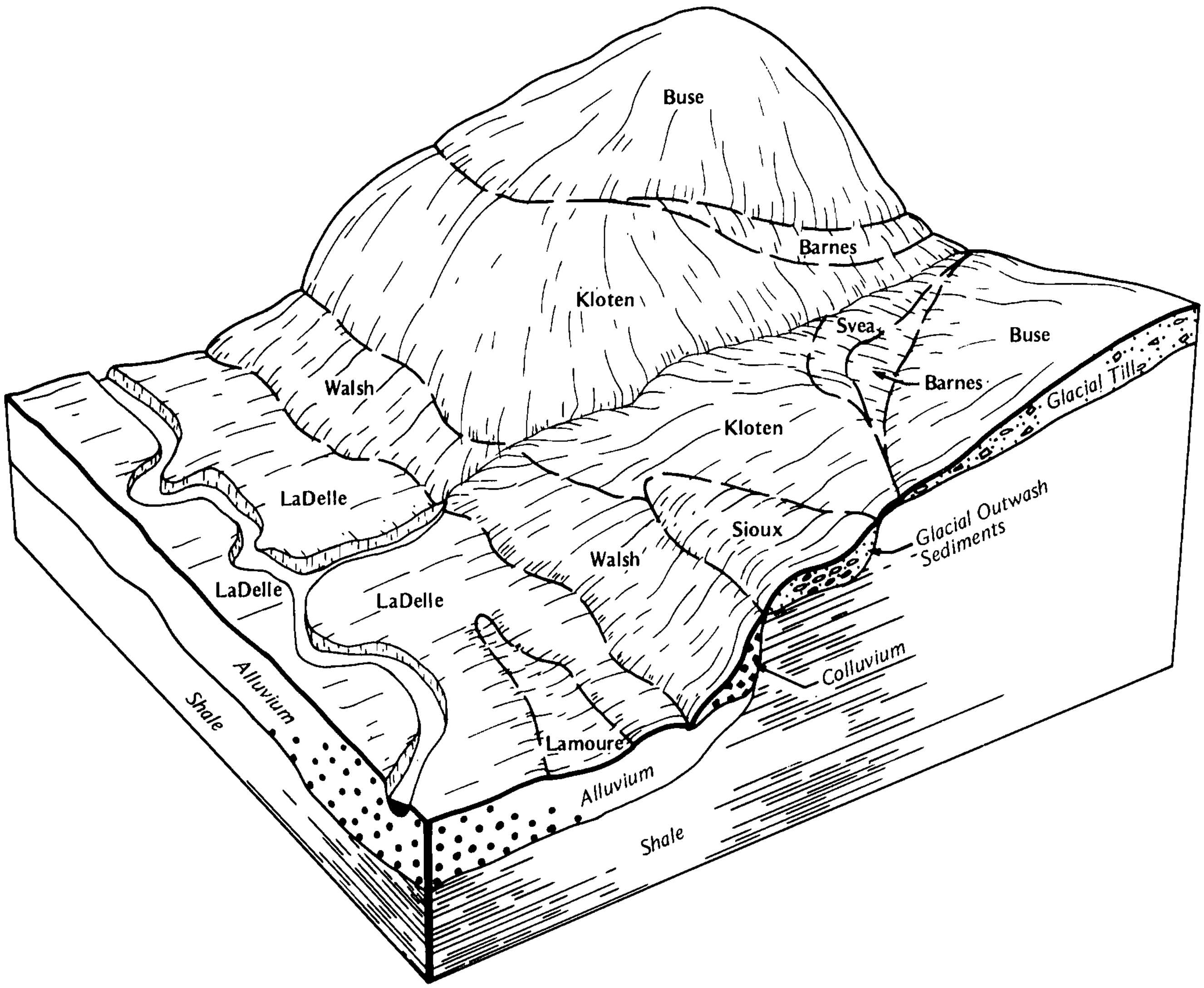

Figure 7.—Typical pattern of soils and parent material in the Kloten-Buse-LaDelle association.

abandoned beaches are separated by swales that parallel the beach line.

This association makes up about 1 percent of the survey area. It is about 35 percent Wamduska soils, 30 percent Lallie soils, 25 percent Mauvais soils, and 10 percent soils of minor extent (fig. 8).

The nearly level to very steep, excessively drained, nonstony to extremely stony Wamduska soils are on the abandoned beaches. Typically, the surface layer is very dark gray loamy coarse sand or sandy loam about 3 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, very dark grayish brown, dark brown, and black. In sequence downward, it is gravelly loamy coarse sand, very gravelly sand, very gravelly coarse sand, and coarse sandy loam.

The level, poorly drained, saline Lallie soils are on flats. Typically, the surface layer is very dark gray silty clay loam about 3 inches thick. The substratum to a depth of about 60 inches is olive gray. It is silty clay loam in the upper part and mottled silty clay in the lower part.

The nearly level to moderately sloping, somewhat poorly drained Mauvais soils are in swales between the abandoned beaches. Typically, the surface layer is black loam about 2 inches thick. The subsoil is loam about 35 inches thick. In sequence downward, it is grayish brown, light olive brown, olive brown, and dark brown. It has

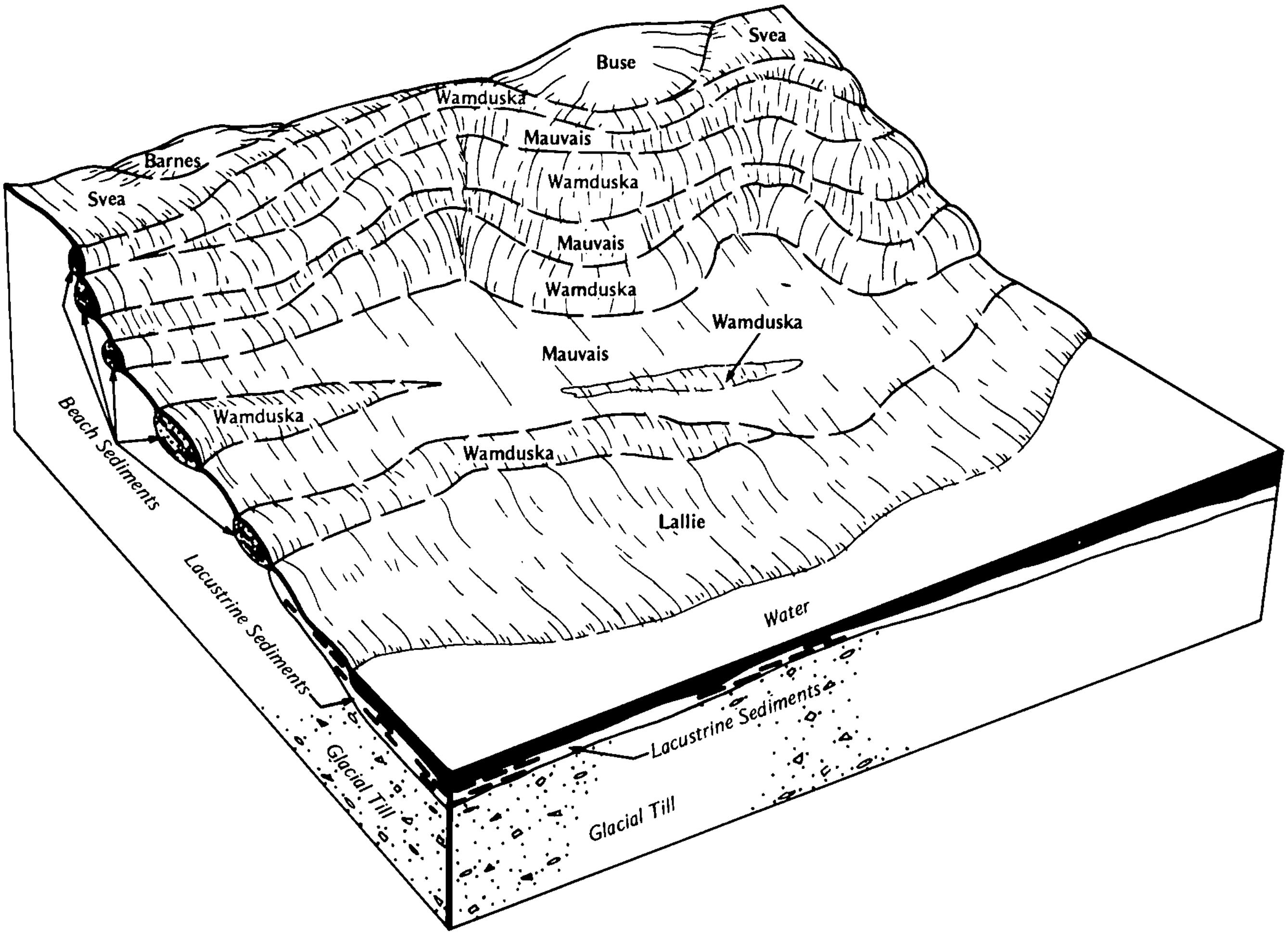

Figure 8.—Typical pattern of soils and parent material in the Wamduska-Lallie-Mauvais association.

masses of salts and gypsum below a depth of 18 inches. The substratum to a depth of about 60 inches is olive brown and grayish brown, mottled loam.

Barnes, Buse, Glyndon, Maddock, and Svea are the minor soils in this association. The well drained Barnes and Buse soils are on the upper wave-cut shorelines. Buse soils have a calcareous loam subsoil. The somewhat poorly drained Glyndon soils have an accumulation of lime in the subsoil. They are on flats. The well drained Maddock soils have a sand and loamy very fine sand substratum. They are on former beaches. Svea soils are moderately well drained. They are in swales.

Most areas are used for range. A few are used for cultivated crops. This association generally is unsuited to small grain and sunflowers because of the wetness of the Lallie and Mauvais soils; the slope, droughtiness, and stoniness in areas of the Wamduska soils; and the salinity of the Lallie soils. The association is best suited to range. The principal concerns in managing range are maintaining the important plants and achieving a uniform distribution of grazing.

The main limitations affecting building site development are slope, stoniness, flooding, ponding, and wetness. The principal limitations affecting septic tank absorption fields are rapid permeability, flooding, ponding, slope, and wetness.

Dominantly Level to Gently Sloping, Loamy Soils on Outwash Plains

These soils formed in glacial outwash sediments. They make up about 2 percent of the survey area. In most areas surface water flows to drainageways. The soils are used primarily for cultivated crops, hay, or pasture.

The main concerns in managing the soils for cultivated crops are overcoming droughtiness and controlling soil blowing. The principal limitation affecting septic tank absorption fields is rapid or very rapid permeability. No major hazards or limitations affect building site development.

9. Renshaw-Arvilla Association

Deep, level to gently sloping, somewhat excessively drained, medium textured and moderately coarse textured soils

This association consists of soils on knolls, ridges, and flats on outwash plains. Drainageways are common. Slope ranges from 0 to 6 percent.

This association makes up about 2 percent of the survey area. It is about 40 percent Renshaw soils, 25 percent Arvilla soils, and 35 percent soils of minor extent.

The nearly level and gently sloping Renshaw soils are on flats and the sides of knolls and ridges. Typically, the surface layer is black loam about 8 inches thick. The subsoil is dark brown loam about 7 inches thick. The substratum to a depth of about 60 inches is dark brown very gravelly coarse sand.

The level to gently sloping Arvilla soils are on flats and the upper sides of knolls and ridges. Typically, the surface layer is black sandy loam about 8 inches thick. The subsoil is very dark grayish brown sandy loam about 7 inches thick. The substratum to a depth of about 60 inches is dark brown gravelly coarse sand.

Brantford, Divide, Fordville, Maddock, and Vang are the minor soils in this association. The well drained Brantford soils have a very gravelly substratum made up mainly of shale fragments. They are on the sides of knolls and ridges. The somewhat poorly drained Divide soils have an accumulation of lime in the subsoil. They are on flats and in drainageways. The well drained Fordville and Vang soils are 20 to 40 inches deep over sand and gravel. They are on flats. The well drained Maddock soils have a sand and loamy very fine sand substratum. They are on the sides of ridges and knolls.

Most areas are used for cultivated crops; however, some are used for hay or pasture. This association is poorly suited to small grain and sunflowers. Controlling soil blowing and overcoming droughtiness are the main concerns in managing cultivated areas. The productivity index of this association for spring wheat is 45.

The main limitation affecting septic tank absorption fields is rapid or very rapid permeability. No major hazards or limitations affect building site development.

Broad Land Use Considerations

In 1985, about 75 percent of the acreage in the survey area was used for cultivated crops. The rest was used for range, tame hay and pasture, woodland, wildlife habitat, or other purposes. The general soil map is most useful in determining the general outline of areas that are suitable for cultivated crops, urban development, wildlife habitat, or recreational uses. It cannot be used in the selection of sites for specific structures.

Deciding which land is to be developed for urban uses is an issue of increasing concern in the state and in the survey area. Generally, the soils that have good potential for cultivated crops also have good potential for urban development. Areas where the soils are so unfavorable that urban or recreational development is prohibited are not extensive in the survey area. The Wamduska-Lallie-Mauvais association, however, is subject to inundation because of the fluctuating levels of Stump Lake. The major soils in the Renshaw-Arvilla association are rapidly permeable or very rapidly permeable. As a result, ground water can be polluted if these soils are used for onsite sewage disposal. Most of the associations have a small acreage of poorly drained and very poorly drained soils. These soils are so wet that they have very poor potential for urban uses.

Of all the associations, the Svea-Barnes association has the highest potential for cultivated crops. The Wamduska-Lallie-Mauvais association has the lowest potential. The other associations have fair potential.

Wildlife habitat is extensive in the survey area. The soils generally have good or fair potential for one or more types of wildlife habitat. Those used for wildlife habitat generally have one or more limitations that restrict their potential for other uses.

Detailed Soil Map Units

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

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

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

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

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Svea loam, 1 to 3 percent slopes, is a phase of the Svea series.

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

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Svea-Buse loams, 3 to 6 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Vallers and Hamerly loams, 0 to 3 percent slopes, is an undifferentiated group in this survey area.

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

The descriptions, names, and delineations of the soils identified on the detailed soil maps of this survey area do not always agree or join with those of the soils identified on the maps of adjoining counties published at an earlier date. Differences result from a better knowledge of soils, modifications in series concepts, and variations in map unit design and in the extent of the soils in the survey areas.

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

Soil Descriptions

2—Parnell silt loam. This deep, level, very poorly drained soil is in deep depressions on glacial till plains. It is frequently ponded. Individual areas range from about 5 to 75 acres in size.

Typically, the surface soil is black silt loam about 14 inches thick. It is covered by organic material about 4 inches thick. The subsurface layer is black silty clay loam about 2 inches thick. The subsoil is about 24 inches thick. It is black silty clay loam in the upper part; very dark gray, mottled silty clay in the next part; and dark grayish brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled loam. In some places the subsurface layer is mottled and is more than 4 inches thick. In other places the soil is continuously ponded.

Included with this soil in mapping are small areas of Hamerly, Playmoor, and Vallers soils on the rims of depressions. These soils make up about 15 percent of the unit. Hamerly and Vallers soils have a subsoil that has accumulated lime within a depth of 16 inches. Playmoor soils are saline.

Permeability is slow in the Parnell soil. Runoff is ponded. Available water capacity is high. A seasonal high water table is 2 feet above to 2 feet below the surface. Tilth is good.

Most areas are used for wetland wildlife habitat. Some are used for native hay or range. A few have been drained and are used for cultivated crops. This soil is best suited to wetland wildlife habitat, native hay, and range. Undrained areas are poorly suited to tame hay and cultivated crops. The hazards of soil blowing and water erosion are slight. Excessive wetness is a critical limitation affecting crops and pasture. A drainage system improves the suitability for cultivated crops; however, drainage outlets are difficult to locate. The soil and the ponded water provide excellent winter cover for resident wildlife and high-quality feeding, breeding, and rearing areas for wetland wildlife. The main concerns in managing wetland wildlife habitat are reducing siltation and maintaining the natural water level.

The important native forage plants on this soil are rivergrass and slough sedge. Compaction, trampling, and root shearing are problems, especially if the range is grazed during wet periods. They can be overcome by deferring grazing when the soil is wet.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover improve the survival and growth rates of the seedlings.

This soil generally is unsuited to septic tank absorption fields and buildings because of the ponding. Better sites generally are nearby.

The land capability classification is IIIw. The productivity index for spring wheat ranges from 0 to 72, depending on the degree of drainage. The range site is Wetland. The pasture group also is Wetland.

3—Playmoor silty clay loam, saline. This deep, level, poorly drained, moderately saline soil is on flats and in drainageways on glacial till plains. It is frequently flooded. Individual areas range from about 5 to 150 acres in size.

Typically, the surface soil is black silty clay loam about 18 inches thick. The subsoil is silty clay loam about 10 inches thick. It is black in the upper part and very dark gray in the lower part. The next layer is black silty clay loam about 20 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled loam. The soil has threads of salts throughout. In some places the surface soil is clay loam or loam. In other places the subsoil and substratum are alkali silty clay.

Included with this soil in mapping are small areas of Hamerly, Parnell, Svea, and Tonka soils. These soils make up about 15 percent of the unit. The somewhat poorly drained Hamerly soils have a subsoil that has accumulated lime within 16 inches of the surface. They are on flats. Parnell soils are very poorly drained. They are in deep depressions. Svea soils are moderately well drained and well drained. They are on the higher lying flats. Tonka soils are poorly drained. They are in shallow depressions. Also included are some stony areas.

Permeability is moderately slow in the Playmoor soil. Runoff is very slow. Available water capacity is moderate. It is restricted by the salts in the soil. A seasonal high water table is at a depth of 0.5 foot to 3.5 feet. Tilth is fair.

Most areas are used for native hay, range, or wetland wildlife habitat. A few areas are cultivated along with the more productive adjacent soils. This soil is best suited to wetland wildlife habitat, native hay, pasture, and range. It is poorly suited to cultivated crops because of the wetness, the salinity, and the susceptibility to soil blowing. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The best suited crops are those that are salt tolerant. The degree of salinity can increase if the soil is drained and cultivated. Fallowing should be avoided because it results in the accumulation of salts in the surface layer. A system of conservation tillage helps to control soil blowing and provides food and cover for resident and migratory wildlife.

The important native forage plants on this soil are Nuttall alkaligrass and western wheatgrass. Alsike clover, sweetclover, and wheatgrasses are suitable hay and pasture plants. The high content of salts, the limited available water capacity, compaction, trampling, and root shearing are problems, especially if the range is grazed during wet periods. They can be overcome by maintaining an adequate cover of the important salt tolerant plants and by deferring grazing while the soil is wet. Stock water ponds constructed in this soil frequently contain salty water.

This soil is suited to only the most salt tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the reduced amount of available water resulting from the salts in the soil. Reducing the evaporation rate at the surface improves seedling survival. When the bare soil surface dries, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields and buildings because of the wetness and the flooding. Better sites generally are nearby.

The land capability classification is IIIs. The productivity index for spring wheat is 35. The range site is Saline Lowland. The pasture group is Saline.

4—Southam silty clay loam. This deep, level, very poorly drained soil is in deep depressions on glacial till plains. It is frequently ponded. Individual areas range from about 5 to 600 acres in size.

Typically, the surface soil is black silty clay loam about 26 inches thick. It is covered by organic material about 2 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay loam. In some places the soil has a subsoil of accumulated clay. In other places the surface layer is silt loam.

Included with this soil in mapping are small areas of the poorly drained Playmoor and Vallers soils on the rims of depressions. These soils make up about 5 percent of the unit. Playmoor soils are saline. Vallers soils have a subsoil that has accumulated lime.

Permeability is slow in the Southam soil. Runoff is ponded. Available water capacity is high. A seasonal high water table is 5 feet above the surface to 1 foot below.

Most areas are used for wildlife habitat. This soil is best suited to wetland wildlife habitat (fig. 9). It is generally unsuited to cultivated crops, pasture, hay, range, and trees and shrubs because of the ponding and a scarcity of suitable drainage outlets. The hazards of soil blowing and water erosion are slight. The soil and the ponded water provide excellent winter cover for resident wildlife and high-quality feeding, breeding, and rearing areas for wetland wildlife. The main concerns in managing wetland wildlife habitat are reducing siltation and maintaining the natural water level.

This soil generally is unsuited to septic tank absorption fields and buildings because of the ponding. Better sites generally are nearby.

The land capability classification is VIIIw. The productivity index for spring wheat is 0. No range site or pasture group has been assigned.

5—Hamerly-Tonka complex, 0 to 3 percent slopes. These deep soils are in areas on glacial till plains where runoff collects in depressions. The level and nearly level, somewhat poorly drained Hamerly soil is on rises between and surrounding the depressions. The level, poorly drained Tonka soil is in the depressions (fig. 10). It is subject to ponding. Individual areas range from about 5 to more than 1,000 acres in size. They are about 50 to 60 percent Hamerly soil and 35 to 45 percent Tonka soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Hamerly soil has a very dark gray loam surface layer about 9 inches thick. The subsoil is light brownish gray, calcareous loam about 12 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In some places the upper part of the subsoil is noncalcareous. In other places the soil is moderately saline.

Typically, the Tonka soil has a black silt loam surface soil about 10 inches thick. The subsurface layer is dark grayish brown, mottled silt loam about 6 inches thick. The subsoil is mottled clay loam about 23 inches thick. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled loam. In some places the subsurface layer is less than 4 inches thick. In other places the soil does not have a subsurface layer. In some areas the surface soil is loam.

Included with these soils in mapping are small areas of the poorly drained Playmoor and Vallers soils. These included soils are on flats between the Hamerly and Tonka soils. They make up about 5 percent of the unit. Playmoor soils are saline. Vallers soils have a grayish brown substratum. Also included are some stony areas.

Permeability is moderately slow in the Hamerly soil and slow in the Tonka soil. Runoff is slow on the Hamerly soil and ponded on the Tonka soil. Available water capacity is high in both soils. A seasonal high water table is at a depth of 2.0 to 4.0 feet in the Hamerly soil and is 0.5 foot above to 1.0 foot below the surface of the Tonka soil. Tilth is good in both soils.

Most areas are used for cultivated crops, hay, or pasture. These soils are suited to small grain and sunflowers but are best suited to late-seeded crops. The hazard of soil blowing is moderate on the Hamerly soil, and the hazard of water erosion is slight on both soils. Controlling soil blowing and overcoming wetness and ponding are the main management concerns if cultivated crops are grown. Ponding on the Tonka soil delays tillage and seeding and hinders harvesting in some years. A drainage system improves the suitability for crops; however, locating drainage outlets generally is difficult. Field windbreaks, a conservation tillage system, and buffer strips help to control soil blowing.

The Tonka soil and the ponded water provide breeding sites and a good supply of invertebrate protein for wetland wildlife. Conservation tillage helps to provide food and cover for resident and migratory wildlife.

Big bluestem, reed canarygrass, sweetclover, and alsike clover are suitable hay and pasture plants on these soils. Compaction, trampling, and root shearing are problems, especially if the pasture is grazed during wet periods. They can be overcome by deferred grazing when the Tonka soil is wet. Maintaining an adequate cover of the suitable plants helps to control soil blowing.

If drained, the Tonka soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained

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Figure 9.—An area of Southam silty clay loam that provides habitat for wetland wildlife.

areas generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover improve the survival and growth rates of the seedlings. The Hamerly soil is suited to all of the climatically adapted species. It has no critical limitations. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The Hamerly soil is suited to buildings. Both soils generally are unsuited to septic tank absorption fields. The seasonal high water table and moderately slow permeability of the Hamerly soil are limitations in septic tank absorption fields, but installing a mound system helps to overcome these limitations. The shrink-swell potential of the Hamerly soil is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements. In this survey area, the Tonka soil generally is not used as a site for buildings or septic tank absorption fields because of the ponding. Better sites generally are nearby.

The land capability classification of the Hamerly soil is IIe, and that of the Tonka soil is IIw. The productivity index for spring wheat ranges from 66 to 85, depending on the degree of drainage in areas of the Tonka soil. The pasture group of the Hamerly soil is Limy Subirrigated, and that of the Tonka soil is Wet.

7—Parnell-Vallers complex, 0 to 3 percent slopes. These deep soils are in areas on glacial till plains where runoff collects in depressions. The level, very poorly

Figure 10.—An area of Hamerly-Tonka complex, 0 to 3 percent slopes. The Tonka soil is ponded.

drained Parnell soil is in the depressions. It is frequently ponded. The level and nearly level, poorly drained, moderately saline, highly calcareous Vallers soil is on rises between and around the depressions. Individual areas range from about 5 to 200 acres in size. They are about 60 to 70 percent Parnell soil and 30 to 40 percent Vallers soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Parnell soil has a black, mottled silt loam surface soil about 14 inches thick. The subsurface layer is very dark gray and black, mottled silty clay loam about 2 inches thick. The subsoil is about 30 inches thick. It is very dark grayish brown clay loam in the upper part, dark grayish brown silty clay loam in the next part, and olive gray, mottled, calcareous silty clay in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled loam. In some places the surface soil is silty clay loam. In other places the subsurface layer is more than 4 inches thick. In some areas the soil is calcareous throughout.

Typically, the Vallers soil has a black loam surface layer about 8 inches thick. The subsoil is calcareous silty clay loam about 10 inches thick. It is grayish brown in the upper part and light brownish gray and mottled in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled loam. In some places the substratum is light olive brown. In other places the soil is only slightly saline.

Included with these soils in mapping are small areas of Playmoor soils. These included soils make up about 5 percent of the unit. They have a silty clay loam surface layer. They are intermingled with areas of the Vallers soil. Also included are some stony areas.

Permeability is slow in the Parnell soil and moderately slow in the Vallers soil. Runoff is ponded on the Parnell soil and slow on the Vallers soil. Available water capacity is high in the Parnell soil and moderate in the Vallers soil. It is restricted by the content of salts in the Vallers soil. A seasonal high water table is 2 feet above to 2 feet below the surface of the Parnell soil and is within a depth of 1 foot in the Vallers soil. Tilth is good in both soils.

Most areas are used for wetland wildlife habitat. A few areas are used for range or native hay or have been drained and are used for cultivated crops. These soils are best suited to wetland wildlife habitat, native hay, and range. Undrained areas are poorly suited to tame hay, pasture, and cultivated crops. The hazard of soil blowing is moderate on the Vallers soil, and the hazard of water erosion is slight on both soils. Ponding and wetness are critical limitations affecting crops, pasture, and tame hay. A drainage system improves the suitability for crops; however, locating drainage outlets generally is difficult. The best suited crops are those that are salt tolerant. The degree of salinity in the Vallers soil can increase in areas that are drained and cultivated. Fallowing should be avoided because it results in the accumulation of salts in the surface layer. A system of conservation tillage helps to control soil blowing.

The Parnell soil and the ponded water provide excellent winter cover for resident wildlife and high-quality feeding, breeding, and rearing grounds for wetland wildlife. The main concerns in managing wetland wildlife habitat are reducing siltation and maintaining the natural water level.

The important native forage plants on these soils are rivergrass, slough sedge, big bluestem, and switchgrass. The Vallers soil is suited to tall wheatgrass, alkali sacaton, and sweetclover. Compaction, trampling, and root shearing are problems, especially if the range is grazed during wet periods. They can be overcome by maintaining an adequate cover of the important plants and deferring grazing when the soil is wet. Stock water ponds constructed in areas of the Vallers soil sometimes contain salty water.

If drained, the Parnell soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover improve the survival and growth rates of the seedlings. The Vallers soil is suited to only the most salt tolerant, climatically adapted species. Individual trees and shrubs vary in height, density, and vigor, which are affected by the reduced amount of available water resulting from the salts in the soil. Reducing the evaporation rate at the surface improves seedling survival. When the bare soil surface dries, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils generally are unsuited to septic tank absorption fields and buildings because of the ponding and the wetness. Better sites generally are nearby.

The land capability classification of the Parnell soil is IIIw, and that of the Vallers soil is IIIs. The productivity index for spring wheat ranges from 0 to 64, depending on the degree of drainage. The range site of the Parnell soil is Wetland, and that of the Vallers soil is Saline Lowland. The pasture group of the Parnell soil is Wetland, and that of the Vallers soil is Wet.

8—Svea loam. This deep, level, well drained soil is in areas on broad, smooth glacial till plains where runoff flows into shallow drainageways. Individual areas range from about 25 to more than 1,000 acres in size.

Typically, the surface soil is loam about 17 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is about 19 inches thick. It is very dark grayish brown loam in the upper part, dark grayish brown clay loam in the next part, and light olive brown, mottled, calcareous loam in the lower part. It has a layer of cobblestones as much as 4 inches thick. The substratum to a depth of about 60 inches is olive brown, mottled loam. In some places the dark color of the surface soil extends to a depth of only 8 to 16 inches. In other places the subsoil has an accumulation of lime within a depth of 16 inches. In some areas the surface soil and subsoil are fine sandy loam or silt loam.

Included with this soil in mapping are small areas of Buse, Cresbard, Fordville, and Renshaw soils. These soils make up about 10 percent of the unit. Buse soils have a subsoil that is calcareous throughout. They are on knolls. Cresbard soils have a dense, alkali subsoil. Fordville and Renshaw soils have a gravelly substratum. Renshaw soils are on low ridges. Cresbard and Fordville soils are intermingled with areas of the Svea soil. Also included are some stony areas.

Permeability is moderately slow in the Svea soil. Runoff is slow. Available water capacity is high. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. The hazards of soil blowing and water erosion are slight. Maintaining tilth and fertility is the main management concern if cultivated crops are grown. Applying a conservation tillage system and adding the proper amounts and kinds of fertilizer help to maintain tilth, fertility, and the organic matter content. Conservation tillage also helps to control erosion and provides food and cover for resident and migratory wildlife.

Smooth bromegrass, intermediate wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. No major hazards or limitations affect the use of this soil for hay or pasture. Maintaining an adequate cover of the suitable plants helps to control erosion.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

This soil is suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling.

The land capability classification is IIc. The productivity index for spring wheat is 92. The pasture group is Loamy and Silty.

10—Svea loam, 1 to 3 percent slopes. This deep, nearly level, moderately well drained soil is in swales on glacial till plains. Runoff collects in depressions. Individual areas range from about 5 to 250 acres in size.

Typically, the surface soil is black loam about 15 inches thick. The subsoil is about 22 inches thick. It is very dark grayish brown clay loam in the upper part, dark grayish brown clay loam in the next part, and grayish brown, mottled, calcareous loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loam. In some places the dark color of the surface soil extends to a depth of only 8 to 16 inches. In other places the subsoil is calcareous throughout.

Included with this soil in mapping are small areas of Buse, Cresbard, and Tonka soils. These soils make up about 10 percent of the unit. Buse soils have a subsoil that is calcareous throughout. They are on knolls. Cresbard soils have a dense, alkali subsoil. They are on slight rises. Tonka soils are poorly drained. They are in shallow depressions. Also included are some stony areas.

Permeability is moderately slow in the Svea soil. Runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 4 to 6 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. The hazards of soil blowing and water erosion are slight. Maintaining tilth and fertility is the main management concern if cultivated crops are grown. Applying a conservation tillage system and adding the proper amounts and kinds of fertilizer help to maintain tilth, fertility, and the organic matter content. Conservation tillage also helps to control erosion and provides food and cover for resident and migratory wildlife.

Smooth bromegrass, intermediate wheatgrass, alfalfa, and red clover are suitable hay and pasture plants. No major hazards or limitations affect the use of this soil for hay or pasture. Maintaining an adequate cover of the suitable plants helps to control erosion.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

This soil is suited to buildings but is poorly suited to septic tank absorption fields. The moderately slow permeability and the seasonal high water table are limitations in septic tank absorption fields, but installing a mound system helps to overcome these limitations. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements.

The land capability classification is IIc. The productivity index for spring wheat is 92. The pasture group is Overflow and Run-on.

11B—Svea-Buse loams, 3 to 6 percent slopes. These deep, undulating soils are in areas on glacial till plains where runoff flows to drainageways or collects in depressions. The moderately well drained Svea soil is in swales. The well drained Buse soil is on knolls. Individual areas range from about 5 to more than 1,000 acres in size. They are about 55 to 70 percent Svea soil and 20 to 30 percent Buse soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Svea soil has a black loam surface soil about 11 inches thick. The subsoil is about 27 inches thick. In sequence downward, it is very dark grayish brown clay loam, dark brown loam, dark brown clay loam, and light olive brown, calcareous clay loam. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam. In some places the dark color of the surface soil extends to a depth of only 8 to 16 inches. In other places the subsoil is calcareous throughout.

Typically, the Buse soil has a black loam surface layer about 7 inches thick. The subsoil is light yellowish brown, calcareous clay loam about 13 inches thick (fig. 11). The substratum to a depth of about 60 inches is loam. It is olive brown and mottled in the upper part and dark grayish brown in the lower part. In places the dark color of the surface layer extends to a depth of only 3 to 6 inches.

Included with these soils in mapping are small areas of Cresbard, Parnell, Tonka, and Vallers soils. These

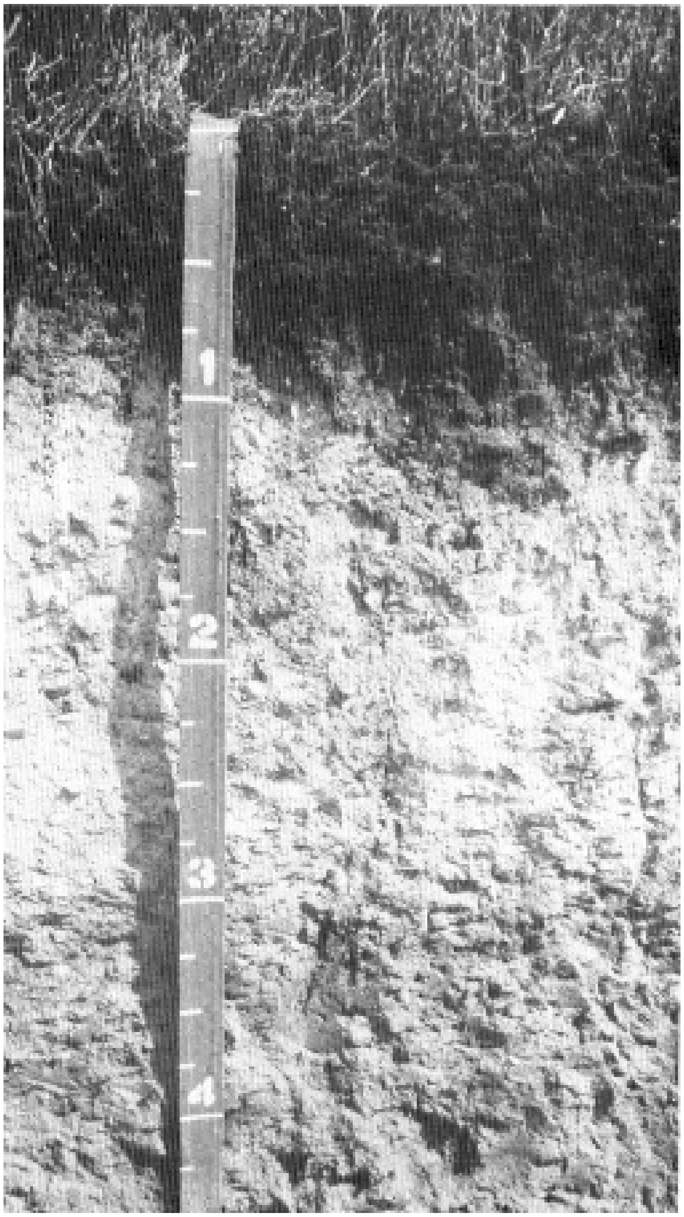

Figure 11.—A profile of Buse loam, which has a dark surface layer and a light colored subsoil. Depth is marked in feet.

included soils make up about 10 percent of the unit. Cresbard soils have a dense, alkali subsoil. They are intermingled with areas of the Svea soil. Parnell soils are very poorly drained, and Tonka and Vallers soils are poorly drained. Parnell and Tonka soils are in depressions. Vallers soils are in drainageways and on the rims of depressions. Also included are some narrow, steep areas adjacent to drainageways and some stony areas.

Permeability is moderately slow in the Svea and Buse soils. Runoff is slow on the Svea soil and medium on the Buse soil. Available water capacity is high in both soils. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to small grain and sunflowers. The hazard of soil blowing on the Buse soil and the hazard of water erosion on both soils are moderate. Grassed waterways in areas where runoff concentrates help to control gullying. Field windbreaks, a conservation tillage system, stripcropping, and buffer strips help to control soil blowing and water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Smooth bromegrass, intermediate wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. No major hazards or limitations affect the use of these soils for hay or pasture. Maintaining an adequate cover of the suitable plants helps to control soil blowing and water erosion.

The Svea soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. The Buse soil is suited only to the most drought tolerant species. Optimum growth, survival, and vigor are unlikely. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The Buse soil is suited to septic tank absorption fields, but the Svea soil is poorly suited. The moderately slow permeability in the Buse soil is a limitation, but it can be overcome by enlarging the field. The moderately slow permeability and the seasonal high water table in the Svea soil are limitations, but installing a mound system helps to overcome these limitations.

These soils are suited to buildings. The shrink-swell potential is a limitation, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements in areas of the Svea soil.

The land capability classification of the Svea soil is IIe, and that of the Buse soil is IIIe. The productivity index for spring wheat is 73. The pasture group of the Svea soil is Loamy and Silty, and that of the Buse soil is Thin Upland.

11C—Svea-Buse loams, 6 to 9 percent slopes. These deep, gently rolling soils are in areas on glacial till plains where runoff flows to drainageways or collects in depressions. The moderately well drained Svea soil is in swales. The well drained Buse soil is on knolls and ridges. Individual areas range from about 5 to 400 acres in size. They are about 55 to 65 percent Svea soil and 25 to 35 percent Buse soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Svea soil has a black loam surface soil about 14 inches thick. The subsoil is about 26 inches thick. It is very dark grayish brown clay loam in the upper part, dark brown loam in the next part, and brown, calcareous loam in the lower part. The substratum to a depth of about 60 inches is light olive brown loam. In some places the dark color of the surface soil extends to a depth of only 8 to 16 inches. In other places the subsoil is calcareous throughout.

Typically, the Buse soil has a very dark gray loam surface layer about 8 inches thick. The subsoil is grayish brown, calcareous loam about 10 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, mottled loam. In some places the dark color of the surface layer extends to a depth of only 3 to 6 inches. In other places the surface layer and subsoil are silt loam or very fine sandy loam.

Included with these soils in mapping are small areas of Cresbard, Parnell, Playmoor, Tonka, and Vallers soils. These included soils make up about 10 percent of the unit. Cresbard soils have a dense, alkali subsoil. They are intermingled with areas of the Svea soil. Parnell soils are very poorly drained, and Playmoor, Tonka, and Vallers soils are poorly drained. Parnell and Tonka soils are in depressions. Playmoor and Vallers soils are in drainageways and on the rims of depressions. Also included are some steep, narrow areas adjacent to drainageways and some stony areas.

Permeability is moderately slow in the Svea and Buse soils. Runoff is medium on the Svea soil and rapid on the Buse soil. Available water capacity is high in both soils. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to small grain and sunflowers. The hazard of soil blowing is moderate on the Buse soil, and the hazard of water erosion is severe on both soils. Grassed waterways in areas where runoff concentrates help to control gullying. Field windbreaks, a conservation tillage system, and stripcropping help to control soil blowing and water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Smooth bromegrass, intermediate wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants on these soils. Water erosion and soil blowing are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants reduces these hazards.

The Svea soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Buse soil is suited only to the most drought tolerant species. Optimum growth, survival, and vigor are unlikely. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The Buse soil is suited to septic tank absorption fields, but the Svea soil is poorly suited. The moderately slow permeability of the Buse soil is a limitation, but it can be overcome by enlarging the field. The moderately slow permeability and seasonal high water table in the Svea soil are limitations, but installing a mound system helps to overcome these limitations.

These soils are suited to buildings. The shrink-swell potential is a limitation, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements in areas of the Svea soil.

The land capability classification of the Svea soil is IIe, and that of the Buse soil is IVe. The productivity index for spring wheat is 64. The pasture group of the Svea soil is Loamy and Silty, and that of the Buse soil is Thin Upland.

12B—Barnes-Svea loams, 3 to 6 percent slopes. These deep, gently sloping, well drained soils are in areas on glacial till plains where runoff flows to drainageways or collects in depressions. In most areas the surface has been smoothed by flowing water. The Barnes soil is on rises. The Svea soil is in swales. Individual areas range from about 5 to 300 acres in size. They are about 40 to 50 percent Barnes soil and 40 to 50 percent Svea soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 19 inches thick. It is very dark grayish brown in the upper part, dark brown in the next part, and grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loam. In places the subsoil is calcareous throughout. In some areas south of the Sheyenne River, the soil has a thin layer of sand, gravel, or cobblestones between the subsoil and the substratum.

Typically, the Svea soil has a black loam surface soil about 10 inches thick. The subsoil is about 24 inches thick. In sequence downward, it is very dark brown loam; dark brown loam; light yellowish brown, calcareous clay loam; and light olive brown, calcareous clay loam. The substratum to a depth of about 60 inches is olive brown, mottled loam. In some places the subsoil is calcareous throughout. In other places it is mottled. In some areas south of the Sheyenne River, the soil has a thin layer of cobblestones between the subsoil and the substratum.

Included with these soils in mapping are small areas of Cresbard, Renshaw, and Tonka soils. These included soils make up about 10 percent of the unit. Cresbard soils have a dense, alkali subsoil. They are intermingled with areas of the Barnes and Svea soils. Renshaw soils have a gravelly substratum. They are on ridges. Tonka soils are poorly drained. They are in depressions. Also included are some long and narrow, steep areas of stony soils adjacent to drainageways.

Permeability is moderately slow in the Barnes and Svea soils. Runoff is medium on the Barnes soil and slow on the Svea soil. Available water capacity is high in both soils. Tilth is good.

Most areas are used for cultivated crops. These soils are suited to small grain and sunflowers. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. Grassed waterways in areas where runoff concentrates help to control gullying. A system of conservation tillage helps to control water erosion. It also helps to provide food and cover for resident and migratory wildlife.

Smooth bromegrass, intermediate wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. No major hazards or limitations affect the use of these soils for hay and pasture. Maintaining an adequate cover of the suitable plants helps to control water erosion.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Svea soil is suited to all species. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

These soils are suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling.

The land capability classification is IIe. The productivity index for spring wheat is 84. The pasture group is Loamy and Silty.

13D—Buse-Svea loams, 9 to 15 percent slopes. These deep, rolling, well drained soils are in areas on glacial till plains where runoff flows to drainageways or collects in depressions. The Buse soil is on knolls and ridges. The Svea soil is in swales (fig. 12). Individual areas range from about 5 to 150 acres in size. They are about 55 to 70 percent Buse soil and 25 to 40 percent Svea soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Buse soil has a black loam surface layer about 9 inches thick. The subsoil is light brownish gray, calcareous loam about 13 inches thick. The substratum to a depth of about 60 inches is light olive brown loam. In some places the dark color of the surface layer extends to a depth of only 3 to 6 inches. In other places, particularly south of the Sheyenne River, the substratum is sandy loam. In some areas the upper part of the subsoil is noncalcareous.

Typically, the Svea soil has a black loam surface soil about 11 inches thick. The subsoil is about 25 inches thick. It is very dark grayish brown loam in the upper part and light brownish gray, calcareous clay loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loam. In places the subsoil has accumulated lime within a depth of 16 inches.

Included with these soils in mapping are small areas of Cresbard, Parnell, Sioux, Tonka, and Zell soils. These included soils make up about 10 percent of the unit. Cresbard soils have a dense, alkali subsoil. They are intermingled with areas of the Svea soil. Parnell and Tonka soils are in depressions. Parnell soils are very poorly drained, and Tonka soils are poorly drained. Sioux and Zell soils are intermingled with areas of the Buse soil. Sioux soils have a gravelly loamy sand substratum. Zell soils contain less clay and sand than the Buse and Svea soils. Also included are some long and narrow, steep areas of stony soils adjacent to drainageways.

Permeability is moderately slow in the Buse and Svea soils. Runoff is rapid on the Buse soil and medium on the Svea soil. Available water capacity is high in both soils. Tilth is good.

Most areas are used for hay or range. Some are used for cultivated crops, grazeable woodland, or wildlife habitat. These soils are best suited to pasture, hay, and range. They generally are unsuited to cultivated crops because of the susceptibility to soil blowing and water erosion and the slope. The hazard of soil blowing is moderate on the Buse soil, and the hazard of water erosion is severe on both soils.

The important native forage plants on these soils are needleandthread, western wheatgrass, green needlegrass, and little bluestem. Alfalfa, sweetclover, wheatgrasses, and smooth bromegrass are suitable hay and pasture plants. Water erosion and soil blowing are hazards, especially if the range or pasture is overgrazed. They can be controlled by maintaining an adequate plant cover. Gullies can form along livestock trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

The Buse soil is generally unsuited to the trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be planted for esthetic purposes or for wildlife if special treatment, such as hand planting or scalp planting, is applied. The Svea soil is suited to nearly all of the climatically adapted species. Eliminating grasses and weeds before the trees and

Figure 12.—An area of Buse-Svea loams, 9 to 15 percent slopes. The Buse soil is on the light colored knolls and ridges, and the Svea soil is in the dark swales.

shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

These soils are suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The buildings and absorption fields should be designed so that they conform to the natural slope of the land.

The land capability classification of the Buse soil is Vle, and that of the Svea soil is IVe. The productivity index for spring wheat is 0. The range site of the Buse soil is Thin Upland, and that of the Svea soil is Silty. The pasture group of the Buse soil is Thin Upland, and that of the Svea soil is Loamy and Silty.

13E—Buse-Svea loams, 15 to 25 percent slopes. These deep, hilly, well drained soils are on glacial till plains and moraines and in stream valleys. Runoff flows to drainageways and streams. The Buse soil is on knolls and ridges. The Svea soil is in swales. Individual areas range from about 15 to 400 acres in size. They are about 45 to 65 percent Buse soil and 25 to 45 percent Svea soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Buse soil has a very dark gray loam surface layer about 8 inches thick. The subsoil is grayish brown, calcareous loam about 14 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In some places the dark color of the surface layer extends to a depth of only 3 to 6 inches. In other places the surface layer is sandy loam. In some areas the subsoil is noncalcareous in the upper few inches. In a few areas, particularly south of the Sheyenne River, the substratum is sandy loam or has thin lenses of sand, gravel, or silt.

Typically, the Svea soil has a black loam surface soil about 16 inches thick. The subsoil is about 23 inches thick. It is very dark grayish brown loam in the upper part, olive brown clay loam in the next part, and light olive brown clay loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loam. In places the surface soil is fine sandy loam.

Included with these soils in mapping are small areas of LaDelle, Renshaw, and Sioux soils. These included soils make up about 10 percent of the unit. LaDelle soils are moderately well drained. They are in drainageways. Renshaw soils have a very gravelly substratum. They are on side slopes. Sioux soils have a gravelly substratum. They are intermingled with areas of the Buse soil. Also included are some long and narrow areas of stony soils.

Permeability is moderately slow in the Buse and Svea soils. Runoff is very rapid on the Buse soil and rapid on the Svea soil. Available water capacity is high in both soils.

Most areas are used for range or wooded pasture. A few areas are used for cultivated crops. These soils are best suited to wildlife habitat and range. They are generally unsuited to cultivated crops and hay because of soil blowing, water erosion, and the slope. The hazard of soil blowing is moderate on the Buse soil, and the hazard of water erosion is severe on both soils.

The important native forage plants on these soils are western wheatgrass, green needlegrass, needleandthread, and little bluestem. Water erosion and soil blowing are hazards, especially if the range is overgrazed. They can be controlled by maintaining an adequate cover of the important plants. Gullies can form along livestock trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

These soils generally are unsuited to the trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be planted for esthetic purposes or for wildlife if special treatment, such as hand planting or scalp planting, is applied. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

These soils generally are unsuited to buildings and septic tank absorption fields because of the slope. Better sites generally are nearby.

The land capability classification of the Buse soil is VIIe, and that of the Svea soil is VIe. The productivity index for spring wheat is 0. The range site of the Buse soil is Thin Upland, and that of the Svea soil is Silty.

14D—Sioux-Barnes loams, 6 to 15 percent slopes. These deep, gently rolling and rolling soils are in areas on eskers where runoff flows to drainageways. The excessively drained Sioux soil is on ridges and knobs. The well drained Barnes soil is on side slopes. Individual areas range from about 5 to 250 acres in size. They are about 50 to 70 percent Sioux soil and 20 to 40 percent Barnes soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Sioux soil has a black loam surface layer about 8 inches thick. The next layer is very dark grayish brown very gravelly loam about 4 inches thick. The substratum to a depth of about 60 inches is dark brown very gravelly sand. In some places the substratum is dominantly gravel-size shale fragments. In other places the soil has a thin subsoil.

Typically, the Barnes soil has a black loam surface layer about 8 inches thick. The subsoil is loam about 15 inches thick. It is dark brown in the upper part and grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loam. In some places, particularly south of the Sheyenne River, the substratum is sandy loam or fine sandy loam. In other places the subsoil is calcareous throughout.

Included with these soils in mapping are small areas of Hamerly and Svea soils. These included soils make up about 10 percent of the unit. Svea soils are dark to a depth of more than 16 inches. They are in swales. Hamerly soils are somewhat poorly drained. They are on flats. Also included are some long and narrow, steep areas of stony soils adjacent to drainageways.

Permeability is very rapid in the Sioux soil and moderately slow in the Barnes soil. Runoff is slow on the Sioux soil and rapid on the Barnes soil. Available water capacity is very low in the Sioux soil and high in the Barnes soil.

Most areas are used for native hay, range, or wildlife habitat. Some are used for cultivated crops. These soils are best suited to range, pasture, and hay. They are generally unsuited to cultivated crops because of the droughtiness of the Sioux soil, the slope, and the susceptibility to water erosion. The hazard of soil blowing is slight, and the hazard of water erosion is severe.

The important native forage plants on these soils are blue grama, needleandthread, western wheatgrass, and green needlegrass. Alfalfa, sweetclover, wheatgrasses, and smooth bromegrass are suitable hay and pasture plants. Water erosion and the droughtiness of the Sioux soil are problems, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas of the Sioux soil. Maintaining an adequate cover of plants at a height that traps snow helps to overcome droughtiness, control water erosion, and prevent denuding. Gullies can form along livestock trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

The Sioux soil generally is unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings, but the Barnes soil is suited to nearly all species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

The Barnes soil is suited to septic tank absorption fields, but the Sioux soil is poorly suited. The moderately slow permeability of the Barnes soil is a limitation, but it can be overcome by enlarging the field. Because of the very rapid permeability, the Sioux soil readily absorbs but does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water. Installing a mound system helps to prevent this pollution.

These soils are suited to buildings. In areas of the Sioux soil, the sides of shallow excavations, such as those for basements, tend to cave in unless they are shored. The buildings should be designed so that they conform to the natural slope of the land. The moderate shrink-swell potential of the Barnes soil is a limitation, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling.

The land capability classification of the Sioux soil is VIs, and that of the Barnes soil is IVe. The productivity index for spring wheat is 0. The range site of the Sioux soil is Very Shallow, and that of the Barnes soil is Silty. The pasture group of the Sioux soil is Very Shallow to Gravel, and that of the Barnes soil is Loamy and Silty.

15—Borup silt loam. This deep, level, poorly drained, highly calcareous soil is on flats, in drainageways, and adjacent to depressions on glacial lake plains. It is subject to rare flooding. Individual areas range from about 5 to 100 acres in size.

Typically, the surface soil is black silt loam about 12 inches thick. The subsoil is dark gray, calcareous silt loam about 10 inches thick. The next layer is gray silt loam about 12 inches thick. The upper part of the substratum is grayish brown, mottled silt loam. The lower part to a depth of about 60 inches is light olive gray, mottled silty clay loam. In some places the substratum is brown or olive brown. In other places the surface layer and subsoil are silty clay loam. In a few areas the substratum is fine sand or sand below a depth of 40 inches.

Included with this soil in mapping are small areas of the somewhat poorly drained Divide soils on rises. These soils have sand and gravel within a depth of 40 inches. They make up about 15 percent of the unit.

Permeability is moderate in the Borup soil. Runoff is very slow. Available water capacity is high. A seasonal high water table is at a depth of 1.0 to 2.5 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. Soil blowing and wetness are the main management concerns if cultivated crops are grown. A drainage system improves the suitability for crops; however, locating drainage outlets generally is difficult. A system of conservation tillage, field windbreaks, stripcropping, and buffer strips help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

Meadow fescue, alsike clover, reed canarygrass, and creeping foxtail are suitable hay and pasture plants on this soil. Soil blowing is a hazard, especially if the pasture is overgrazed. This hazard can be reduced by maintaining an adequate cover of the suitable plants.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields and buildings because of the wetness and the flooding. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat ranges from 43 to 70, depending on the degree of drainage. The pasture group is Wet.

17—Borup silt loam, saline. This deep, level, poorly drained, moderately saline, highly calcareous soil is on flats, in drainageways, and adjacent to depressions on glacial lake plains. It is subject to rare flooding. Individual areas range from about 10 to 250 acres in size.

Typically, the surface soil is silt loam about 11 inches thick. It has threads of salts. It is black in the upper part and very dark gray in the lower part. The subsoil is calcareous silt loam about 19 inches thick. It is dark gray in the upper part and gray in the lower part. The upper part of the substratum is olive, mottled very fine sandy loam. The lower part to a depth of about 60 inches is olive gray, mottled silt loam. In some places the surface soil is silty clay loam. In other places the subsoil and substratum are silty clay loam.

Included with this soil in mapping are small areas of Divide, Miranda, and Parnell soils. These soils make up about 20 percent of the unit. Divide and Miranda soils are on slight rises. Divide soils have sand and gravel within a depth of 40 inches. Miranda soils have a dense, alkali subsoil. Parnell soils are very poorly drained. They are in depressions.

Permeability is moderate in the Borup soil. Runoff is very slow. Available water capacity is moderate. It is restricted by the salts in the soil. A seasonal high water table is within a depth of 1 foot. Tilth is good.

Most areas are used for native hay or range. A few areas are used for cultivated crops. This soil is best suited to wildlife habitat and range. It is poorly suited to cultivated crops because of the wetness, the salinity, and the susceptibility to soil blowing. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The wetness in undrained areas delays or prevents tillage and seeding in some years. Fallowing should be avoided because it results in the accumulation of salts in the surface layer. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing and provides food and cover for resident and migratory wildlife.

The important native forage plants on this soil are western wheatgrass, Nuttall alkaligrass, and inland saltgrass. Tall wheatgrass is a suitable hay or pasture plant. The high content of salts, the limited available water capacity, compaction, trampling, and root shearing are problems, especially if the range is grazed during wet periods. They can be overcome by maintaining an adequate cover of the important salt tolerant plants and by deferring grazing when the soil is wet. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil is suited to only the most salt tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the reduced amount of available water resulting from the salts in the soil. Reducing the evaporation rate at the surface improves seedling survival. When the bare soil surface dries, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields and buildings because of the wetness and the flooding. Better sites generally are nearby.

The land capability classification is IIIs. The productivity index for spring wheat ranges from 0 to 44, depending on the degree of drainage. The range site is Saline Lowland. The pasture group is Saline.

20—Hamerly loam, 0 to 2 percent slopes. This deep, level and nearly level, somewhat poorly drained, highly calcareous soil is on flats on glacial till plains. Runoff collects in depressions. Individual areas range from about 5 to 150 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsoil is about 17 inches thick. It is calcareous. It is very dark gray loam in the upper part and light brownish gray clay loam in the lower part. The substratum to a depth of about 60 inches is light olive brown and light brownish gray, mottled loam. In some places the upper part of the subsoil is noncalcareous. In other places the upper part of the substratum is light brownish gray. In some areas the surface layer is clay loam. In a few areas the soil is moderately saline.

Included with this soil in mapping are small areas of Barnes, Cresbard, Parnell, and Tonka soils. These soils make up about 10 percent of the unit. Barnes soils are well drained. They are on rises. Cresbard soils have a dense, alkali subsoil. They are intermingled with areas of the Hamerly soil. Parnell soils are very poorly drained. They are in deep depressions. Tonka soils have a light colored subsurface layer. They are in shallow depressions. Also included are some stony areas.

Permeability is moderately slow in the Hamerly soil. Runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 2 to 4 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The seasonal high water table delays seeding in some years, but crops can be grown each year. A system of conservation tillage, field windbreaks, cover crops, stripcropping, and buffer strips help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

Big bluestem, indiangrass, sweetclover, and red clover are suitable hay and pasture plants on this soil. Soil blowing is a hazard, especially if the range is overgrazed. This hazard can be reduced by maintaining an adequate cover of the suitable plants.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings but is poorly suited to septic tank absorption fields. The moderately slow permeability and the seasonal high water table are limitations in septic tank absorption fields, but installing a mound system helps to overcome these limitations. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements.

The land capability classification is IIe. The productivity index for spring wheat is 82. The pasture group is Limy Subirrigated.

20B—Hamerly loam, 2 to 5 percent slopes. This deep, nearly level and undulating, somewhat poorly drained, highly calcareous soil is in swales on glacial till plains. Runoff collects in depressions. Individual areas range from about 5 to 250 acres in size.

Typically, the surface layer is black loam about 7 inches thick. The subsoil is about 26 inches thick. It is light yellowish brown clay loam in the upper part and olive brown, mottled loam in the lower part. The substratum to a depth of about 60 inches is olive brown and olive gray, mottled loam. In some places the upper part of the subsoil is noncalcareous. In other places the upper part of the substratum is light brownish gray. In a few areas the soil is moderately saline.

Included with this soil in mapping are small areas of Barnes, Buse, Cresbard, Miranda, and Tonka soils. These soils make up about 20 percent of the unit. Barnes and Buse soils are well drained. Barnes soils are on side slopes and Buse soils are on shoulder slopes. Cresbard and Miranda soils have a dense, alkali subsoil. Cresbard soils are on rises. Miranda soils are intermingled with areas of the Hamerly soil. Tonka soils are poorly drained. They are in depressions. Also included are some stony areas.

Permeability is moderately slow in the Hamerly soil. Runoff is medium. Available water capacity is high. A seasonal high water table is at a depth of 2 to 4 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. The seasonal high water table delays seeding in some years, but crops can be grown each year. The hazards of soil blowing and water erosion are moderate. Establishing grassed waterways in areas where runoff concentrates helps to control gullying. A system of conservation tillage, field windbreaks, stripcropping, cover crops, and buffer strips help to control water erosion and soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

Big bluestem, indiangrass, sweetclover, and red clover are suitable hay and pasture plants on this soil. Water erosion and soil blowing are hazards, especially if the range is overgrazed. They can be controlled by maintaining an adequate cover of the suitable plants.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings but is poorly suited to septic tank absorption fields. The moderately slow permeability and the seasonal high water table are limitations in septic tank absorption fields, but installing a mound system helps to overcome these limitations. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements.

The land capability classification is IIe. The productivity index for spring wheat is 72. The pasture group is Limy Subirrigated.

21—Vallers and Hamerly loams, saline, 0 to 3 percent slopes. These deep, level and nearly level, moderately saline, highly calcareous soils are in drainageways and on flats on glacial till plains. Runoff flows to drainageways or collects in depressions. The poorly drained Vallers soil is on flats and in swales. It is subject to rare flooding. The somewhat poorly drained Hamerly soil is on slight rises. Any one area can consist of all Vallers soil, all Hamerly soil, or any combination of both soils. Individual areas range from about 5 to 300 acres in size.

Typically, the Vallers soil has a black loam surface layer about 9 inches thick. This layer has threads of salts. The next layer is dark gray and gray loam about 6 inches thick. The subsoil is light brownish gray, calcareous, mottled loam about 9 inches thick. The upper part of the substratum is light brownish gray, mottled loam. The lower part to a depth of about 60 inches is grayish brown, mottled clay loam. In some places the surface layer is silt loam or silty clay loam. In other places the soil is nonsaline or is only slightly saline.

Typically, the Hamerly soil has a very dark gray loam surface layer about 9 inches thick. This layer has threads of salts. The subsoil is grayish brown, calcareous clay loam about 12 inches thick. The substratum to a depth of about 60 inches is olive brown and grayish brown, mottled clay loam. In places the soil is nonsaline or is only slightly saline.

Included with these soils in mapping are small areas of Cresbard, Parnell, Playmoor, and Tonka soils. These included soils make up about 15 percent of the unit. Cresbard soils have a dense, alkali subsoil. They are on rises above the Vallers and Hamerly soils. Parnell and Tonka soils are in depressions. Parnell soils are very poorly drained. Tonka soils have a light colored subsurface layer. Playmoor soils have a silty clay loam surface layer. They surround depressions. Also included are some stony areas.

Permeability is moderately slow in the Vallers and Hamerly soils. Runoff is slow. Available water capacity is moderate. It is restricted by salts in the soils. A seasonal high water table is within a depth of 1 foot in the Vallers soil and at a depth of 2 to 4 feet in the Hamerly soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are poorly suited to small grain and sunflowers. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. Soil blowing, wetness, and salinity are the main management concerns if cultivated crops are grown. A drainage system improves the suitability for cultivated crops; however, drainage outlets are difficult to locate. The degree of salinity can increase in improperly drained areas. Salt-tolerant crops should be selected for planting, and summer fallow and deep tillage should be avoided. A system of conservation tillage helps to control soil blowing and minimizes the accumulation of salts in the surface layer. It also provides food and cover for resident and migratory wildlife.

The important native forage plants on these soils are western wheatgrass, Nuttall alkaligrass, and inland saltgrass. Tall wheatgrass, slender wheatgrass, alsike clover, and sweetclover are suitable hay and pasture plants. The high content of salts, the limited available water capacity, compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed during wet periods. They can be overcome by maintaining an adequate plant cover and by deferring grazing when the soil is wet. Stock water ponds constructed in areas of these soils frequently contain salty water.

These soils are suited to only the most salt tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the reduced amount of available water resulting from the salts in the soils. Reducing the evaporation rate at the surface improves seedling survival. When the bare soil surface dries, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils generally are unsuited to septic tank absorption fields and buildings because of the wetness and the flooding. Better sites generally are nearby.

The land capability classification is IIIs. The productivity index for spring wheat ranges from 35 to 49, depending on the degree of drainage. The range site is Saline Lowland. The pasture group is Saline.

22—Vallers loam, 0 to 3 percent slopes. This deep, level and nearly level, poorly drained, highly calcareous soil is on flats on glacial till plains. Runoff collects in depressions. Individual areas range from about 5 to 75 acres in size.

Typically, the surface layer is black loam about 8 inches thick (fig. 13). The subsoil is about 15 inches thick. It is calcareous and mottled. It is very dark gray loam in the upper part and light brownish gray sandy clay loam in the lower part. The substratum to a depth of about 60 inches is light brownish gray and light olive brown, mottled loam. In places the surface layer and substratum are silty clay loam. In a few areas the upper part of the substratum is olive brown. In some areas the soil is moderately saline.

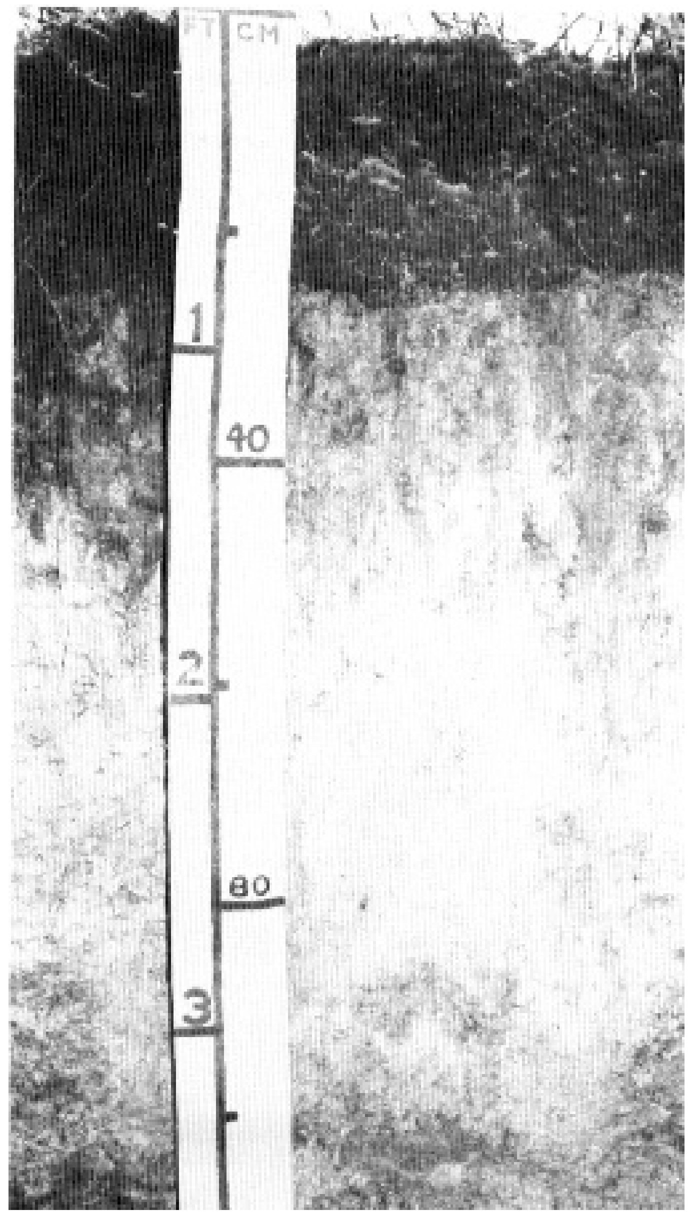

Figure 13.—A profile of Vallers loam, 0 to 3 percent slopes. Because of cultivation, the boundary between the surface layer and the subsoil is abrupt.

Included with this soil in mapping are small areas of Playmoor, Svea, and Tonka soils. These soils make up about 20 percent of the unit. Playmoor soils have a surface soil that is thicker than that of the Vallers soil. They are in swales. Svea soils are moderately well drained. They are on rises. Tonka soils are poorly drained. They are in depressions. Also included are some stony areas.

Permeability is moderately slow in the Vallers soil. Runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 1.0 to 2.5 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. Wetness and soil blowing are the main management concerns if cultivated crops are grown. A drainage system improves the suitability for crops; however, drainage outlets generally are difficult to locate. The degree of salinity can increase in improperly drained areas. A system of conservation tillage helps to control soil blowing and reduces the salinity in the surface layer. It also provides food and cover for resident and migratory wildlife.

Reed canarygrass, creeping foxtail, meadow fescue, and alsike clover are suitable hay and pasture plants on this soil. Compaction, trampling, and root shearing are problems if the range is grazed during wet periods. They can be overcome by deferring grazing when the soil is wet.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields and buildings because of the wetness. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat ranges from 42 to 70, depending on the degree of drainage. The pasture group is Wet.

23—Cavour-Cresbard loams, 0 to 3 percent slopes. These deep, level and nearly level, moderately well drained, alkali soils are in areas on glacial till plains where runoff flows to drainageways. The Cavour soil is in swales. The Cresbard soil in on slight rises. Individual areas range from about 5 to 100 acres in size. They are about 45 to 65 percent Cavour soil and 20 to 40 percent Cresbard soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Cavour soil has a black loam surface layer about 5 inches thick. The subsurface layer is very dark gray loam about 2 inches thick. The subsoil is about 23 inches thick. It is black clay in the upper part, very dark grayish brown clay in the next part, and dark grayish brown clay loam in the lower part. The next layer is grayish brown loam about 12 inches thick. The substratum to a depth of about 60 inches is dark grayish brown loam. In some places salts are within a depth of 16 inches. In other places, particularly south of the Sheyenne River, the subsoil and substratum are sandy loam or fine sandy loam. In some areas the surface layer is silt loam.

Typically, the Cresbard soil has a black loam surface layer about 8 inches thick. The next 3 inches is very dark grayish brown clay loam that has very dark brown silt coatings. The subsoil is about 19 inches thick. It is very dark grayish brown and dark brown clay loam in the upper part and grayish brown, dark grayish brown, and light brownish gray, mottled loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loam. In places the upper part of the subsoil has been mixed with the surface layer by tillage.

Included with these soils in mapping are small areas of Barnes, Hamerly, Playmoor, and Svea soils and the saline Vallers soils. These included soils make up about 15 percent of the unit. They do not have a dense, alkali subsoil. Barnes soils are on rises above the Cresbard soil. Svea soils are in swales. Hamerly and Vallers soils have a subsoil that has accumulated lime. They are on flats. Playmoor soils have a silty clay loam surface layer. They are in swales below the Cavour soil. Also included are some stony areas.

Permeability is slow in the Cavour soil and moderately slow in the Cresbard soil. Runoff is slow on both soils. Available water capacity is moderate. The dense, alkali subsoil restricts the depth to which roots can penetrate. A seasonal high water table is at a depth of 4 to 6 feet. Tilth is fair.

Most areas are used for cultivated crops. These soils are suited to small grain and sunflowers. The hazards of soil blowing and water erosion are slight. Improving root penetration in the dense, alkali subsoil and improving or maintaining tilth are the main management concerns if cultivated crops are grown. Crops have an uneven appearance because of moisture stress in most years. The uneven appearance is most noticeable as the crops near maturity. Adding plant residue and growing green manure crops improve tilth and increase the rate of water infiltration. Growing deep-rooted legumes, such as alfalfa, improves root penetration in the dense subsoil. Timely tillage improves tilth. The soils should not be tilled when they are too wet or too dry. The surface tends to puddle when wet and becomes cloddy as it dries. A conservation tillage system helps to control erosion and provides food and cover for resident and migratory wildlife.

Smooth bromegrass, Russian wildrye, alfalfa, and sweetclover are suitable hay and pasture plants on these soils. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the suitable plants helps to prevent denuding.

The Cavour soil is suited to only a few of the drought- and salt tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Cresbard soil is suited to many species. Supplemental watering helps to ensure the survival of seedlings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the restricted root development in the dense, alkali subsoil and the limited available water capacity resulting from the salts in the soils. Eliminating weeds and grasses before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

These soils are suited to buildings but are poorly suited to septic tank absorption fields. The moderately slow or slow permeability and the seasonal high water table are limitations in septic tank absorption fields, but installing a mound system helps to overcome these limitations. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements.

The land capability classification of the Cavour soil is IVs, and that of the Cresbard soil is IIIs. The productivity index for spring wheat is 47. The pasture group of the Cavour soil is Claypan, and that of the Cresbard soil is Clayey Subsoil.

24—Svea-Cresbard loams, 0 to 3 percent slopes. These deep, level and nearly level, moderately well drained soils are in areas on glacial till plains where runoff collects in depressions. The Svea soil is on rises. The alkali Cresbard soil is in swales. Individual areas range from about 5 to 350 acres in size. They are about 45 to 60 percent Svea soil and 40 to 50 percent Cresbard soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Svea soil has a black loam surface soil about 11 inches thick. The subsoil is about 24 inches thick. It is very dark gray loam in the upper part, very dark grayish brown and dark brown clay loam in the next part, and light yellowish brown, calcareous loam in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam. In some places the dark color of surface soil extends to a depth of only 8 to 16 inches. In other places the upper part of the subsoil is calcareous.

Typically, the Cresbard soil has a black loam surface layer about 9 inches thick. The subsurface layer is very dark gray loam about 2 inches thick. The next 2 inches is very dark gray clay loam that has dark gray silt coatings. The subsoil is clay loam about 15 inches thick. It is black in the upper part, very dark grayish brown in the next part, and light brownish gray and calcareous in the lower part. The substratum to a depth of about 60 inches is grayish brown and light olive brown, mottled clay loam. In places the soil does not have silt coatings below the subsurface layer.

Included with these soils in mapping are small areas of Buse, Tonka, and Vallers soils. These included soils make up about 5 percent of the unit. Buse soils are well drained. They are on knolls. Tonka and Vallers soils are poorly drained. Tonka soils are in depressions. Vallers soils are on flats. Also included are some stony areas.

Permeability is moderately slow in the Svea and Cresbard soils. Runoff is slow. Available water capacity is moderate in the Cresbard soil and high in the Svea soil. The dense, alkali subsoil of the Cresbard soil restricts the depth to which roots can penetrate. A seasonal high water table is at a depth of 4 to 6 feet in both soils. Tilth is fair.

Most areas are used for cultivated crops. These soils are suited to small grain and sunflowers. The hazards of soil blowing and water erosion are slight. Improving root penetration in the dense subsoil of the Cresbard soil and maintaining or improving tilth in both soils are the main management concerns if cultivated crops are grown. In some years crops have an uneven appearance because of moisture stress. The uneven appearance is most noticeable as the crops near maturity. Adding plant residue and growing green manure crops improve tilth and increase the rate of water infiltration. Growing deep-rooted legumes, such as alfalfa, improves root penetration in the dense, alkali subsoil of the Cresbard soil. A conservation tillage system helps to control erosion and provides food and cover for resident and migratory wildlife.

Smooth bromegrass, Russian wildrye, alfalfa, and sweetclover are suitable hay and pasture plants. No major hazards or limitations affect the use of these soils for hay or pasture. Maintaining an adequate cover of the suitable plants helps to control erosion.

The Cresbard soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Svea soil is suited to all species. It has no critical limitations. Individual trees and shrubs on the Cresbard soil vary in height, density, and vigor, which are affected by restricted root development in the dense subsoil and the reduced amount of available water resulting from the salts in the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

These soils are suited to buildings but are poorly suited to septic tank absorption fields. The moderately slow permeability and the seasonal high water table are limitations in septic tank absorption fields, but installing a mound system helps to overcome these limitations. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements.

The land capability classification of the Svea soil is IIc, and that of the Cresbard soil is IIIs. The productivity index for spring wheat is 85. The pasture group of the Svea soil is Overflow and Run-on, and that of the Cresbard soil is Clayey Subsoil.

25—Miranda-Cavour loams, 0 to 3 percent slopes. These deep, level and nearly level, alkali soils are in areas on glacial till plains where runoff flows to drainageways. The somewhat poorly drained Miranda soil is on flats. The moderately well drained Cavour soil is on rises. Individual areas range from about 5 to 150 acres in size. They are about 30 to 50 percent Miranda soil and 30 to 50 percent Cavour soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Miranda soil has a black loam surface layer about 3 inches thick. This layer is covered by organic material about 2 inches thick. The subsurface layer is very dark gray silt loam about 3 inches thick. The subsoil is about 18 inches thick. It is black clay loam in the upper part, black loam in the next part, and dark grayish brown and light brownish gray, mottled, calcareous loam in the lower part. It has masses of salts and gypsum below a depth of 10 inches. The substratum is olive gray, dark olive gray, light gray, and very dark gray, mottled clay loam about 24 inches thick. Below this is very dark gray, soft shale bedrock. In places the soft bedrock is at a depth of more than 60 inches.

Typically, the Cavour soil has a black loam surface layer about 5 inches thick. The subsurface layer is very dark gray loam about 3 inches thick. The subsoil is about 23 inches thick. It is black and dark brown clay in the upper part and light yellowish brown and light olive brown, calcareous clay loam in the lower part. The next layer is light yellowish brown and light olive brown, calcareous clay loam about 13 inches thick. It has masses of gypsum. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam. In some places the soil has silt coatings below the subsurface layer. In other places the surface layer is silt loam.

Included with these soils in mapping are small areas of Playmoor and Svea soils and the saline and nonsaline Hamerly and Vallers soils. These included soils make up about 20 percent of the unit. Hamerly and Vallers soils have a subsoil that has accumulated lime. Hamerly soils are on slight rises. Vallers soils are intermingled with areas of the Miranda soil. Playmoor soils are poorly drained. They are in swales. Svea soils do not have a dense, alkali subsoil. They are on rises above the Cavour soil. Also included are some stony areas.

Permeability is very slow in the Miranda soil and slow in the Cavour soil. Runoff is slow on both soils. Available water capacity is moderate. It is restricted by the content of salts in the Miranda soil. A seasonal high water table is at a depth of 2 to 4 feet in the Miranda soil and 4 to 6 feet in the Cavour soil. The dense, alkali subsoil in both soils restricts the depth to which roots can penetrate.

Most areas are used for hay or range. Some are used for cultivated crops. These soils are best suited to range, pasture, and wildlife habitat. They generally are unsuited to cultivated crops because of the high alkalinity and the restricted rooting depth. The hazards of soil blowing and water erosion are slight.

The important native forage plants on these soils are green needlegrass, western wheatgrass, and blue grama. Western wheatgrass, slender wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. The dense, alkali subsoil and the high content of salts are problems, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate plant cover helps to control erosion. Stock water ponds constructed in areas of the Miranda soil sometimes contain salty water.

The Miranda soil generally is unsuited to the trees and shrubs grown as windbreaks and environmental plantings. The Cavour soil is suited to only a few of the drought- and salt tolerant species. Supplemental watering helps to ensure survival of seedlings. Individual trees and shrubs vary in height, density, and vigor, which are affected by the restricted root development in the dense, alkali subsoil and the limited available water capacity resulting from the salts in the soils.

These soils are suited to buildings but are poorly suited to septic tank absorption fields. The very slow or slow permeability and the seasonal high water table are limitations in septic tank absorption fields, but installing a mound system helps to overcome these limitations. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements.

The land capability classification of the Miranda soil is VIs, and that of the Cavour soil is IVs. The productivity index for spring wheat is 0. The range site and pasture group of the Miranda soil are Thin Claypan, and those of the Cavour soil are Claypan.

26B—Cresbard-Barnes loams, 3 to 6 percent slopes. These deep, undulating soils are in areas on glacial till plains where runoff collects in depressions. The moderately well drained, alkali Cresbard soil is in swales. The well drained Barnes soil is on rises. Individual areas range from about 5 to 300 acres in size. They are about 35 to 45 percent Cresbard soil and 30 to 45 percent Barnes soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Cresbard soil has a black loam surface layer about 7 inches thick (fig. 14). The subsurface layer is very dark brown loam about 2 inches thick. The next 3 inches is very dark grayish brown, black, and very dark brown clay loam that has dark gray silt coatings. The subsoil is about 28 inches thick. It is dark grayish brown and very dark grayish brown clay loam in the upper part; light olive brown, calcareous loam in the next part; and olive brown, mottled, calcareous loam in the lower part. The upper part of the substratum is light brownish gray and light olive brown, mottled silt loam. The lower part to a depth of about 60 inches is olive brown and grayish brown, mottled loam. In places the soil does not have silt coatings below the subsurface layer.

Typically, the Barnes soil has a black loam surface layer about 8 inches thick. The subsoil is clay loam about 15 inches thick. It is dark brown in the upper part, brown in the next part, and grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In places the dark color of the surface layer extends to a depth of more than 16 inches.

Included with these soils in mapping are small areas of Buse, Hamerly, Miranda, Parnell, Tonka, and Vallers soils. These included soils make up about 25 percent of the unit. Buse soils have a subsoil that is calcareous throughout. They are on knolls. Hamerly soils are somewhat poorly drained. They are on flats. Miranda soils have soluble salts within a depth of 16 inches. They are in swales below the Cresbard soil. Parnell and Tonka soils are in depressions. Parnell soils are very poorly drained, and Tonka soils are poorly drained. Vallers soils have a subsoil that has accumulated lime. They are on flats. Also included are some stony areas adjacent to drainageways.

Permeability is moderately slow in the Cresbard and Barnes soils. Runoff is medium. Available water capacity is high in the Barnes soil and moderate in the Cresbard soil. The dense, alkali subsoil in the Cresbard soil restricts the depth to which roots can penetrate. Tilth is fair.

Most areas are used for cultivated crops. These soils are suited to small grain and sunflowers. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. Controlling water erosion, improving or maintaining tilth, and improving root penetration in the dense subsoil of the Cresbard soil are the main management concerns if cultivated crops are grown. In most years crops have an uneven appearance because of moisture stress. The uneven appearance is most noticeable as the crops near maturity. Grassed waterways in areas where runoff concentrates help to control gullying. Returning crop residue to the soil increases the rate of water infiltration and improves or maintains tilth. Growing deep-rooted legumes, such as alfalfa, improves root penetration in the dense, alkali

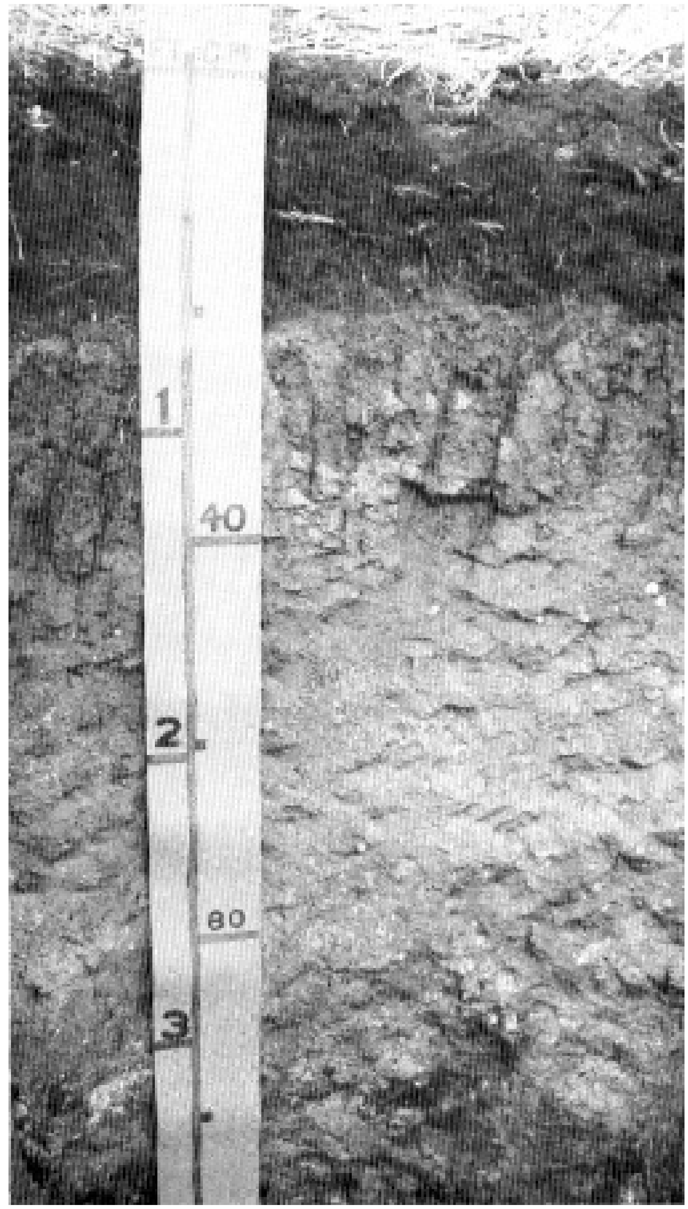

Figure 14.—A profile of Cresbard loam, which has a black surface layer.

subsoil of the Cresbard soil. Conservation tillage helps to control erosion and provides food and cover for resident and migratory wildlife.

Smooth bromegrass, western wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants on these soils. Water erosion is a hazard, especially if the pasture is overgrazed. This hazard can be reduced by maintaining an adequate cover of the suitable plants.

The Cresbard soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Barnes soil is suited to nearly all species. Individual trees and shrubs on the Cresbard soil vary in height, density, and vigor, which are affected by the restricted root development in the dense subsoil and by the limited available water capacity resulting from the salts in the soil. Eliminating weeds and grasses before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

These soils are suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling.

The land capability classification of the Cresbard soil is IIIe, and that of the Barnes soil is IIe. The productivity index for spring wheat is 70. The pasture group of the Cresbard soil is Clayey Subsoil, and that of the Barnes soil is Loamy and Silty.

27—Hamar loamy sand. This deep, level, poorly drained soil is in swales on glacial outwash plains. Runoff flows to drainageways. Individual areas range from about 5 to 75 acres in size.

Typically, the surface soil is loamy sand about 12 inches thick. It is black in the upper part and very dark brown and mottled in the lower part. The next layer is very dark grayish brown, mottled loamy sand about 6 inches thick. The upper part of the substratum is dark grayish brown, mottled sand. The lower part to a depth of about 60 inches is grayish brown, mottled loam. In some places the substratum is fine sandy loam. In other places the dark color of the surface layer extends to a depth of only 3 to 6 inches. In some areas the soil is ponded for short periods. In other areas the lower part of the substratum is sand. In a few places the surface soil is sandy loam.

Included with this soil in mapping are small areas of Arvilla, Divide, and Maddock soils. These soils make up about 15 percent of the unit. Arvilla soils are somewhat excessively drained. They are on knobs. Divide and Maddock soils are on rises. Divide soils have a subsoil that has accumulated lime. Maddock soils are well drained.

Permeability is moderately rapid in the upper part of the Hamar soil and moderately slow in the lower part. Runoff is very slow. Available water capacity is low. A seasonal high water table is within a depth of 2 feet. Tilth is good.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to small grain and sunflowers. In most years it is best suited to late-seeded crops. The hazard of soil blowing is severe, and the hazard of water erosion is slight. Wetness and soil blowing are the main management concerns if cultivated crops are grown. A drainage system improves the suitability for crops. A conservation tillage system, field windbreaks, stripcropping, cover crops, and buffer strips help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

Reed canarygrass, creeping foxtail, and alsike clover are suitable hay and pasture plants on this soil. Soil blowing is a hazard, especially if the pasture is overgrazed. This hazard can be reduced by maintaining an adequate cover of the suitable plants. The wetness hinders haying in some years.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields and buildings because of the wetness. Better sites generally are nearby.

The land capability classification is IVe. The productivity index for spring wheat ranges from 30 to 51, depending on the degree of drainage. The pasture group is Wet.

28E—Wamduska sandy loam, 9 to 45 percent slopes, extremely stony. This deep, strongly sloping to very steep, excessively drained soil is on former beaches on lake plains. Stones cover about 35 to 60 percent of the surface (fig. 15). Individual areas range from about 20 to 300 acres in size.

Typically, the surface layer is black sandy loam about 1 inch thick. The substratum to a depth of about 60 inches is very dark grayish brown and dark grayish brown, stratified very gravelly coarse sand, very gravelly sand, fine sand, and coarse sand. In some places it is dominantly shale gravel. In other places it is dominantly very gravelly granitic sand. In some areas the surface layer is loamy coarse sand or loam. In other areas the substratum is dominantly coarse sand and very coarse

Figure 15.—An area of Wamduska sandy loam, 9 to 45 percent slopes, extremely stony.

sand. In a few places it is loam or clay loam in the lower part.

Included with this soil in mapping are small areas of Buse, Kloten, and Mauvais soils. These soils make up about 25 percent of the unit. Buse soils have a loam or clay loam substratum. They are on shoulder slopes. Kloten soils are shallow. They are intermingled with areas of the Wamduska soil. Mauvais soils are somewhat poorly drained. They are in swales. Also included are some areas that are not stony.

Permeability is rapid in the Wamduska soil. Runoff is very slow. Available water capacity is very low.

Most areas are used for range or wildlife habitat. This soil is best suited to rangeland wildlife habitat and range. It generally is unsuited to cultivated crops, trees and shrubs, and hay because of the droughtiness, the stoniness, and the slope. Soil blowing and water erosion are severe hazards.

The important native forage plants on this soil are western wheatgrass, needleandthread, and blue grama. Soil blowing, water erosion, and drought are hazards, especially if the range is overgrazed. Reestablishing vegetation in denuded areas is difficult. The slope and the stoniness limit the use of machinery. Maintaining an adequate cover of the important plants at a height that traps snow helps to store water in the soil, control soil blowing and water erosion, and prevent denuding. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

This soil generally is unsuited to septic tank absorption fields and buildings because of the slope, the stoniness, and the rapid permeability. Better sites generally are nearby.

The land capability classification is VIIs. The productivity index for spring wheat is 0. The range site is Very Shallow.

29B—Maddock loamy sand, 1 to 6 percent slopes. This deep, nearly level and gently sloping, well drained soil is on knolls and ridges on glacial outwash plains. Individual areas range from about 5 to 150 acres in size.

Typically, the surface soil is loamy sand about 12 inches thick. It is very dark gray in the upper part and very dark grayish brown in the lower part. The upper part of the substratum is dark grayish brown sand. The lower part to a depth of about 60 inches is light brownish gray, mottled loamy very fine sand. In some places the surface layer is sandy loam. In other places the dark color of the surface layer extends to a depth of only 3 to 6 inches. In a few places it extends to a depth of more than 16 inches. In some areas the substratum is gravelly. In a few areas the lower part of the substratum is loam or clay loam.

Included with this soil in mapping are small areas of Barnes, Egeland, Embden, Gardena, and Zell soils. These soils make up about 20 percent of the unit. Barnes, Egeland, Embden, and Gardena soils contain more clay than the Maddock soil, and Zell soils contain less sand. Barnes, Egeland, Embden, and Gardena soils are on flats. Zell soils are on ridges and knolls above the Maddock soil.

Permeability is rapid in the Maddock soil. Runoff is very slow. Available water capacity is low. Tilth is good.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to small grain and sunflowers. It is particularly well suited to rye and winter wheat. These crops help to control soil blowing in fall, winter, and spring and can make the best use of early season moisture. The hazard of soil blowing is severe, and the hazard of water erosion is slight. Controlling soil blowing and overcoming droughtiness are the main management concerns if cultivated crops are grown. Field windbreaks, stripcropping, a conservation tillage system, cover crops, and buffer strips help to control soil blowing. Planting buffer strips and leaving tall stubble on the field help to trap snow, store soil moisture, and overcome the droughtiness.

Sand bluestem, prairie sandreed, and alfalfa are suitable hay and pasture plants on this soil. Soil blowing and drought are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants at a height that traps snow helps to overcome the droughtiness and control soil blowing.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is somewhat droughty, and the trees and shrubs commonly are affected by moisture stress. Irrigation helps to ensure survival of the seedlings. Because of the low available water capacity, little benefit is derived from fallowing during the season prior to planting. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is well suited to buildings but is poorly suited to septic tank absorption fields. Because of the rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Installing a mound system helps to prevent this pollution. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IVe. The productivity index for spring wheat is 47. The pasture group is Sands.

30—Embden fine sandy loam, 0 to 3 percent slopes. This deep, level and nearly level, moderately well drained soil is on flats on glacial outwash plains. Individual areas range from about 5 to 150 acres in size.

Typically, the surface soil is fine sandy loam about 15 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is fine sandy loam about 15 inches thick. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The upper part of the substratum is olive brown fine sandy loam. The lower part to a depth of about 60 inches is light olive brown gravelly sandy loam. In some places the substratum is loam or silt loam. In other places the lower part of the substratum is stratified sand. In a few places the surface layer is sandy loam.

Included with this soil in mapping are small areas of the somewhat excessively drained Arvilla soils on rises. These soils have a gravelly coarse sand substratum. They make up about 15 percent of the unit.

Permeability is moderately rapid in the Embden soil. Runoff is slow. Available water capacity is moderate. A seasonal high water table is at a depth of 4 to 6 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. It is particularly well suited to rye and winter wheat. These crops help to control soil blowing in fall, winter, and spring and can make the best use of early season moisture. The hazard of soil blowing is severe, and the hazard of water erosion is slight. Controlling soil blowing and overcoming droughtiness are the main management concerns if cultivated crops are grown. Field windbreaks, stripcropping, a conservation tillage system, cover crops, and buffer strips help to control soil blowing. Planting buffer strips and leaving tall stubble on the field help to trap snow, store soil moisture, and overcome the droughtiness.

Green needlegrass, western wheatgrass, and alfalfa are suitable hay and pasture plants on this soil. Soil blowing and drought are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants at a height that traps snow helps to store soil moisture, overcome the droughtiness, and control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect the trees and shrubs. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings but is poorly suited to septic tank absorption fields. The seasonal high water table is a limitation in septic tank absorption fields, but installing a mound system helps to overcome this limitation. Installing a surface and foundation drainage system helps to prevent seepage into basements. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IIIe. The productivity index for spring wheat is 71. The pasture group is Sandy.

31B—Egeland sandy loam, 3 to 6 percent slopes. This deep, gently sloping, well drained soil is on knolls and ridges on glacial outwash plains. Individual areas range from about 5 to 50 acres in size.

Typically, the surface layer is black sandy loam about 9 inches thick. The subsoil is dark brown sandy loam about 5 inches thick. The upper part of the substratum is dark grayish brown sandy loam. The lower part to a depth of about 60 inches is grayish brown loamy sand. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places the surface layer is fine sandy loam.

Included with this soil in mapping are small areas of Glyndon and Maddock soils. These soils make up about 15 percent of the unit. Glyndon soils are somewhat poorly drained. They are in swales. Maddock soils have a loamy sand surface layer. They are on knolls and ridges.

Permeability is moderately rapid in the Egeland soil. Runoff is slow. Available water capacity is low. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. It is particularly well suited to rye and winter wheat. These crops help to control soil blowing in fall, winter, and spring and can make the best use of early season moisture. The hazard of soil blowing is severe, and the hazard of water erosion is moderate. Soil blowing, water erosion, and droughtiness are the main management concerns if cultivated crops are grown. Field windbreaks, stripcropping, a conservation tillage system, cover crops, and buffer strips help to control soil blowing and water erosion. Planting buffer strips and leaving tall stubble on the field helps to trap snow, store soil moisture, and overcome the droughtiness.

Green needlegrass, western wheatgrass, and alfalfa are suitable hay and pasture plants on this soil. Soil blowing and drought are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants at a height that traps snow helps to store soil moisture and control soil blowing.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is somewhat droughty, and the trees and shrubs commonly are affected by moisture stress. Irrigation helps to ensure survival of the seedlings. Because of the low available water capacity, little benefit is derived from fallowing during the season prior to planting. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is well suited to septic tank absorption fields and buildings. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IIIe. The productivity index for spring wheat is 62. The pasture group is Sandy.

32—Gardena silt loam, 0 to 3 percent slopes. This deep, level and nearly level, moderately well drained soil is on flats on glacial lake plains. Individual areas range from about 10 to 100 acres in size.

Typically, the surface soil is black silt loam about 13 inches thick. The subsoil also is silt loam about 13 inches thick. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The upper part of the substratum is light olive brown silt loam. The lower part to a depth of about 60 inches is grayish brown, mottled loam. In some areas the subsoil and substratum are loam or fine sandy loam. In a few areas the subsoil is silty clay. In places it is calcareous.

Included with this soil in mapping are small areas of Svea soils, which have a loam or clay loam substratum. These soils are intermingled with areas of the Gardena soil. They make up about 10 percent of the unit.

Permeability is moderate in the Gardena soil. Runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 4 to 6 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. The hazards of soil blowing and water erosion are slight, but soil blowing can occur during some storms. Controlling soil blowing and maintaining tilth are the main management concerns if cultivated crops are grown. Field windbreaks, stripcropping, a conservation tillage system, cover crops, and buffer strips help to control soil blowing. Conservation tillage also helps to maintain tilth and provides food and cover for resident and migratory wildlife.

Smooth bromegrass, intermediate wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants on this soil. Soil blowing is a hazard, especially if the pasture is overgrazed. This hazard can be reduced by maintaining an adequate cover of the suitable plants.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect the trees and shrubs. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

This soil is suited to buildings but is poorly suited to septic tank absorption fields. The seasonal high water table is a limitation in septic tank absorption fields, but installing a mound system helps to overcome this limitation. Installing a surface and foundation drainage system helps to prevent seepage into basements.

The land capability classification is IIe. The productivity index for spring wheat is 100. The pasture group is Loamy and Silty.

32B—Gardena silt loam, 3 to 6 percent slopes. This deep, gently sloping, moderately well drained soil is on glacial lake plains. Individual areas range from about 5 to 100 acres in size.

Typically, the surface soil is black silt loam about 15 inches thick. The subsoil is silt loam about 19 inches thick. It is very dark grayish brown in the upper part, dark grayish brown in the next part, and grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is grayish brown very fine sandy loam. In places the subsoil is loam. In a few areas it is calcareous throughout.

Included with this soil in mapping are small areas of Barnes and Svea soils. These soils make up about 20 percent of the unit. They have a loam surface layer and a clay loam subsoil. They are intermingled in areas with the Gardena soil.

Permeability is moderate in the Gardena soil. Runoff is medium. Available water capacity is high. A seasonal high water table is at a depth of 4 to 6 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. Soil blowing is a slight hazard, but it can occur during some storms. The hazard of water erosion is moderate. Controlling soil blowing and water erosion and maintaining tilth are the main management concerns if cultivated crops are grown. Field windbreaks, stripcropping, a conservation tillage system, cover crops, and buffer strips help to control soil blowing and water erosion. Grassed waterways in areas where runoff concentrates help to control gullying. Returning crop residue to the soil increases the infiltration rate and helps to maintain tilth. Conservation tillage helps to maintain tilth and provides food and cover for resident and migratory wildlife.

Smooth bromegrass, intermediate wheatgrass, alfalfa, and sweetclover are suitable pasture and hay plants on this soil. Water erosion and soil blowing are hazards, especially if the pasture is overgrazed. They can be controlled by maintaining an adequate cover of the suitable plants.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect the trees and shrubs. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

This soil is suited to buildings but is poorly suited to septic tank absorption fields. The seasonal high water table is a limitation in septic tank absorption fields, but installing a mound system helps to overcome this limitation. Installing a surface and foundation drainage system helps to prevent seepage into basements.

The land capability classification is IIe. The productivity index for spring wheat is 90. The pasture group is Loamy and Silty.

33—Glyndon silt loam. This deep, level, somewhat poorly drained, highly calcareous soil is on flats and along drainageways on glacial lake plains. Individual areas range from about 5 to 75 acres in size.

Typically, the surface soil is silt loam about 12 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is gray, calcareous silt loam about 10 inches thick. The upper part of the substratum is olive brown, mottled silt loam. The lower part to a depth of about 60 inches is dark grayish brown and olive brown, mottled very fine sandy loam. In some places the surface layer and subsoil are fine sandy loam. In other places the lower part of the substratum is light olive gray.

Included with this soil in mapping are small areas of Divide, Hamerly, and Lamoure soils. These soils make up about 25 percent of the unit. Divide and Hamerly soils are intermingled with areas of the Glyndon soil. Divide soils have very gravelly coarse sand in the lower part of the substratum. Hamerly soils have a loam or clay loam substratum. Lamoure soils are poorly drained. They are on narrow flood plains.

Permeability is moderately rapid in the Glyndon soil. Runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 2.5 to 6.0 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. The seasonal high water table delays seeding in some years, but crops can be grown each year. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. Field windbreaks, stripcropping, cover crops, a conservation tillage system, and buffer strips help to control soil blowing. Conservation tillage also provides food and cover for resident and migratory wildlife.

Big bluestem, indiangrass, red clover, and sweetclover are suitable hay and pasture plants on this soil. Soil blowing is a hazard, especially if the pasture is overgrazed. This hazard can be reduced by maintaining an adequate cover of the suitable plants.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect the trees and shrubs. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings but is poorly suited to septic tank absorption fields. The seasonal high water table is a limitation in septic tank absorption fields, but installing a mound system helps to overcome this limitation. Installing a surface and foundation drainage system helps to prevent seepage into basements. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IIe. The productivity index for spring wheat is 88. The pasture group is Limy Subirrigated.

34—LaDelle silt loam. This deep, level, moderately well drained soil is on flood plains. It is subject to rare flooding. In a few areas meandering channels have dissected the landscape into small, irregularly shaped tracts. Individual areas range from about 5 to 130 acres in size.

Typically, the surface soil is about 12 inches thick. It is black. It is silt loam in the upper part and silty clay loam in the lower part. The subsoil is silty clay loam about 17 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The substratum to a depth of about 60 inches is silty clay loam. It is very dark gray in the upper part and very dark grayish brown in the lower part. In places the surface layer and subsoil are clay loam or loam. In a few areas the surface layer is calcareous.

Included with this soil in mapping are small areas of Borup, Walsh, and Wamduska soils. These soils make up about 20 percent of the unit. Borup soils are poorly drained. They are in swales. Walsh soils are well drained. They are on foot slopes in the uplands. Wamduska soils are gravelly. They are on levees. Also included are some long and narrow areas of steep soils adjacent to streams.

Permeability is moderate in the LaDelle soil. Runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 4 to 6 feet. Tilth is good.

Most areas are cultivated. A few areas are used as wooded pasture. This soil is suited to small grain and sunflowers. The hazards of soil blowing and water erosion are slight. Maintaining tilth and fertility are the main management concerns if cultivated crops are grown. Returning crop residue to the soil and applying the proper kinds and amounts of fertilizer help to maintain tilth, fertility, and the organic matter content. When streams overflow in the spring, the floodwater usually recedes before planting time. In some years late-seeded crops, such as flax or millet, are grown following a flood late in spring. A conservation tillage system minimizes the scouring caused by floodwater. It also helps to provide food and cover for resident and migratory wildlife.

Smooth bromegrass, intermediate wheatgrass, alfalfa, and red clover are suitable hay and pasture plants on this soil. Scouring is a hazard during periods of flooding, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants reduces this hazard.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect the trees and shrubs. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of seedlings.

This soil generally is unsuited to buildings and septic tank absorption fields because of the flooding. Better sites generally are nearby.

The land capability classification is IIc. The productivity index for spring wheat is 94. The pasture group is Overflow and Run-on.

35—LaDelle silt loam, channeled. This deep, level, moderately well drained soil is on flood plains. It is occasionally flooded. Most areas are dissected into small, irregularly shaped tracts by meandering channels, and many are isolated by deep channels or steep escarpments. Individual areas range from about 5 to 175 acres in size.

Typically, the surface soil is black silt loam about 23 inches thick. The subsoil is very dark brown silty clay loam about 9 inches thick. The substratum extends to a depth of 60 inches or more. In sequence downward, it is black silty clay loam, very dark brown silty clay loam, dark grayish brown silty clay loam, and dark grayish brown silt loam. In some places the surface soil is silty clay loam. In other places the surface layer and subsoil are clay loam or loam. In a few places the surface layer is calcareous.

Included with this soil in mapping are small areas of Embden, Playmoor, Southam, and Wamduska soils. These soils make up about 40 percent of the unit. Embden soils are well drained. They are on levees. Playmoor and Southam soils are in oxbows and abandoned channels. Playmoor soils are poorly drained, and Southam soils are very poorly drained. Wamduska soils are gravelly. They are on levees.

Permeability is moderate in the LaDelle soil. Runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 4 to 6 feet.

Most areas are used for range or wildlife habitat. This soil is best suited to rangeland wildlife habitat and range. It generally is unsuited to cultivated crops because it is dissected into small, inaccessible tracts. The hazards of soil blowing and water erosion are slight.

The important native forage plants are big bluestem, green needlegrass, and indiangrass. No major hazards or limitations affect the use of this soil for range. Maintaining an adequate cover of the important plants helps to protect the soil from scouring during periods of flooding.

This soil generally is unsuited to the trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs grow well, but the meandering channels hinder the use of machinery. Native trees are common along the stream channels in most areas. The common species are bur oak, American elm, green ash, willow, and juneberry. These areas provide diverse food and cover for wildlife.

This soil generally is unsuited to buildings and septic tank absorption fields because of the flooding. Better sites generally are nearby.

The land capability classification is VIw. The productivity index for spring wheat is 0. The range site is Overflow.

36B—Arvilla sandy loam, 0 to 6 percent slopes. This deep, level to gently sloping, somewhat excessively drained soil is on knolls, ridges, and flats on glacial outwash plains. Individual areas range from about 5 to 300 acres in size.

Typically, the surface layer is black sandy loam about 8 inches thick. The subsoil is very dark grayish brown sandy loam about 7 inches thick. The substratum to a depth of about 60 inches is dark brown gravelly coarse sand. In some places the subsoil is as much as 15 inches thick. In other places the substratum contains mostly gravel-size shale fragments. In some areas it is loam or sand.

Included with this soil in mapping are small areas of Divide, Hamar, Maddock, and Renshaw soils. These soils make up about 15 percent of the unit. Divide soils are somewhat poorly drained. They are in swales. Hamar soils are poorly drained. They are in depressions. Maddock soils have a sand and loamy very fine sand substratum. They are on knolls. Renshaw soils have a loam subsoil. They are intermingled with areas of the Arvilla soil.

Permeability is rapid in the Arvilla soil. Runoff is slow. Available water capacity is low. Tilth is good.

Most areas are used for cultivated crops, pasture, or hay. This soil is suited to small grain and sunflowers. It is particularly well suited rye and winter wheat. These crops help to control soil blowing in fall, winter, and spring and can make the best use of early season moisture. The hazard of soil blowing is severe, and the hazard of water erosion is slight. Controlling soil blowing and overcoming droughtiness are the main management concerns if cultivated crops are grown. Field windbreaks, stripcropping, a conservation tillage system, cover crops, and buffer strips help to control soil blowing. Planting buffer strips and leaving tall stubble on the surface help to trap snow, store soil moisture, and overcome the droughtiness.

Green needlegrass, western wheatgrass, and alfalfa are suitable pasture and hay plants on this soil. Soil blowing and drought are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants at a height that traps snow reduces these hazards.

This soil is suited to some of the trees and shrubs grown as windbreaks and environmental plantings. It is droughty, and the trees and shrubs commonly are affected by moisture stress. Irrigation helps to ensure survival of the seedlings. Because of the low available water capacity, little benefit is derived from fallowing during the year prior to planting. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is well suited to buildings but is poorly suited to septic tank absorption fields. Because of the rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Installing a mound system helps to prevent this pollution. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IIIe. The productivity index for spring wheat is 43. The pasture group is Shallow to Gravel.

37—Fordville loam. This deep, level, well drained soil is on flats on glacial outwash plains. Individual areas range from about 5 to 150 acres in size.

Typically, the surface soil is black loam about 13 inches thick. The subsoil is about 17 inches thick. It is very dark brown loam in the upper part, dark brown loam in the next part, and dark grayish brown, calcareous sandy loam in the lower part. The substratum to a depth of about 60 inches is brown gravelly coarse sand. In places the depth to sand and gravel is only 14 to 20 inches.

Included with this soil in mapping are small areas of Gardena, Glyndon, Hamerly, and Svea soils. These soils make up about 25 percent of the unit. Gardena soils have a silt loam and loam substratum. They are on flats. Glyndon and Hamerly soils are somewhat poorly drained. They are in swales. Svea soils have a clay loam substratum. They are intermingled in areas with the Fordville soil.

Permeability is moderate in the upper part of the Fordville soil and rapid in the lower part. Runoff is very slow. Available water capacity is low. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. It is particularly well suited to rye and winter wheat, which can make the best use of early season moisture. The hazards of soil blowing and water erosion are slight. Overcoming droughtiness is the main management concern if cultivated crops are grown. Applying a system of conservation tillage and leaving tall stubble on the surface help to trap snow, store soil moisture, and overcome the droughtiness.

Smooth bromegrass, intermediate wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants on this soil. Maintaining an adequate cover of the suitable plants at a height that traps snow helps to overcome the droughtiness.

This soil is suited to some of the trees and shrubs grown as windbreaks and environmental plantings. It is droughty, and the trees and shrubs commonly are affected by moisture stress. Irrigation helps to ensure survival of the seedlings. Because of the low available water capacity, little benefit is derived from fallowing during the year prior to planting. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

This soil is well suited to buildings but is poorly suited to septic tank absorption fields. Because of the rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Installing a mound system helps to prevent this pollution. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IIs. The productivity index for spring wheat is 66. The pasture group is Loamy and Silty.

38B—Renshaw loam, 1 to 6 percent slopes. This deep, nearly level and gently sloping, somewhat excessively drained soil is on flats, knolls, and ridges on glacial outwash plains. Individual areas range from about 5 to 175 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsoil is dark brown loam about 7 inches thick. The substratum to a depth of about 60 inches is dark brown very gravelly coarse sand. In some areas the depth to sand and gravel is more than 20 inches. In a few areas it is only 8 to 14 inches. In some places the surface layer and subsoil are sandy loam. In other places, the substratum is clay loam below a depth of 40 inches and the soil has a stone line.

Included with this soil in mapping are small areas of Barnes, Divide, Gardena, and Svea soils. These soils make up about 15 percent of the unit. Barnes, Gardena, and Svea soils do not have a gravelly substratum. They are on flats. Divide soils are somewhat poorly drained. They are in swales.

Permeability is moderately rapid in the upper part of the Renshaw soil and very rapid in the lower part. Runoff is slow. Available water capacity is low. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. It is particularly well suited to rye and winter wheat. These crops help to control water erosion in fall, winter, and spring and can make the best use of early season moisture. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. Applying a conservation tillage system and leaving tall stubble on the surface help to control water erosion, trap snow, store soil moisture, and overcome the droughtiness.

Green needlegrass, western wheatgrass, and alfalfa are suitable hay and pasture plants on this soil. Water erosion and drought are hazards, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants at a height that traps snow reduces these hazards.

This soil is suited to some of the trees and shrubs grown as windbreaks and environmental plantings. It is droughty, and the trees and shrubs commonly are affected by moisture stress. Irrigation helps to ensure survival of the seedlings. Because of the low available water capacity, little benefit is derived from fallowing during the year prior to planting. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

This soil is well suited to buildings but is poorly suited to septic tank absorption fields. Because of the very rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Installing a mound system helps to prevent this pollution. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IIIe. The productivity index for spring wheat is 49. The pasture group is Shallow to Gravel.

39E—Sioux loam, 6 to 25 percent slopes. This deep, moderately sloping to moderately steep, excessively drained soil is on ridges on glacial outwash plains and on terraces. Individual areas range from about 5 to 200 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The next layer is very dark grayish brown gravelly loam about 4 inches thick. The substratum to a depth of about 60 inches is dark grayish brown very gravelly sand. In some places the surface layer is gravelly loam or sandy loam. In other places the substratum is sand or loamy very fine sand. In a few areas the depth to sand and gravel is 14 to 20 inches.

Included with this soil in mapping are small areas of Fordville and LaDelle soils. These soils make up about 15 percent of the unit. Fordville soils have sand and gravel at a depth of 20 to 40 inches. They are in swales or in areas between the Sioux and LaDelle soils. LaDelle soils have a silt loam and silty clay loam substratum. They are in swales.

Permeability is very rapid in the Sioux soil. Runoff is slow. Available water capacity is very low.

Most areas are used for range or wildlife habitat. This soil is best suited to rangeland wildlife habitat and range. It generally is unsuited to cultivated crops and trees and shrubs because of droughtiness and the slope. The hazard of soil blowing is slight, and the hazard of water erosion is moderate.

The important native forage plants on this soil are needleandthread, western wheatgrass, and blue grama. Drought and water erosion are hazards, especially if the range is overgrazed. Reestablishing vegetation in denuded areas is difficult. Maintaining an adequate cover of the important plants at a height that traps snow helps to store soil moisture, overcome the droughtiness, control water erosion, and prevent denuding. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to control gullying.

This soil generally is unsuited to septic tank absorption fields and buildings because of the slope, the instability of cutbanks, and the very rapid permeability. Better sites generally are nearby.

The land capability classification is VIIs. The productivity index for spring wheat is 0. The range site is Very Shallow.

40—Divide loam, 0 to 3 percent slopes. This deep, level and nearly level, somewhat poorly drained, highly calcareous soil is in drainageways and on flats on glacial outwash plains. Individual areas range from about 5 to 50 acres in size.

Typically, the surface soil is loam about 12 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is light brownish gray, calcareous loam about 10 inches thick. The upper part of the substratum is light olive brown gravelly loamy coarse sand. The lower part to a depth of about 60 inches is olive brown very gravelly coarse sand. In some places the lower part of the substratum is olive gray. In other places the upper part of the subsoil is noncalcareous.

Included with this soil in mapping are small areas of Cavour, Fordville, Glyndon, Hamar, Tonka, and Vallers soils. These soils make up about 20 percent of the unit. Cavour and Fordville soils are on rises. Cavour soils have a dense, alkali subsoil. Fordville soils are well drained. Glyndon, Tonka, and Vallers soils do not have a gravelly substratum. Hamar soils are poorly drained. Glyndon, Hamar, and Vallers soils are on flats. Tonka soils are in depressions.

Permeability is moderate in the upper part of the Divide soil and very rapid in the lower part. Runoff is very slow. Available water capacity is moderate. A seasonal high water table is at a depth of 2.5 to 5.0 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. The seasonal high water table delays seeding in some years, but crops can be grown each year. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. Overcoming droughtiness and controlling soil blowing are the main management concerns if cultivated crops are grown. Field windbreaks, stripcropping, a conservation tillage system, cover crops, and buffer strips help to control soil blowing. Applying a conservation tillage system and leaving tall stubble on the surface help to trap snow, store soil moisture, and overcome the droughtiness.

Big bluestem, indiangrass, red clover, and sweetclover are suitable hay and pasture plants on this soil. Soil blowing is a hazard, especially if the pasture is overgrazed. This hazard can be reduced by maintaining an adequate cover of the suitable plants.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect the trees and shrubs. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings but is poorly suited to septic tank absorption fields. The seasonal high water table is a limitation on sites for septic tank absorption fields and buildings. Because of the very rapid permeability, the soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Installing a mound system helps to prevent this pollution and increases the depth to the seasonal high water table. Installing a surface and foundation drainage system helps to prevent seepage into basements. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IIIs. The productivity index for spring wheat is 64. The pasture group is Limy Subirrigated.

41—Vang loam. This deep, level, well drained soil is on flats on glacial outwash plains. Individual areas range from about 5 to 150 acres in size.

Typically, the surface soil is black loam about 15 inches thick. The subsoil is about 12 inches thick. It is very dark grayish brown clay loam in the upper part, dark grayish brown clay loam in the next part, and dark grayish brown gravelly clay loam in the lower part. The substratum to a depth of about 60 inches is very dark gray extremely gravelly sand. In places the depth to sand and gravel is only 14 to 20 inches. In a few places the depth to sand and gravel is as much as 40 to 60 inches.

Included with this soil in mapping are small areas of Divide and Svea soils. These soils make up about 10 percent of the unit. Divide soils are somewhat poorly drained. They are in swales. Svea soils have a clay loam substratum. They are intermingled with areas of the Vang soil.

Permeability is moderate in the upper part of the Vang soil and very rapid in the lower part. Runoff is very slow. Available water capacity is low. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. It is particularly well suited to rye and winter wheat, which can make the best use of early season moisture. The hazards of soil blowing and water erosion are slight. Overcoming droughtiness is the main management concern if cultivated crops are grown. A conservation tillage system that leaves tall stubble on the surface helps to store soil moisture and overcome the droughtiness. It also provides food and cover for resident and migratory wildlife.

Smooth bromegrass, intermediate wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants on this soil. Maintaining an adequate cover of the suitable plants at a height that traps snow helps to overcome the droughtiness.

This soil is suited to some of the trees and shrubs grown as windbreaks and environmental plantings. It is droughty, and the trees and shrubs commonly are affected by moisture stress. Irrigation helps to ensure survival of the seedlings. Because of the low available water capacity, little benefit is derived from fallowing during the year prior to planting. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

This soil is well suited to buildings but is poorly suited to septic tank absorption fields. Because of the very rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Installing a mound system helps to prevent this pollution. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IIs. The productivity index for spring wheat is 64. The pasture group is Loamy and Silty.

42B—Brantford loam, 1 to 6 percent slopes. This deep, nearly level and gently sloping, well drained soil is on flats, ridges, and knolls on glacial outwash plains. Individual areas range from about 5 to 100 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsoil is very dark grayish brown loam about 5 inches thick. The substratum to a depth of about 60 inches is dark grayish brown very gravelly sand. In places the depth to sand and gravel is 20 to 40 inches.

Included with this soil in mapping are small areas of the well drained Barnes, Svea, and Walsh soils. These soils make up about 15 percent of the unit. They do not have a gravelly substratum. They are intermingled in areas with the Brantford soil.

Permeability is moderate in the upper part of the Brantford soil and very rapid in the lower part. Runoff is slow. Available water capacity is low. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. Overcoming droughtiness and controlling water erosion are the main management concerns if cultivated crops are grown. A conservation tillage system that leaves tall stubble on the surface helps to control water erosion, trap snow, store soil moisture, and overcome the droughtiness. It also provides food and cover for resident and migratory wildlife.

Green needlegrass, western wheatgrass, and alfalfa are suitable hay and pasture plants on this soil. Water erosion is a hazard, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants at a height that traps snow helps to control water erosion and overcome the droughtiness.

This soil is suited to some of the trees and shrubs grown as windbreaks and environmental plantings. It is droughty, and the trees and shrubs commonly are affected by moisture stress. Irrigation helps to ensure survival of the seedlings. Because of the low available water capacity, little benefit is derived from fallowing during the year prior to planting. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

This soil is well suited to buildings but is poorly suited to septic tank absorption fields. Because of the very rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Installing a mound system helps to prevent this pollution. The sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification is IIIe. The productivity index for spring wheat is 52. The pasture group is Shallow to Gravel.

43E—Coe gravelly loam, 6 to 25 percent slopes. This deep, moderately sloping to moderately steep, excessively drained soil is on knolls and ridges on collapsed outwash plains. Individual areas range from about 5 to 500 acres in size.

Typically, the surface layer is very dark gray gravelly loam about 8 inches thick. The upper part of the substratum is dark grayish brown very gravelly loamy coarse sand. The lower part to a depth of about 60 inches is dark gray extremely gravelly coarse sand. In places the soil has a subsoil.

Included with this soil in mapping are small areas of Buse, LaDelle, Parnell, Vang, Walsh, and Zell soils. These soils make up about 40 percent of the unit. Buse, LaDelle, Parnell, Walsh, and Zell soils do not have a gravelly substratum. Vang soils are well drained. Buse, Walsh, and Zell soils are intermingled with areas of the Coe soil. LaDelle and Vang soils are in swales. Parnell soils are in depressions.

Permeability is moderately rapid in the upper part of the Coe soil and very rapid in the lower part. Runoff is slow. Available water capacity is very low.

Most areas are used for native hay, range, or wildlife habitat. This soil is best suited to range and range wildlife habitat. It generally is unsuited to cultivated crops and to trees and shrubs because of droughtiness and the slope. The hazard of soil blowing is slight, and the hazard of water erosion is moderate.

The important native forage plants on this soil are needleandthread, western wheatgrass, and blue grama. Drought and water erosion are hazards, especially if the range is overgrazed. Reestablishing vegetation in denuded areas is difficult. Maintaining an adequate cover of the important plants at a height that traps snow helps to store soil moisture, control water erosion, prevent denuding, and overcome the droughtiness. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

This soil generally is unsuited to septic tank absorption fields and buildings because of the slope, the instability of cutbanks, and the very rapid permeability. Better sites generally are nearby.

The land capability classification is VIIs. The productivity index for spring wheat is 0. The range site is Very Shallow.

44B—Walsh loam, 1 to 6 percent slopes. This deep, nearly level and gently sloping, well drained soil is on foot slopes in stream valleys. Individual areas range from about 5 to 150 acres in size.

Typically, the surface soil is black loam about 12 inches thick. The subsoil is very dark grayish brown loam about 24 inches thick. The substratum to a depth of about 60 inches is dark grayish brown. It is channery loam in the upper part and loam in the lower part. In some places the dark color of the surface soil extends to a depth of only 8 to 16 inches. In other places shale bedrock is at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of Arvilla and LaDelle soils. These soils make up about 10 percent of the unit. Arvilla soils have a sand and gravel substratum. They are intermingled with areas of the Walsh soil. LaDelle soils are moderately well drained. They are in swales. Also included are some areas of soils that have soft shale bedrock at a depth of 20 to 40 inches.

Permeability is moderate in the Walsh soil. Runoff is medium. Available water capacity is high. A seasonal high water table is at a depth of 4 to 6 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. Controlling water erosion and maintaining tilth are the main management concerns if cultivated crops are grown. Stripcropping, cover crops, and a conservation tillage system help to control water erosion. Grassed waterways in areas where runoff concentrates help to control gullying. Returning crop residue to the soil increases the infiltration rate and improves or helps to maintain tilth.

Intermediate wheatgrass, smooth bromegrass, alfalfa, and sweetclover are suitable hay and pasture plants on this soil. Water erosion is a hazard, especially if the pasture is overgrazed. This hazard can be reduced by maintaining an adequate cover of the suitable plants.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect the trees and shrubs. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

This soil is suited to buildings but is poorly suited to septic tank absorption fields. The moderate permeability and the seasonal high water table are limitations in septic tank absorption fields, but installing a mound system helps to overcome these limitations. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements.

The land capability classification is IIe. The productivity index for spring wheat is 95. The pasture group is Loamy and Silty.

44C—Walsh loam, 6 to 9 percent slopes. This deep, moderately sloping, well drained soil is on side slopes in stream valleys. Individual areas range from about 10 to 75 acres in size.

Typically, the surface soil is black loam about 12 inches thick. The subsoil is loam about 10 inches thick. It is very dark gray in the upper part and very dark grayish brown in the lower part. The substratum to a depth of about 60 inches is loam. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. In some places the lower part of the subsoil is calcareous. In other places the dark color of the surface soil extends to a depth of only 8 to 16 inches. In a few places shale bedrock is at a depth of 40 to 60 inches. In some areas the lower part of the substratum is gravelly sand.

Included with this soil in mapping are small areas of Barnes, Buse, Kloten, and LaDelle soils. These soils make up about 10 percent of the unit. Barnes soils are dark to a depth of only 8 to 16 inches. They are intermingled with areas of the Walsh soil. Buse soils have a calcareous subsoil. They are on shoulder slopes. Kloten soils have shale bedrock at a depth of 10 to 20 inches. They are on summits and shoulder slopes. LaDelle soils contain less sand than the Walsh soil. They are in swales. Also included are some areas of soils that have soft shale bedrock at a depth of 20 to 40 inches.

Permeability is moderate in the Walsh soil. Runoff is medium. Available water capacity is high. A seasonal high water table is at a depth of 4 to 6 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain and sunflowers. The hazard of soil blowing is slight, and the hazard of water erosion is severe. Controlling water erosion and maintaining tilth are the main management concerns if cultivated crops are grown. Stripcropping, a conservation tillage system, and cover crops help to control water erosion. Grassed waterways in areas where runoff concentrates help to control gullying. Returning crop residue to the soil increases the infiltration rate and improves or helps to maintain tilth.

Intermediate wheatgrass, smooth bromegrass, alfalfa, and sweetclover are suitable hay and pasture plants on this soil. Water erosion is a hazard, especially if the pasture is overgrazed. This hazard can be reduced by maintaining an adequate cover of the suitable plants. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. No critical limitations affect the trees and shrubs. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve survival and growth rates of the seedlings.

This soil is suited to buildings but is poorly suited to septic tank absorption fields. The moderate permeability and the seasonal high water table are limitations in septic tank absorption fields, but installing a mound system helps to overcome these limitations. The shrink-swell potential is a limitation on building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. The drainage system also helps to prevent seepage into basements.

The land capability classification is IIIe. The productivity index for spring wheat is 70. The pasture group is Loamy and Silty.

45E—Zell-Maddock complex, 6 to 25 percent slopes. These deep, gently rolling to hilly, well drained soils are on collapsed glacial lake plains. The Zell soil is on summits and shoulder slopes. The Maddock soil is on side slopes. Individual areas range from about 5 to 200 acres in size. They are about 35 to 50 percent Zell soil and 30 to 45 percent Maddock soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Zell soil has a black silt loam surface layer about 5 inches thick. The next layer is dark brown silt loam about 5 inches thick. The subsoil is about 16 inches thick. It is light olive brown. It is silt loam in the upper part and very fine sandy loam in the lower part. The substratum to a depth of about 60 inches is light olive brown. It is silt loam in the upper part and very fine sandy loam in the lower part. In some places the surface layer and subsoil are loam or sandy loam. In other places the subsoil is noncalcareous. In some areas the surface layer is very fine sandy loam.

Typically, the Maddock soil has a very dark gray loamy fine sand surface soil about 13 inches thick. The upper part of the substratum is dark brown loamy fine sand. The lower part to a depth of about 60 inches is olive brown loamy sand. In places the substratum is gravelly coarse sand or loam. In some areas the dark color of the surface soil extends to a depth of only 3 to 6 inches. In other areas it extends to a depth of more than 16 inches.

Included with these soils in mapping are small areas of Brantford, Coe, Egeland, Embden, Gardena, and LaDelle soils. These included soils make up about 20 percent of the unit. Brantford and Coe soils have a gravelly substratum. Brantford soils are on side slopes. Coe soils are on summits. Egeland and Embden soils are on side slopes. Egeland soils have a sandy loam surface layer, and Embden soils have a fine sandy loam surface layer. Gardena and LaDelle soils are moderately well drained. They are in swales.

Permeability is moderate in the Zell soil and rapid in the Maddock soil. Runoff is rapid on the Zell soil and medium on the Maddock soil. Available water capacity is moderate in the Zell soil and low in the Maddock soil.

Most areas are used for range or wildlife habitat. These soils are best suited to rangeland wildlife habitat, hay, and range. They generally are unsuited to cultivated crops because of the susceptibility to soil blowing and water erosion and the slope. The hazard of soil blowing is moderate on the Zell soil and severe on the Maddock soil. The hazard of water erosion is severe on both soils.

The important native forage plants on these soils are prairie sandreed, needleandthread, western wheatgrass, and little bluestem. Soil blowing and water erosion are hazards, especially if the range is overgrazed. Reestablishing vegetation in denuded areas is difficult. Maintaining an adequate cover of the important plants helps to control soil blowing and water erosion and prevent denuding.

These soils generally are unsuited to the trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be planted for esthetic purposes or for wildlife if special treatment, such as hand planting or scalp planting, is applied.

These soils generally are unsuited to septic tank absorption fields and buildings because of the slope, the instability of cutbanks, and the rapid permeability in the Maddock soil. Better sites generally are nearby.

The land capability classification is VIIe. The productivity index for spring wheat is 0. The range site of the Zell soil is Thin Upland, and that of the Maddock soil is Sands.

46C—Wamduska-Mauvais complex, 1 to 9 percent slopes. These deep, nearly level to moderately sloping soils are on the abandoned beaches and shores of lake plains. The excessively drained Wamduska soil is on the abandoned beaches. The somewhat poorly drained Mauvais soil is between the beaches. It receives seepage from the beaches. Individual areas range from about 15 to 550 acres in size. They are about 35 to 55 percent Wamduska soil and 35 to 55 percent Mauvais soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Wamduska soil has a very dark gray loamy coarse sand surface layer about 3 inches thick. This layer is covered with organic material about 2 inches thick. The substratum extends to a depth of 60 inches or more. In sequence downward, it is dark grayish brown gravelly loamy coarse sand; dark grayish brown very gravelly coarse sand; very dark grayish brown gravelly coarse sand; dark brown, dark grayish brown, and dark brown gravelly coarse sand; and black gravelly coarse sand (fig. 16). In some places the substratum is dominantly gravel-size shale fragments. In other places it is loamy fine sand or fine sand. In some areas the surface layer is loam or sandy loam. In other areas the substratum is coarse sand. In places the content of gravel is more than 35 percent in the substratum.

Typically, the Mauvais soil has a black loam surface layer about 2 inches thick. The subsoil is mottled loam about 35 inches thick. It is grayish brown and light olive

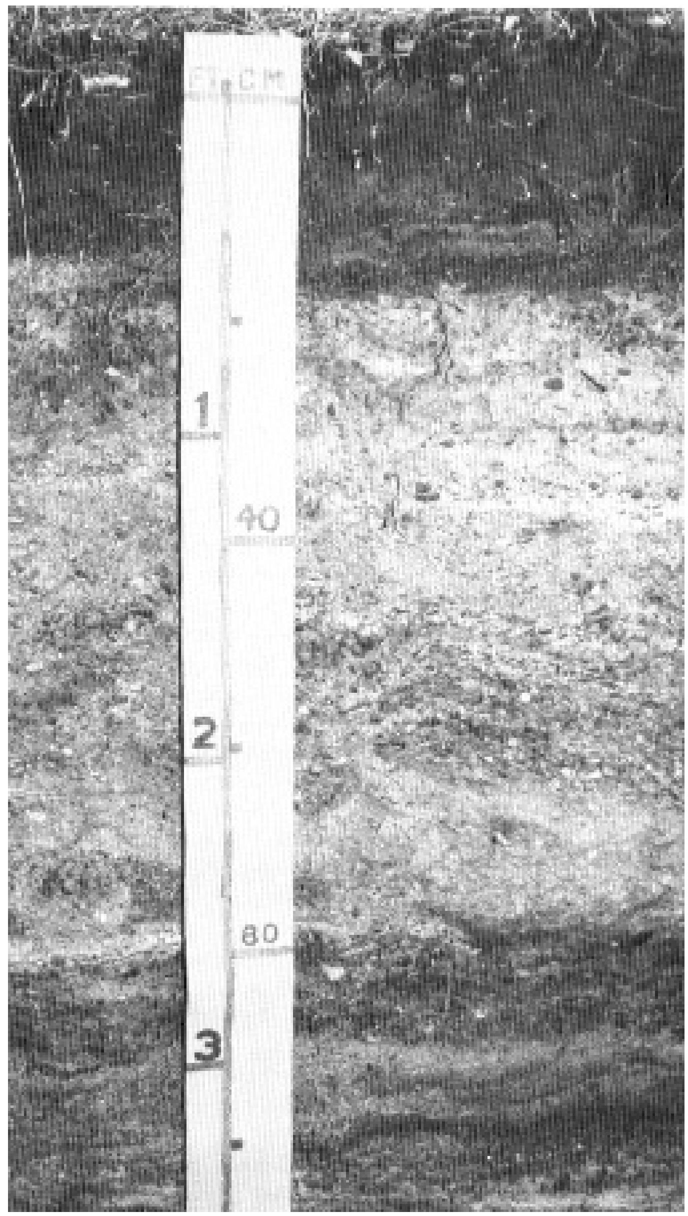

Figure 16.—A profile of Wamduska loamy coarse sand, which has a sandy and gravelly substratum.

brown in the upper part, grayish brown in the next part, and grayish brown and olive brown in the lower part. It has masses of salts and seams of gypsum below a depth of 18 inches. The substratum to a depth of about 60 inches is grayish brown and olive brown, mottled loam. In some places the subsoil has accumulated lime. In other places the surface layer is clay loam, sandy loam, or coarse sand. In some areas the soil is moderately saline.

Included with these soils in mapping are small areas of Buse and Glyndon soils and the saline Lallie soils. These soils make up about 5 percent of the unit. Buse soils are well drained. They are on shoulder slopes. Glyndon soils have a silt loam subsoil. They are in swales. Lallie soils are poorly drained. They are on lake plains. Also included are a few stony areas.

Permeability is rapid in the Wamduska soil and moderately slow in the Mauvais soil. Runoff is very slow on the Wamduska soil and medium on the Mauvais soil. Available water capacity is very low in the Wamduska soil and moderate in the Mauvais soil. A seasonal high water table is at a depth of 1 to 4 feet in the Mauvais soil.

Most areas are used for range or wildlife habitat. A few areas are used for cultivated crops or hay. These soils are best suited to rangeland wildlife habitat and range. They generally are unsuited to cultivated crops. The main limitations are the low natural fertility, stoniness, and droughtiness of the Wamduska soil. The hazard of soil blowing is severe on the Wamduska soil and moderate on the Mauvais soil. The hazard of water erosion is severe on both soils.

The important native forage plants on these soils are prairie sandreed, needleandthread, western wheatgrass, and big bluestem. Western wheatgrass, crested wheatgrass, smooth bromegrass, alfalfa, and sweetclover are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Reestablishing vegetation in denuded areas of the Wamduska soil is difficult. Maintaining an adequate plant cover helps to control soil blowing and water erosion and prevent denuding. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

The Wamduska soil generally is unsuited to the trees and shrubs grown as windbreaks and environmental plantings. The Mauvais soil is suited to many of the climatically adapted trees and shrubs. Eliminating weeds and grasses before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils are poorly suited to septic tank absorption fields. The moderately slow permeability and seasonal high water table in the Mauvais soil are limitations, but installing a mound system helps to overcome these limitations. Because of the rapid permeability, the Wamduska soil readily absorbs but does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water. Installing a mound system helps to prevent this pollution.

The Wamduska soil is well suited to buildings. The Mauvais soil also can be used as a building site, but the shrink-swell potential is a limitation. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. In areas of the Wamduska soil, the sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification of the Wamduska soil is VIs, and that of the Mauvais soil is IVw. The productivity index for spring wheat is 0. The range site of the Wamduska soil is Very Shallow, and that of the Mauvais soil is Subirrigated. The pasture group of the Wamduska soil is Very Shallow to Gravel, and that of the Mauvais soil is Loamy and Silty.

47—Lallie silty clay loam, saline. This deep, level, poorly drained, moderately saline soil is on flats on lake plains. It is frequently flooded and is subject to ponding. Individual areas range from about 5 to 450 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 3 inches thick. The substratum to a depth of about 60 inches is olive gray and mottled. It is silty clay loam in the upper part and silty clay in the lower part. In places the surface layer and the upper part of the substratum are silt loam. In a few areas the soil is nonsaline.

Included with this soil in mapping are small areas of Mauvais and Wamduska soils and the saline Borup soils. These soils make up about 15 percent of the unit. Borup soils have a subsoil that has accumulated lime. They are on flats. Mauvais soils are somewhat poorly drained. They are on rises. Wamduska soils are excessively drained. They are on abandoned beaches. Also included are some stony areas.

Permeability is slow in the Lallie soil. Runoff is ponded. Available water capacity is high. It is restricted by the salts in the soil. A seasonal high water table is 1 foot above to 1 foot below the surface. Tilth is fair.

Most areas are used for range or wetland wildlife habitat. A few areas are cultivated along with the more productive adjacent soils. This soil is best suited to wetland wildlife habitat, hay, pasture, and range. It generally is unsuited to cultivated crops and to trees and shrubs because of wetness, salinity, and low natural fertility. The hazards of soil blowing and water erosion are slight.

The important native forage plants on this soil are western wheatgrass, Nuttall alkaligrass, and inland saltgrass. Tall wheatgrass, slender wheatgrass, alsike clover, and sweetclover are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed during wet periods. They can be overcome by deferring grazing when the soil is wet. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil generally is unsuited to septic tank absorption fields and buildings because of the ponding and the flooding. Better sites generally are nearby.

The land capability classification is VIs. The productivity index for spring wheat is 0. The range site is Saline Lowland, and the pasture group is Saline.

48B—Barnes-Renshaw loams, 1 to 6 percent slopes. These deep, nearly level and undulating soils are on knolls and ridges on eskers and glacial till plains. The well drained Barnes soil is on side slopes. The somewhat excessively drained Renshaw soil is on summits and shoulder slopes. Individual areas range from about 5 to 125 acres in size. They are about 35 to 55 percent Barnes soil and 30 to 50 percent Renshaw soil. The two soils occurs as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 17 inches thick. It is dark brown in the upper part and grayish brown and calcareous in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loam. In some places the subsoil is calcareous throughout. In other places the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Renshaw soil has a black loam surface layer about 7 inches thick. The subsoil is about 18 inches thick. It is dark brown. It is loam in the upper part and calcareous gravelly coarse sand in the lower part. The substratum to a depth of about 60 inches is dark yellowish brown gravelly coarse sand. In places the depth to sand and gravel is only 8 to 14 inches.

Included with these soils in mapping are small areas of Divide, Egeland, Embden, Hamerly, Maddock, and Zell soils. These included soils make up about 10 percent of the unit. Divide and Hamerly soils are somewhat poorly drained. They are in swales. Egeland, Embden, Maddock, and Zell soils are intermingled with areas of the Barnes and Renshaw soils. The surface layer of Egeland soils is sandy loam, that of Embden soils is fine sandy loam, that of Maddock soils is loamy sand, and that of Zell soils is silt loam.

Permeability is moderately slow in the Barnes soil. It is moderately rapid in the upper part of the Renshaw soil and very rapid in the lower part. Runoff is medium on both soils. Available water capacity is high in the Barnes soil and low in the Renshaw soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to small grain and sunflowers. They are particularly well suited to rye and winter wheat. These crops help to control water erosion in fall, winter, and spring and can make the best use of early season moisture. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. Controlling water erosion and overcoming droughtiness are the main management concerns if cultivated crops are grown. Stripcropping, cover crops, and a conservation tillage system help to control water erosion. Grassed waterways in areas where runoff concentrates help to control gullying.

Smooth bromegrass, green needlegrass, intermediate wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants on these soils. Water erosion is a hazard, especially if the pasture is overgrazed. This hazard can be reduced by maintaining an adequate cover of the suitable plants.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Renshaw soil is suited to some of the climatically adapted species. It is droughty, and the trees and shrubs commonly are affected by moisture stress. Irrigation helps to ensure survival of the seedlings. Because of the low available water capacity of the Renshaw soil, little benefit is derived from fallowing during the season prior to planting. Eliminating grasses and weeds before the trees are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

The Barnes soil is suited to septic tank absorption fields, but the Renshaw soil is poorly suited. The moderately slow permeability of the Barnes soil is a limitation, but it can be overcome by enlarging the field. Because of the very rapid permeability, the Renshaw soil readily absorbs but does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water. Installing a mound system helps to prevent this pollution.

The Renshaw soil is well suited to buildings. The Barnes soil also can be used as a building site, but the shrink-swell potential is a limitation. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent the structural damage caused by shrinking and swelling. In areas of the Renshaw soil, the sides of shallow excavations, such as those for basements, tend to cave in unless they are shored.

The land capability classification of the Barnes soil is IIe, and that of the Renshaw soil is IIIe. The productivity index for spring wheat is 62. The pasture group of the Barnes soil is Loamy and Silty, and that of the Renshaw soil is Shallow to Gravel.

70E—Kloten-Buse loams, 9 to 25 percent slopes. These strongly sloping and moderately steep, well drained soils are in stream valleys. Shale bedrock underlying the Kloten soil is exposed in some areas, and there are small earthslides or slumps. The shallow Kloten soil is on side slopes. The deep Buse soil is on shoulder slopes and summits. Individual areas range from about 10 to 350 acres in size. They are about 35 to 55 percent Kloten soil and 25 to 45 percent Buse soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Kloten soil has a black loam surface layer about 7 inches thick. The substratum is very dark grayish brown very channery loam about 11 inches thick. Below this is dark olive gray shale bedrock (fig. 17). In some places the surface layer is channery loam. In other places the depth to shale bedrock is 20 to 40 inches.

Typically, the Buse soil has a very dark grayish brown loam surface layer about 7 inches thick. The subsoil is calcareous loam about 12 inches thick. It is brown in the upper part and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In some places the dark color of the surface layer extends to a depth of only 3 to 6 inches. In other places the upper part of the subsoil is noncalcareous.

Included with these soils in mapping are small areas of Lamoure, Miranda, Svea, and Walsh soils. These included soils make up about 15 percent of the unit. Lamoure soils are poorly drained. They are on flood plains. Miranda soils have a dense, alkali subsoil. They are on foot slopes and toe slopes. Svea soils are moderately well drained. They are on side slopes. Walsh soils have a noncalcareous subsoil and substratum. They are on foot slopes. Also included are some long and narrow areas of very steep soils and some very stony areas.

Permeability is moderate in the Kloten soil and moderately slow in the Buse soil. Runoff is rapid on the Kloten soil and very rapid on the Buse soil. Available water capacity is very low in the Kloten soil and high in the Buse soil. The shale bedrock underlying the Kloten soil restricts the depth to which roots can penetrate.

Most areas are used for range. Hay is harvested in some areas, generally along drainageways and on the lower concave side slopes. These soils are best suited to rangeland wildlife habitat and range. They generally are unsuited to cultivated crops because of the slope of both soils and the droughtiness and shallowness of the Kloten soil. The hazard of soil blowing is moderate on the Buse soil, and the hazard of water erosion is severe on both soils.

The important native forage plants on these soils are needleandthread, western wheatgrass, green needlegrass, and little bluestem. Water erosion and soil blowing are problems, especially if the range is overgrazed. Reestablishing vegetation in denuded areas is difficult. Maintaining an adequate cover of the important plants helps to control water erosion and soil blowing and prevent denuding. Gullies can form along cattle trails. Cross fences that control the pattern of livestock traffic help to prevent gullying.

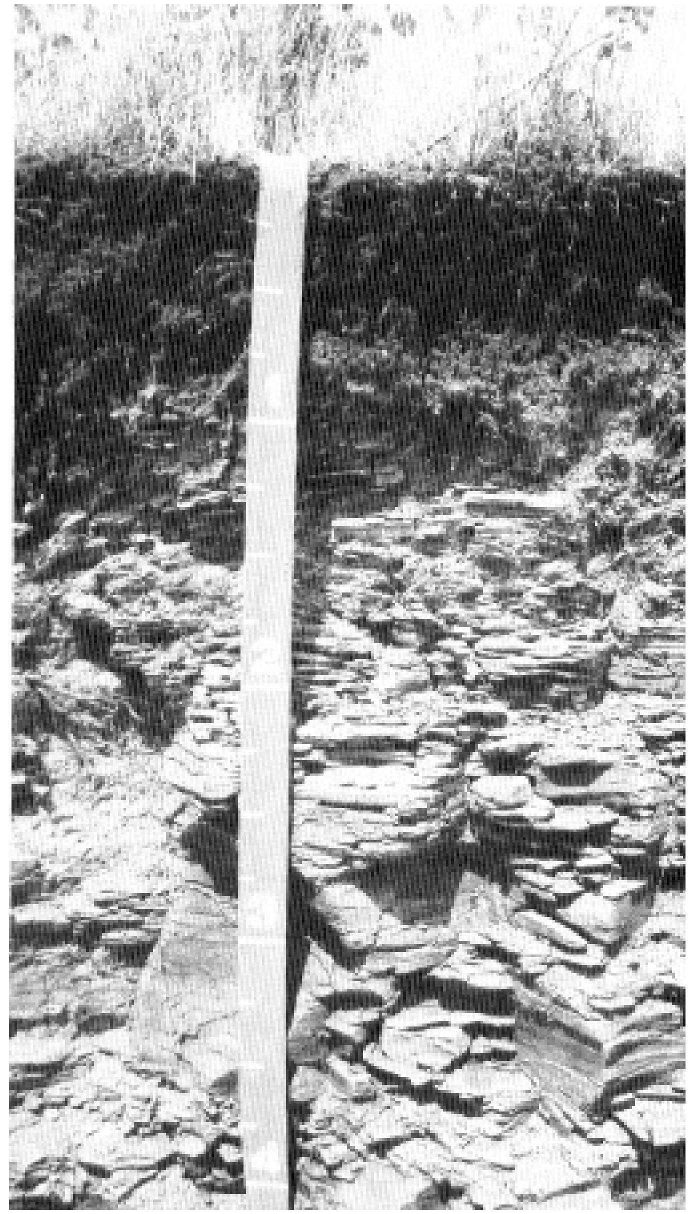

Figure 17.—A profile of Kloten loam. Bedrock is at a depth of about 18 inches. Depth is marked in feet.

These soils generally are unsuited to the trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be planted on the Buse soil for esthetic purposes or for wildlife if special treatment, such as hand planting or scalp planting, is applied.

These soils generally are unsuited to septic tank absorption fields and buildings. The slope of both soils and the shallowness of the Kloten soils are the main limitations. Better sites generally are nearby.

The land capability classification is VIIe. The productivity index for spring wheat is 0. The range site of the Kloten soil is Shallow, and that of the Buse soil is Thin Upland.

73—Lamoure silty clay loam. This deep, level, poorly drained soil is on flood plains and in drainageways. It is frequently flooded. Some areas are dissected into small, irregularly shaped tracts by deep channels or are isolated by steep escarpments. Individual areas range from about 5 to 350 acres in size.

Typically, the surface soil is about 33 inches thick. It is black. It is silty clay loam in the upper part and clay loam in the lower part. The upper part of the substratum is black, mottled sandy clay loam. The next part is dark gray loamy sand. The lower part to a depth of about 60 inches is dark gray loamy coarse sand. In some places the surface layer is silt loam or clay loam. In other places a subsoil that has accumulated lime is within a depth of 16 inches. In a few areas the soil is subject to ponding.

Included with this soil in mapping are small areas of the moderately well drained LaDelle soils on rises. These soils make up about 20 percent of the unit.

Permeability is moderate in the Lamoure soil. Runoff is slow. Available water capacity is high. A seasonal high water table is within a depth of 2 feet. Tilth is good.

Most areas are used for range or hay. This soil is suited to small grain and sunflowers. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. Overcoming the wetness, controlling scouring during periods of flooding, and controlling soil blowing are the main management concerns if cultivated crops are grown. A drainage system improves the suitability for crops, but the flooding is still a hazard. It occurs most commonly after spring thaw and before crops are planted. Cover crops, buffer strips, and a conservation tillage system help to control soil blowing and minimize the scouring caused by floodwater.

Reed canarygrass, creeping foxtail, big bluestem, and alsike clover are suitable hay and pasture plants on this soil. The wetness hinders haying in some years. Scouring is a hazard during periods of flooding, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable plants reduces this hazard.

The important native forage plants on this soil are big bluestem, switchgrass, indiangrass, and prairie cordgrass. Soil blowing and scouring by floodwater are hazards, especially if the range is overgrazed. Maintaining an adequate cover of the important plants reduces these hazards.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating these plants before the trees and shrubs are planted and then controlling the regrowth of the ground cover improve the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields and buildings because of the flooding and the wetness. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat is 51 to 76, depending on the degree of drainage. The range site is Subirrigated, and the pasture group is Wet.

Prime Farmland

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

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

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

About 263,000 acres in the survey area, or more than 45 percent of the total acreage, meets the soil requirements for prime farmland. Most areas of this land are in associations 1, 2, 4, and 5, which are described under the heading "General Soil Map Units." Nearly all of the prime farmland is used for crops, mainly spring wheat, durum wheat, and sunflowers.

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

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

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

5	Hamerly-Tonka complex, 0 to 3 percent slopes (where drained)
8	Svea loam
10	Svea loam, 1 to 3 percent slopes
11B	Svea-Buse loams, 3 to 6 percent slopes
12B	Barnes-Svea loams, 3 to 6 percent slopes
15	Borup silt loam (where drained)
20	Hamerly loam, 0 to 2 percent slopes
20B	Hamerly loam, 2 to 5 percent slopes
22	Vallers loam, 0 to 3 percent slopes (where drained)
30	Embden fine sandy loam, 0 to 3 percent slopes
31B	Egeland sandy loam, 3 to 6 percent slopes
32	Gardena silt loam, 0 to 3 percent slopes
32B	Gardena silt loam, 3 to 6 percent slopes
33	Glyndon silt loam
34	LaDelle silt loam
37	Fordville loam
40	Divide loam, 0 to 3 percent slopes
41	Vang loam
44B	Walsh loam, 1 to 6 percent slopes
73	Lamoure silty clay loam (where drained)

Use and Management of the Soils

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

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

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

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

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

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

Crops and Pasture

This section was prepared by Lyle Samson, agronomist, and David R. Hernandez, soil conservationist, Soil Conservation Service.

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

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

About 75 percent of the survey area is cultivated. In 1984, about 267,000 acres was used for close-grown crops, 101,000 acres for row crops, and 31,000 acres for forage crops (*11*). The acreage of summer fallow was about 105,000 acres in 1980; 85,000 acres in 1981; 70,000 acres in 1982; 130,000 acres in 1983; and 105,000 acres in 1984. The acreage used for sunflowers has fluctuated, but generally it is increasing. It averaged 76,600 acres per year from 1980 to 1984. It was 61,000 acres in 1980 and 72,000 acres in 1983. The acreage used for corn and forage has been stable since 1981.

In 1984, the acreages of the principal close-grown crops were as follows: spring wheat, 90,000 acres; durum wheat, 86,000 acres; winter wheat, 4,000 acres; barley, 67,000 acres; oats, 10,500 acres; and flax, 8,500 acres. The main row crops were sunflowers and corn. Sunflowers were grown on 89,000 acres, corn for grain on 3,100 acres, and corn for silage on 2,600 acres. Alfalfa was grown on 10,500 acres and other hay crops on 21,000 acres. Small acreages were planted to mustard, rye, buckwheat, lentil, millet, and soybeans. About 800 acres is irrigated.

The potential of the soils in the survey area for increased production of food and fiber is good. This production is steadily increasing as the latest crop production technology is applied. This soil survey can facilitate the application of this technology.

The soils and climate are suited to most of the crops that are commonly grown in the survey area. Crops that are not commonly grown but are suitable include dry edible beans, potatoes, and rapeseed.

The principal management measures that help to ensure continuing productivity are those that control soil blowing and water erosion, maintain or improve fertility and tilth, and result in proper utilization of soil moisture.

Water erosion and soil blowing reduce the productivity of the soils. If the surface layer is lost, most of the available plant nutrients also are lost. As a result, applications of fertilizer are needed to maintain adequate crop production.

Of equal concern is the loss of organic matter through erosion. Soil structure, water infiltration, available water capacity, and tilth are all negatively affected by this loss. As organic matter is lost and the subsoil is exposed and tilled, the remaining soil becomes increasingly susceptible to both soil blowing and water erosion.

Soil blowing is a hazard on most of the soils in the survey area. It is a severe hazard on the coarse textured and moderately coarse textured soils, including Arvilla, Egeland, and Maddock soils.

Borup, Buse, Divide, Glyndon, Hamerly, Mauvais, Vallers, Zell, and other soils that have a relatively high content of lime are susceptible to soil blowing in the spring if they have been bare throughout the winter. Because of freezing and thawing, soil structure breaks down, resulting in aggregates that are susceptible to movement. Nearly all soils can be damaged by soil blowing if they are bare.

Water erosion is a severe hazard on moderately sloping to very steep soils, such as the steeper Barnes, Buse, Kloten, Svea, and Zell soils. It is most severe when the surface is bare.

Conservation practices that control both soil blowing and water erosion are those that maintain a protective cover. Examples are conservation tillage systems that keep a protective amount of crop residue on the surface. Applications of herbicide can help to eliminate the need for summer fallow tillage. Cover crops also are effective in controlling both soil blowing and water erosion. Field windbreaks, annual wind barriers, and stripcropping help to control soil blowing. Inclusion of grasses and legumes in the cropping sequence, grassed waterways, diversions, terraces, contour farming, and field stripcropping across the slope help to control water erosion. A management system that includes several measures is the best means of protecting the soil. For example, conservation tillage can control soil blowing during years when the amount of crop residue is adequate, but windbreaks are needed during years when the amount of residue is low.

Soil moisture at planting time is critical to the success of the crop during the growing season. In years when the amount of available soil moisture is low at planting time, crop success is greatly reduced. Measures that reduce evaporation and runoff rates, increase the rate of water infiltration, and control weeds conserve moisture. Examples are stubble mulch; mulch tillage; no-till farming; stripcropping; cover crops; crop residue management; standing stubble, which traps snow; and applications of fertilizer. When fallow is used to carry moisture over to the next season, a cover of crop residue is essential during winter to guard against moisture loss and erosion. Weed control helps to prevent depletion of the moisture supply.

Measures that improve fertility are needed on many soils. Examples are applications of commercial fertilizer or barnyard manure, green manure crops, and inclusion of legumes in the cropping sequence.

Proper management of soils includes measures that maintain good tilth. These measures are especially needed on soils that have an alkali subsoil, such as Cavour and Cresbard soils. Measures that maintain the content of organic matter are very important if good tilth is to be maintained. The traditional practice of clean-tilled summer fallow contributes to the loss of organic matter because it increases the susceptibility to erosion.

Pasture Groups

The following paragraphs describe the pasture groups in the survey area. The names of these groups are Clayey Subsoil, Claypan, Limy Subirrigated, Loamy and Silty, Overflow and Run-on, Saline, Sands, Sandy, Shallow to Gravel, Thin Claypan, Thin Upland, Very Shallow to Gravel, Wet, and Wetland. The production potential under improved management is specified for each group.

Clayey Subsoil. This group is dominated by soils having a subsoil that moderately restricts root penetration. It is suited to a wide range of native and introduced pasture plants. The production potential is moderately high.

Claypan. This group is dominated by soils having a subsoil that severely restricts root penetration. It is suited to an intermediate range of native and introduced pasture plants. The production potential is low.

Limy Subirrigated. This group is dominated by highly calcareous soils that have a seasonal high water table within rooting depth. It is suited to a wide range of native and introduced pasture plants. The production potential is high.

Loamy and Silty. This group is dominated by soils that have few limitations affecting pasture plants. It is suited to a wide range of native and introduced pasture plants. The production potential is high.

Overflow and Run-on. This group is dominated by soils that receive additional water because of flooding or runoff. It is suited to a wide range of native and introduced pasture plants. The production potential is high.

Saline. This group is dominated by soils that contain an appreciable amount of salts, which reduce the amount of water available to plants. It is suited to a narrow range of salt tolerant pasture plants. The production potential is moderately high.

Sands. This group is dominated by soils that are droughty and are highly susceptible to soil blowing. It is suited to an intermediate range of pasture plants. The production potential is moderately high.

Sandy. This group is dominated by soils that are moderately droughty and are highly susceptible to soil blowing. It is suited to an intermediate range of pasture plants. The production potential is high.

Shallow to Gravel. This group is dominated by soils that are droughty. It is suited to a narrow range of drought-tolerant pasture plants. The production potential is moderate.

Thin Claypan. This group is dominated by soils having a subsoil that very severely restricts root penetration. It is suited to a narrow range of pasture plants. The production potential is low.

Thin Upland. This group is dominated by soils that have a calcareous, generally thin surface layer and a high runoff potential. It is suited to an intermediate range of pasture plants. The production potential is moderate.

Very Shallow to Gravel. This group is dominated by soils that are very droughty. It is suited to a very narrow range of pasture plants. The production potential is low.

Wet. This group is dominated by soils that have a seasonal high water table and that commonly are subject to ponding. It is suited to a narrow range of water-tolerant pasture plants. The production potential is very high.

Wetland. This group is dominated by soils that are too wet for pasture plants unless a drainage system is installed.

Management of Saline and Alkali Soils

Saline and alkali soils make up nearly 12 percent of the survey area. Saline soils make up about 9 percent of the area, or about 52,000 acres; alkali soils make up nearly 3 percent, or about 15,000 acres; and saline-alkali soils make up less than 1 percent, or about 700 acres.

Saline soils have a high concentration of soluble salts, or salts that dissolve in water. The saline soils in the survey area are phases of the Borup, Hamerly, Lallie, Playmoor, and Vallers series.

Saline soils generally develop in areas of restricted drainage, such as those adjacent to sloughs and waterways. Where drainage is poor, salts rise with the water table and are concentrated near the surface. This salt buildup is reduced by plants and a surface cover. The plant roots use the soil water before it can reach the surface and before the salts accumulate. The surface cover prevents evaporation at the surface, the upward movement of water in the soil, and the concentration of salts at the surface.

Plants growing on saline soils absorb salts from the soil water. Excess amounts of certain salts can interfere with plant growth. High concentrations of some salts are toxic to certain plants. Some salts cause nutritional imbalances or deficiencies by restricting the uptake or availability of certain plant nutrients. Detecting salinity by visual observations in the field is difficult. The salts are generally not visible during much of the growing season, particularly when the soil is moist. Flecks, threads, or masses of soluble salts are usually visible when the soil is dry. Laboratory analysis is needed to determine the actual degree of salinity in soils.

Crop response, particularly during periods of moisture stress, is a useful indicator of the degree of salinity in saline soils. For instance, a small grain crop growing on saline soils tends to be stunted and has fewer tillers than small grain on nonsaline soils. Strongly saline soils are best suited to native grasses or to salt tolerant introduced grasses. Slightly saline or moderately saline soils can produce salt-tolerant crops and forage. Barley is the most salt tolerant of the small grains. Of the forage crops, tall wheatgrass, western wheatgrass, and alfalfa are salt tolerant once they are established.

Alkali soils are characterized by a high content of exchangeable sodium, which adheres to the clay particles in the soil. Cavour and Cresbard are the alkali soils in the survey area. Locally, alkali soils are known as "alkali" or "gumbo."

Alkali soils develop in a complex pattern with a very distinct microrelief. The physical and chemical properties of these soils differ markedly within very short distances. In many areas the distance between the alkali soils and the surrounding soils that have normal physical properties is only a few feet, perhaps 5 to 10 feet.

Alkali soils develop in areas of saline soils that contain large quantities of sodium salts. Over a long period, usually centuries, as the water table lowers, rainwater gradually leaches the salts from the surface to lower horizons. During this leaching process, the clay in the soil becomes saturated with sodium, disperses, and moves downward with the percolating water. As the moving clay concentrates, a dense, alkali subsoil forms. The dense subsoil is hard when dry, sticky when wet, and nearly impervious to roots, water, and air. Cavour soils are an example of soils that have a dense, alkali subsoil.

As the leaching by soil water continues, the sodium is gradually moved lower in the soil profile and eventually is carried below rooting depth. The result is a more manageable soil, such as Cresbard loam. If the leaching process continues and nearly all of the sodium is removed from the profile, the soil eventually changes into a nonalkali soil. This change requires a long period, usually centuries (*6*).

If plowed, alkali soils are characterized by a surface layer that is sticky when wet and hard and cloddy when dry. A crust forms easily at the surface. The chemical and physical properties of these soils are unfavorable for plant growth. The harmful effects of the properties on plants generally increase as the sodium content increases. The effects of the reduced amount of water available to plants are more harmful than the toxic effect of the sodium. The plants also are affected by the depth to the dense subsoil.

Identification of alkali soils in cultivated fields commonly is difficult because many of the physical characteristics, such as columnar structure, have been altered by tillage. Crop response, particularly during periods of moisture stress, is a useful indicator of the level of alkalinity in a soil. Crops grown on soils with varying amounts of sodium exhibit varying heights and stages of development. If the level of alkalinity is very high, the crop cannot grow. The effects of sodium on crop growth are influenced by weather conditions, the stage of crop growth, and the soil moisture status. A measure of the effect of alkalinity on vegetative growth is not necessarily a reliable measure of crop yields. In many areas the yields of barley and wheat are affected less than the vegetative growth of these crops.

The variability of alkali soils can cause management problems. The soils that have a dense, alkali subsoil near the surface, such as Cavour soils, are better suited to grasses than to small grain and sunflowers.

Timely tillage is an important management need in areas of the leached alkali soils, such as Cresbard soils. These areas should be tilled and seeded only when the moisture content is favorable. If worked when too wet, the soils puddle and crust. If the soils are tilled when too dry, tillage and seeding implements cannot easily penetrate the surface. Deep plowing and chemical amendments can help to reclaim alkali soils, but they may not be feasible. To be effective, deep tillage should reach to the alkali subsoil and mix several inches of the underlying material with the subsoil and topsoil. Depending on the soil, tillage to a depth of 15 to 36 inches may be needed. Any reclamation of alkali soils is a long-term endeavor. Complete reclamation may never be achieved. Onsite investigation is needed to confirm the feasibility of deep tillage in a particular area.

Saline-alkali soils develop in areas of restricted drainage where salts rise with the water table but where some leaching downward of clay and some saturation with sodium are evident and a dense, alkali subsoil has formed. Miranda loam is a saline-alkali soil (fig. 18). The management needs and crop responses on this soil are a combination of those on saline soils and those on alkali soils.

Additional information about management or reclamation of saline and alkali soils can be obtained from the Soil Conservation Service, the North Dakota Agricultural Experiment Station, and the Cooperative Extension Service.

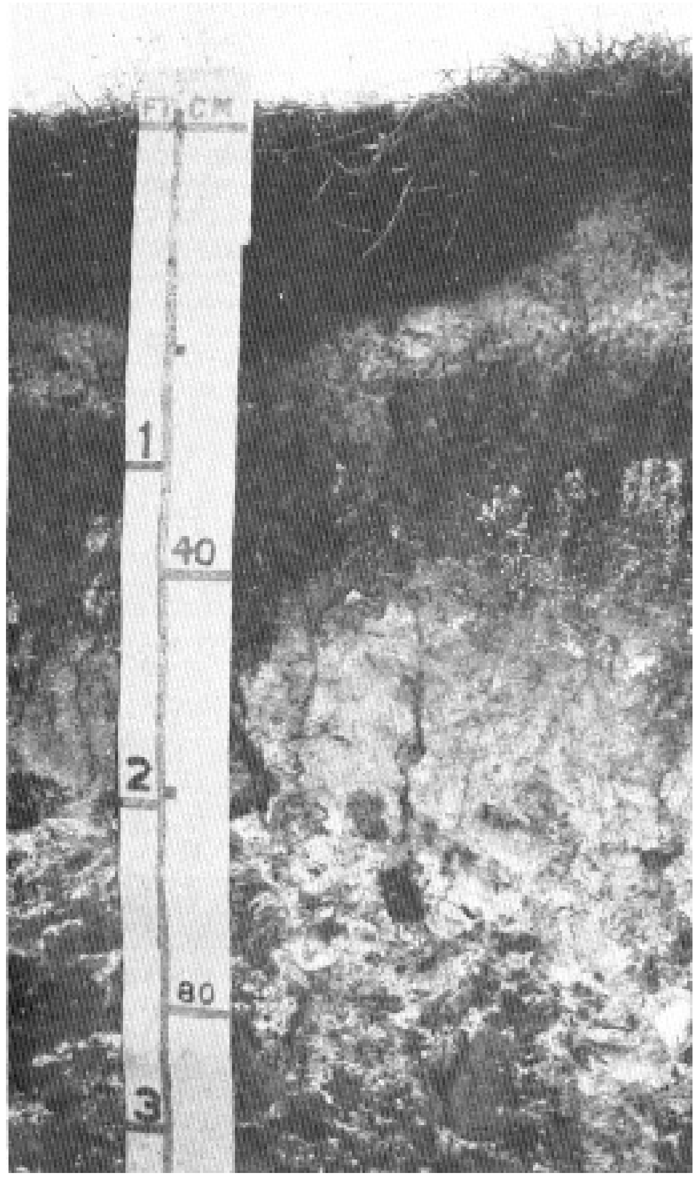

Figure 18.—A profile of Miranda loam. The light colored subsurface layer is highly leached, and salts are in the lower part of the subsoil.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

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

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

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

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

Productivity Index

The productivity index is a relative rating of the ability of a particular map unit to produce a particular crop yield in comparison to other map units. The index ranges from 0, which indicates no yield, to 100, which indicates the highest yield. When the index is calculated, the similar and contrasting inclusions are considered as well as the soils specified in the name of the map unit. In the survey area a productivity index of 100 was considered equal to an average yield of 40 bushels per acre of spring wheat. Multiplying the productivity index by 40 and then dividing the product by 100 will convert the index number to a figure representing the expected average yield per acre. Svea-Buse loams, 3 to 6 percent slopes, for example, has a productivity index of 73, which when multiplied by 40 and then divided by 100, converts to 29, which is the expected annual yield of spring wheat in bushels per acre for this map unit. (See table 5.)

Land Capability Classification

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

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

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

Class I soils have few limitations that restrict their use.

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

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

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

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

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

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

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

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

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

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

Rangeland

This section was prepared by Leonard Jurgens, range conservationist, Soil Conservation Service.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

The native vegetation on rangeland consists of a wide variety of grasses, grasslike plants, forbs, shrubs, and trees. Generally, the plants are suitable for grazing and the plant cover is sufficiently productive to justify grazing. Cultural treatments generally are not used to increase forage production. The composition and production of the plant community are determined by soil, climate, topography, overstory canopy, and grazing management.

In 1985, approximately 66,000 acres in Nelson County, or about 10 percent of the total acreage, was rangeland. In areas where it is properly managed, this rangeland is similar to the presettlement prairie of the late 1800's and early 1900's. Most of the rangeland is on loamy glacial till plains, in stream valleys, and on lake plains. Much of it occurs as rolling to steep soils or as level soils that are wet, saline, or alkaline. The soils generally are unsuited or poorly suited to cultivated crops.

Most of the farms include a cow-calf operation. A number also include a yearling operation, which adds flexibility during periods of low or high forage production. On some farms used for a cow-calf operation, sheep are raised for improved income stability. In 1985, the farms in Nelson County had about 17,000 head of cattle. Of that number, about 1,000 were milk cows (*11*).

Because of the relatively short growing season, many operators have established cool-season tame pastures to supplement the forage produced on rangeland and to extend the grazing season in the spring and fall. Droughts of short duration are common. As a result, cool-season pastures cannot be grazed in the fall in many years. Generally, large amounts of hay and feed are needed because of the long winters. In 1984, hay was harvested on about 31,500 acres in Nelson County (*11*).

Range Site and Condition Classes

Soils vary in their capacity to produce grasses and other plants suitable for grazing. Soils that produce about the same kinds and amounts of forage are grouped into a range site.

Each range site has a distinctive potential plant community that is referred to as the climax vegetation. The climax vegetation is relatively stable and indicates what the range site is capable of producing. It reproduces itself annually and changes very little as long as the environment remains unchanged. On the prairie the climax vegetation consists of the kind of plants that grew when the region was settled. It is generally the most productive combination of forage plants that can be grown on the site. When the site is grazed, some of the climax vegetation decreases in extent and some of it increases. Also, other plants invade the site.

Decreaser plants are the species that decline in quantity under close, continuous grazing. They generally are the tallest and most productive grasses and forbs and are the most palatable to livestock.

Increaser plants are the species that increase in quantity under close grazing at the expense of the decreaser species. They generally are the shorter plants or the ones less palatable to livestock.

Invader plants are species normally not included in the climax plant community because they cannot compete with the climax vegetation for moisture, nutrients, and light. They invade the site only after the extent of the climax vegetation has been reduced by continual heavy grazing. Most invader species have little grazing value.

Range condition classes indicate the present composition of the plant community on a range site in relation to the climax vegetation. Range condition is expressed as excellent, good, fair, or poor, depending on how much the present plant community has departed from the climax. *Excellent* indicates that 76 to 100 percent of the present plant community is the same as the climax vegetation; *good*, 51 to 75 percent; *fair*, 26 to 50 percent; and *poor*, 25 percent or less.

Potential forage production depends on the kind of range site. Current forage production depends on the range condition and the amount of moisture available to the plants during the growing season.

Table 6 shows, for some soils in the survey area, the range site and the potential annual production of vegetation in favorable, average, and unfavorable years. Only those soils that are used as rangeland or are suited to use as rangeland are listed. An explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Potential annual production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, average, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as exposure, amount of shade, recent rains, and unseasonable dry periods.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Good range management keeps the range in excellent or good condition. Water is conserved, yields are improved, and soils are protected. The main management concern is recognizing the changes in the plant community that take place gradually and can be misinterpreted or overlooked. Growth encouraged by heavy rainfall, for example, may lead to the conclusion that the range is in good condition, when actually the plant cover is weedy and the long-term trend is toward lower production. On the other hand, some rangeland that has been grazed closely for a short period may have a degraded appearance that temporarily obscures its quality and ability to recover rapidly.

Rangeland can recover from prolonged overuse if the climax decreaser species have not been completely grazed out. If overgrazing is stopped, enough climax plants generally remain for proper grazing use, deferred grazing, and the grazing system to restore the rangeland to an excellent condition. In areas where the climax plant community has been destroyed, range seeding can improve the condition. Seeding the proper climax species also can restore productive rangeland in areas of poor-quality cropland. Brush control, development of watering facilities, and other mechanical practices are needed to improve the potential of some rangeland. Fencing is one of the most overlooked means of improving rangeland.

The following paragraphs describe the range sites in the survey area. The names of these sites are Claypan, Overflow, Saline Lowland, Sands, Shallow, Silty, Subirrigated, Thin Claypan, Thin Upland, Very Shallow, and Wetland.

Claypan range site. The vegetation on this site is primarily a mixture of short and mid grasses, sedges, and forbs. The principal species are western wheatgrass, green needlegrass, and prairie junegrass. Other species are Sandberg bluegrass, plains reedgrass, blue grama, and upland sedges. The common forbs are scarlet globemallow, prairie thermopsis, and western yarrow. The site has only a minor amount of woody species.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, prairie junegrass, needleandthread, and plains reedgrass. The plants that increase in abundance under these conditions are western wheatgrass, blue grama, upland sedges, and fringed sagewort. Further deterioration results in a dominance of blue grama, upland sedges, fringed sagewort, and unpalatable forbs.

This site is easily damaged by overgrazing. Because of a dense subsoil and the content of salts in the soil, reestablishing the vegetation is difficult in denuded areas. Careful management that maintains an abundance of the important plants is the best way to maintain forage production and protect the soil from water erosion.

Overflow range site. Both tall and mid grasses are dominant when this site is in excellent condition. The principal species are big bluestem, green needlegrass, western wheatgrass, and needleandthread. Other species are porcupinegrass, bearded wheatgrass, thickspike wheatgrass, Pennsylvania sedge, fescue sedge, little bluestem, and Kentucky bluegrass. Several forbs, such as Missouri goldenrod and tall white aster, make up about 10 percent of the total herbage. Several woody plants, such as western snowberry, prairie rose, common chokecherry, buffaloberry, and green ash, commonly grow on the site, depending on the position on the landscape. In some areas they make up about 5 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, green needlegrass, prairie dropseed, and little bluestem. The plants that increase in abundance under these conditions are western wheatgrass, blue grama, Pennsylvania sedge, fescue sedge, and Kentucky bluegrass. Further deterioration results in a dominance of blue grama, sedges, and unpalatable forbs.

Because of its position on the landscape, this site is frequently overgrazed. Fencing generally is not feasible because of the small size or the shape of areas of this site. As a result of flooding and the runoff received by these areas, this is a very productive site when properly managed. A planned grazing system can restore the site and can maintain a high level of productivity. Reseeding is needed in areas that have been farmed. In areas where shrubs dominate, brush control can help to restore productivity.

Saline Lowland range site. Salt-tolerant, mid grasses dominate this site. The principal species are Nuttall alkaligrass, inland saltgrass, alkali cordgrass, and salt-tolerant varieties of western wheatgrass and slender wheatgrass. Other species are alkali muhly, foxtail barley, mat muhly, and prairie bulrush. Forbs, such as silverweed cinquefoil and Pursh seepweed, make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as Nuttall alkaligrass, slender wheatgrass, and alkali cordgrass. The plants that increase in abundance under these conditions are western wheatgrass, inland saltgrass, foxtail barley, and mat muhly. Further deterioration results in a dominance of inland saltgrass, foxtail barley, mat muhly, and unpalatable forbs, such as silverweed cinquefoil and dock.

A high content of salts and a restricted available water capacity limit forage production on this site. Careful management of the adapted salt tolerant plants can maintain good forage production. If the plant community has been severely damaged, however, the site recovers slowly. Soil blowing and water erosion are hazards in denuded areas. Stock water ponds on this site frequently contain salty water. If feasible, alternative water sources should be developed.

Sands range site. The principal grasses on this site are prairie sandreed, needleandthread, sand bluestem, and little bluestem. Other species are blue grama, prairie junegrass, sand dropseed, western wheatgrass, and upland sedges. Forbs make up about 10 percent of the total herbage. This site has a small amount of woody species, such as prairie rose, western snowberry, and leadplant amorpha.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as prairie sandreed, needleandthread, little bluestem, sand bluestem, and leadplant amorpha. The plants that increase in abundance under these conditions are sand dropseed, blue grama, upland sedges, and several forbs. Further deterioration results in a dominance of blue grama, Pennsylvania sedge, threadleaf sedge, sun sedge, and unpalatable forbs, such as green sagewort, fringed sagewort, and gray sagewort.

A low or very low available water capacity and the hazard of soil blowing are concerns in managing this site. Measures that minimize the formation of livestock trails and that do not allow the animals to concentrate in an area for too long a time are needed. In severely overgrazed areas, blowouts are common. On large blowouts, shaping, seeding, and mulching are needed before the climax vegetation can be reestablished. The vegetation in areas where the site is in fair or poor condition responds rapidly to improved grazing management.

Shallow range site. A mixture of cool- and warm-season, mid grasses dominates this site. The principal species are western wheatgrass, needleandthread, and green needlegrass. Other species are plains muhly, blue grama, porcupinegrass, threadleaf sedge, and Pennsylvania sedge. Forbs make up about 10 percent of the total herbage. The site has only a small amount of woody plants.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, needleandthread, and porcupinegrass. The plants that increase in abundance under these conditions are blue grama, western wheatgrass, red threeawn, and upland sedges. Further deterioration results in a dominance of blue grama, upland sedges, unpalatable forbs, and fringed sagewort.

Because of a limited available water capacity, forage production is limited on this site. It varies, depending on rainfall patterns. The site is fragile, and the plant community can deteriorate rapidly if poor management results in severe erosion. Management that keeps the plant community near its potential helps to control erosion and results in the best use of the available water.

Silty range site. Mid grasses dominate this site. The principal species are western wheatgrass, needleandthread, green needlegrass, and blue grama. Other species are prairie junegrass, prairie dropseed, Kentucky bluegrass, and upland sedges. Forbs make up about 10 percent of the total herbage. The site has minor amounts of woody species.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, prairie junegrass, needleandthread, and porcupinegrass. The plants that increase in abundance under these conditions are western wheatgrass, blue grama, Kentucky bluegrass, threadleaf sedge, needleleaf sedge, and fringed sagebrush. Further deterioration results in a dominance of blue grama, threadleaf sedge, needleleaf sedge, and varying amounts of fringed sagebrush, gray sagewort, and other forbs.

Generally, no major problems affect management of this site. In the sloping areas, however, gullies can form along livestock trails. Fencing and improved grazing management help to prevent gullying. They are also beneficial in areas where gullies have already formed. Areas where the site is in poor or fair condition generally can be restored to good or excellent condition by good management. In some areas brush control is needed.

Subirrigated range site. Tall grasses dominate this site. The principal species are big bluestem, switchgrass, prairie cordgrass, little bluestem, and northern reedgrass. Other species are indiangrass, western wheatgrass, tall dropseed, slender wheatgrass, and Kentucky bluegrass. The site has minor amounts of sedges and rushes. A variety of forbs makes up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, switchgrass, prairie cordgrass, northern reedgrass, indiangrass, and little bluestem. The plants that increase in abundance under these conditions are mat muhly, fowl bluegrass, Kentucky bluegrass, Baltic rush, common spikerush, and undesirable forbs. Further deterioration results in a dominance of short grasses and grasslike plants and of undesirable forbs.

Because of the high percentage of warm-season grasses, this site can provide high-quality forage late in the growing season. In areas where the plant community has deteriorated from its potential, deferment of grazing during the growing season or a planned grazing system can restore the site. In areas where the potential plant community has been destroyed by cultivation or by extremely severe overuse, range seeding can reestablish the major grass species.

Thin Claypan range site. Short grasses dominate this site. The principal species are western wheatgrass, blue grama, prairie junegrass, and Sandberg bluegrass. Other species are inland saltgrass, tumblegrass, buffalograss, Pennsylvania sedge, and other upland sedges. Forbs make up about 5 percent of the total herbage. The common woody plants are fringed sagebrush, broom snakeweed, and cactus.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as western wheatgrass, prairie junegrass, and needleandthread. Plants that increase in abundance under these conditions are blue grama, inland saltgrass, Sandberg bluegrass, upland sedges, and fringed sagebrush. Further deterioration results in a dominance of short grasses, sedges, fringed sagebrush, broom snakeweed, and undesirable forbs.

Because of a high content of salts near the surface, productivity is quite low on this site. The site produces good-quality forage only if properly managed. If the site is in poor or fair condition, recovery is quite slow because of the salts and a dense, alkali subsoil. Stock water pits should not be constructed on this site because the water is likely to be salty. Careful management can maintain or restore the site to good or excellent condition. If the vegetation has been destroyed by cultivation or the site denuded, range seeding can restore the climax vegetation. Good seeding techniques are needed.

Thin Upland range site. Mid, cool- and warm-season grasses dominate this site. The principal species are little bluestem, needleandthread, western wheatgrass, and blue grama. Other species are plains muhly, sideoats grama, red threeawn, Kentucky bluegrass, and upland sedges. Forbs make up about 10 percent of the herbage. The site has minor amounts of woody plants, such as silverberry and western snowberry.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as little bluestem, needleandthread, western wheatgrass, and sideoats grama. The plants that increase in abundance under these conditions are blue grama, red threeawn, Kentucky bluegrass, upland sedges, and unpalatable forbs. Further deterioration results in a dominance of blue grama, Kentucky bluegrass, upland sedges, and fringed sagebrush.

Generally, no major problems affect management of this site. In the sloping areas, however, gullies can form along livestock trails. Fencing and improved grazing management help to prevent gullying. They also are beneficial in areas where gullies have already formed. Soil blowing is a problem in denuded areas. Areas where the site is in poor or fair condition generally can be restored to good or excellent condition by good management. In some areas brush control is needed.

Very Shallow range site. The site has a mixture of cool- and warm-season, mid grasses. Forage production is much lower on this site than on the Shallow range site. The principal species are needleandthread, western wheatgrass, little bluestem, blue grama, and plains muhly. Other species are prairie junegrass, red threeawn, sideoats grama, and upland sedges. Forbs and woody plants make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as needleandthread, western wheatgrass, little bluestem, sideoats grama, and plains muhly. The plants that increase in abundance under these conditions are blue grama, red threeawn, sand dropseed, Sandberg bluegrass, and upland sedges. Further deterioration results in a dominance of blue grama, red threeawn, upland sedges, and undesirable forbs and shrubs.

Available water capacity is very low on this site. Also, water erosion is a hazard in the more sloping areas. Gullies can readily form along cattle trails and in denuded areas. The site is frequently overgrazed. Once it is in fair or poor condition, it recovers slowly because of the very low available water capacity. Productivity can be maintained by careful management of the cool-season, mid grasses and by cross fencing, which helps to control livestock traffic patterns.

Wetland range site. Tall grasses dominate this site. The principal species are rivergrass, prairie cordgrass, northern reedgrass, slough sedge, and slim sedge. Other species are American mannagrass, American sloughgrass, Baltic rush, and common spikesedge. Common forbs are longroot smartweed and waterparsnip.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as rivergrass, slough sedge, prairie cordgrass, and northern reedgrass. The plants that increase in abundance under these conditions are slim sedge, Baltic rush, common spikesedge, and American sloughgrass. Further deterioration results in a dominance of Baltic rush, common spikesedge, and Mexican dock.

This site is easily damaged by grazing when it is wet. Livestock traffic during wet periods results in soil compaction, trampling, and root shearing. Livestock are attracted to this site because of the supply of moisture. A planned grazing system and deferment of grazing when the site is wet help to maintain the climax vegetation.

Woodland, Windbreaks, and Environmental Plantings

This section was prepared by Bruce C. Wight, forester, Soil Conservation Service.

Nelson County has about 5,200 acres of native woodland. Of this total, approximately 3,880 acres is in the survey area. Most of the woodland is adjacent to Stump Lake or along the Sheyenne and Forest Rivers. The woodland adjacent to Stump Lake is primarily in areas of Wamduska and Mauvais soils. That along the Sheyenne and Forest Rivers is mainly in areas of Buse, Kloten, and Svea soils.

The woodland supports primarily bur oak, green ash, and American elm. Other species include quaking aspen, basswood, boxelder, common chokecherry, hackberry, hawthorn, American plum, silverberry, currant, dogwood, woods rose, juneberry, and silver buffaloberry.

Woody draws and wetlands are less common areas of woodland. Quaking aspen, cottonwood, various species of willow, and some American elm surround some wetlands. The woody draws mainly support species of shrubs, such as common chokecherry, hawthorn, western snowberry, and silverberry.

The early settlers used the trees for fuel, lumber, and fenceposts. Currently, there is a renewed interest in using trees for fuel. The principal uses of the trees, however, are for protection and esthetic purposes. Windbreaks have been planted in the survey area since the early days of settlement. Most of the early plantings were made to protect farmsteads and livestock.

In the late 1930's, approximately 965 acres was planted to trees and shrubs under the Prairie States Forestry Project of the U.S. Department of Agriculture, Forest Service. Since that time, more than 3 million trees have been planted on about 4,500 acres by local farmers and landowners assisted by the Soil Conservation Service and the Nelson County Soil Conservation District. Trees and shrubs are still needed around numerous farmsteads, but the major need is for windbreaks that help to protect the soils that are highly susceptible to soil blowing.

Before windbreaks are established, the purpose of the windbreak, the suitability of the soils for the various species of trees and shrubs selected for planting, and the location and design of the windbreak should be considered. Otherwise, a poor or unsuccessful windbreak may result. Proper site preparation and adequate maintenance are needed after the trees and shrubs are planted. Competing grasses and broadleaf weeds should be eliminated before the trees and shrubs are planted, and the regrowth of this ground cover should be controlled for the life of the windbreak. Some replanting of the trees and shrubs may be necessary during the first 2 years.

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

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

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

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

Recreation

This section was prepared by Erling B. Podoll, biologist, Soil Conservation Service.

The survey area has many recreational facilities. The major recreational developments are Old Settlers Park at Stump Lake and the lakes at McVille, Tolna, and Whitman. These and other county and municipal developments are used for outdoor activities, such as fishing, boating, swimming, camping, picnicking, golfing, trapshooting, and ice skating.

Opportunities for outdoor activities requiring few basic facilities are available on some private land and in federal and state wildlife areas. These activities include birding, hiking, hunting, and cross-country skiing.

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

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

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

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

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

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

Wildlife Habitat

This section was prepared by Erling B. Podoll and David D. Dewald, biologists, Soil Conservation Service.

Fish and wildlife benefit from the good quality and diversity of the wildlife habitat in the survey area. Important bird species include gray partridge, ducks, geese, and mourning dove. Habitat for sharp-tailed grouse and pheasant is limited; however, small numbers of these species inhabit the survey area. Important mammal species include cottontail rabbit, white-tailed deer, tree squirrels, mink, raccoon, badger, striped skunk, red fox, muskrat, and white-tailed jackrabbit. The average annual white-tailed deer harvest is about 350 animals.

Private landowners manage some areas of upland and wetland habitat primarily for wildlife. Some landowners, acting in the public interest, have conveyed their drainage rights on 37,000 acres of wetland to the federal government under the Small Acquisition Program. The federal government manages about 3,000 acres in the county for waterfowl production. The North Dakota Game and Fish Department manages about 11,000 acres of wildlife habitat.

The Sheyenne River and reservoirs at McVille, Tolna, and Whitman provide opportunities for fishing. The major species in the reservoirs are trout and walleye. The Sheyenne River supports northern pike, walleye, perch, and bullheads.

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

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

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

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

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

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

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

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are common chokecherry, juneberry, snowberry, and silver buffaloberry.

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

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

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

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

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

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include deer, sharp-tailed grouse, meadowlark, and lark bunting.

Most of the wetland wildlife habitat in the survey area is in areas of hydric soils. About 129,000 acres, or more than 22 percent of the survey area, meets the requirements for hydric soils. The map units in the survey area that generally display hydric conditions are listed in this section. They are considered hydric soils unless they have been artificially drained or otherwise so altered that they no longer support a predominance of hydrophytic vegetation. The soil maps in this survey do not identify the drained areas. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4, and the location is shown on the detailed maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

2 Parnell silt loam
3 Playmoor silty clay loam, saline
4 Southam silty clay loam
5 Hamerly-Tonka complex, 0 to 3 percent slopes (Tonka part)
7 Parnell-Vallers complex, 0 to 3 percent slopes
15 Borup silt loam
17 Borup silt loam, saline
21 Vallers and Hamerly loams, saline, 0 to 3 percent slopes (Vallers part)
22 Vallers loam, 0 to 3 percent slopes
27 Hamar loamy sand
47 Lallie silty clay loam, saline

Engineering

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

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

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

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

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

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

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

Building Site Development

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

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

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

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

Sanitary Facilities

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

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

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

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

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

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

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

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

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

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

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

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

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

Construction Materials

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Water Management

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

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

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

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

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

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

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

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

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

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

Soil Properties

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

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 17.

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

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

Engineering Index Properties

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

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

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

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

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

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

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 17.

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

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

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

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

Physical and Chemical Properties

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

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

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

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

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

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

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

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

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

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

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

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly

erodible. Crops can be grown if intensive measures to control soil blowing are used.

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

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

5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

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

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

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and Water Features

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

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

The four hydrologic soil groups are:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Engineering Index Test Data

Table 17 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the North Dakota State Highway Department Laboratory.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*15*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

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

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

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

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

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

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

Soil Series and Their Morphology

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

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*14*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*15*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Arvilla Series

The Arvilla series consists of deep, somewhat excessively drained, rapidly permeable soils on glacial outwash plains. These soils formed in glacial outwash sediments. Slope ranges from 0 to 6 percent.

Typical pedon of Arvilla sandy loam, 0 to 6 percent slopes, 1,260 feet south and 100 feet east of the northwest corner of sec. 6, T. 149 N., R. 60 W.

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

Bw—8 to 15 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to weak medium subangular blocky; soft, very friable, nonsticky and nonplastic; common fine roots; neutral; gradual smooth boundary.

2C—15 to 60 inches; dark brown (10YR 3/3) gravelly coarse sand, brown (10YR 5/3) dry; single grain; loose, nonsticky and nonplastic; about 15 percent gravel; strong effervescence; mildly alkaline.

The mollic epipedon is 7 to 19 inches thick. The depth to the 2C horizon is 14 to 22 inches.

The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 2 to 4 (3 to 5 dry) and chroma of 1 to 3. The content of gravel in the 2C horizon ranges from 5 to 35 percent.

Barnes Series

The Barnes series consists of deep, well drained, moderately slowly permeable soils on glacial till plains. These soils formed in glacial till. Slope ranges from 1 to 15 percent.

Typical pedon of Barnes loam, in an area of Cresbard-Barnes loams, 3 to 6 percent slopes; 1,980 feet east and 170 feet north of the southwest corner of sec. 35, T. 154 N., R. 57 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; mildly alkaline; abrupt smooth boundary.

A—6 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; mildly alkaline; abrupt smooth boundary.

Bw1—8 to 12 inches; dark brown (10YR 3/3) clay loam, brown (10YR 4/3) dry; moderate medium prismatic structure parting to weak medium subangular blocky; hard, friable, sticky and plastic; few fine roots; few thin black (10YR 2/1) clay films on faces of peds; mildly alkaline; gradual smooth boundary.

Bw2—12 to 15 inches; brown (10YR 4/3) clay loam, yellowish brown (10YR 5/4) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, sticky and plastic; few fine roots; about 2 percent gravel; slight effervescence; mildly alkaline; gradual smooth boundary.

Bk—15 to 23 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; weak medium subangular blocky structure; slightly hard, very firm, sticky and plastic; few very fine roots; about 2 percent gravel; common medium masses of lime; violent effervescence; mildly alkaline; gradual wavy boundary.

C—23 to 60 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; few fine prominent dark red (2.5YR 3/6) mottles; massive; hard, firm, sticky and plastic; about 2 percent gravel; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 18 to 30 inches. The mollic epipedon is 7 to 14 inches thick.

The A horizon has value of 2 or 3 (3 or 4 dry). The Bw and Bk horizons are clay loam or loam. The Bw horizon has hue of 10YR or 2.5Y, value of 4 to 6 when dry, and chroma of 2 to 4. The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4.

Borup Series

The Borup series consists of deep, poorly drained, moderately permeable, highly calcareous soils on glacial lake plains. These soils formed in lacustrine sediments. Slope is 0 to 1 percent.

Typical pedon of Borup silt loam, 1,755 feet south and 95 feet east of the northwest corner of sec. 30, T. 149 N., R. 60 W.

A—0 to 12 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; few coarse and many fine and medium roots; few fine soft masses of lime; strong effervescence; moderately alkaline; clear wavy boundary.

Bk—12 to 22 inches; dark gray (10YR 4/1) silt loam, light gray (10YR 6/1) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few coarse and fine roots; common medium soft masses of lime; strong effervescence; moderately alkaline; clear irregular boundary.

BCkg—22 to 34 inches; gray (5Y 6/1) silt loam, light gray (5Y 7/1) dry; massive; hard, firm, slightly sticky and slightly plastic; common medium soft masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

C—34 to 43 inches; grayish brown (2.5Y 5/2) silt loam, light gray (5Y 7/2) dry; few fine prominent dark brown (7.5YR 4/4) mottles; massive; hard, very friable, slightly sticky and slightly plastic; few fine threads of lime; slight effervescence; moderately alkaline; clear wavy boundary.

Cg—43 to 60 inches; light olive gray (5Y 6/2) silty clay loam, light gray (5Y 7/2) dry; few fine prominent dark brown (7.5YR 4/4) mottles; massive; hard, very friable, slightly sticky and plastic; few fine threads of lime; slight effervescence; moderately alkaline.

The mollic epipedon is 9 to 16 inches thick. The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 0 or 1. The Bk horizon has hue of 10YR to 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 or 2. The C horizon has value of 4 to 6 (6 or 7 dry) and chroma of 1 to 3. It is very fine sand or silt loam in the upper part and silt loam, loamy very fine sand, or silty clay loam in the lower part. Some pedons have an Ak or ABk horizon.

Brantford Series

The Brantford series consists of deep, well drained soils on glacial outwash plains. These soils formed in glacial outwash sediments. Permeability is moderate in the upper part of the profile and very rapid in the lower part. Slope ranges from 1 to 6 percent.

Typical pedon of Brantford loam, 1 to 6 percent slopes, 2,135 feet north and 1,935 feet east of the southwest corner of sec. 25, T. 153 N., R. 57 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine roots; neutral; abrupt wavy boundary.

Bw—9 to 14 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; neutral; clear wavy boundary.

2C—14 to 60 inches; dark grayish brown (2.5Y 4/2) very gravelly sand, light brownish gray (2.5Y 6/2) dry; single grain; loose, nonsticky and nonplastic; few very fine roots to a depth of about 32 inches; about 40 percent gravel-size shale fragments; moderately alkaline.

The mollic epipedon is 10 to 16 inches thick. The depth to the 2C horizon ranges from 10 to 20 inches.

The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has hue of 10YR or 2.5Y and value of 3 or 4 (4 or 5 dry). It is loam or gravelly loam. In some pedons a weak accumulation of lime is at the base of the Bw horizon. The content of gravel-size shale fragments is 35 to 65 percent in the 2C horizon. Thin strata of gravelly loam, gravelly sand, or sandy loam are in the lower part of this horizon in some pedons.

Buse Series

The Buse series consists of deep, well drained, moderately slowly permeable soils on glacial till plains, on moraines, and in stream valleys. These soils formed in glacial till. Slope ranges from 3 to 25 percent.

Typical pedon of Buse loam, in an area of Svea-Buse loams, 3 to 6 percent slopes; 465 feet west and 55 feet north of the southeast corner of sec. 31, T. 152 N., R. 60 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine and very fine roots; about 2 percent gravel; slight effervescence; mildly alkaline; abrupt smooth boundary.

Bk—7 to 20 inches; light yellowish brown (2.5Y 6/4) clay loam, light gray (2.5Y 7/2) dry; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; lime disseminated throughout; strong effervescence; moderately alkaline; gradual smooth boundary.

C1—20 to 34 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; few medium prominent strong brown (7.5YR 5/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; about 5 percent gravel; common fine irregular soft masses of lime; slight effervescence; moderately alkaline; clear wavy boundary.

C2—34 to 44 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; common medium prominent dark reddish brown (5YR 3/4) mottles; few very fine roots; about 6 percent gravel; common medium nests of gypsum; common medium irregular soft masses of lime; slight effervescence; moderately alkaline; gradual smooth boundary.

C3—44 to 60 inches; dark grayish brown (2.5Y 4/2) and olive brown (2.5Y 4/4) loam, light brownish gray (2.5Y 6/2) and light yellowish brown (2.5Y 6/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; about 10 percent gravel; few fine nests of gypsum; few fine irregular soft masses of lime; slight effervescence; moderately alkaline.

The mollic epipedon is 7 to 10 inches thick. The A horizon has value of 2 or 3 (4 or 5 dry). Some pedons have an AB horizon, which is 3 or 4 inches thick. The Bk and C horizons are clay loam or loam. The Bk horizon has hue of 10YR or 2.5Y and value of 4 to 6 (6 or 7 dry).

The Buse soil in the map unit Kloten-Buse loams, 9 to 25 percent slopes, is a taxadjunct to the series because the surface layer is very dark grayish brown. This difference, however, does not alter the usefulness or behavior of the soil.

Cavour Series

The Cavour series consists of deep, moderately well drained, slowly permeable, alkali soils on glacial till plains. These soils formed in glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Cavour loam, in an area of Cavour-Cresbard loams, 0 to 3 percent slopes; 1,910 feet north and 190 feet west of the southeast corner of sec. 25, T. 153 N., R. 57 W.

A—0 to 5 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine and many very fine roots; slightly acid; abrupt smooth boundary.

E—5 to 7 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak fine blocky structure parting to weak very thin platy; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; slightly acid; abrupt smooth boundary.

Bt1—7 to 11 inches; black (10YR 2/1) clay, dark grayish brown (10YR 4/2) dry; strong medium columnar structure parting to moderate medium subangular blocky; extremely hard, extremely firm, very sticky and very plastic; common very fine and fine roots along faces of peds; continuous distinct clay films on faces of peds; mildly alkaline; gradual smooth boundary.

Bt2—11 to 18 inches; very dark grayish brown (10YR 3/2) clay, grayish brown (2.5Y 5/2) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, very firm, very sticky and very plastic; few very fine roots; continuous distinct clay films on faces of peds; mildly alkaline; gradual wavy boundary.

By—18 to 30 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; few very fine roots; few thin faint clay films on faces of peds; about 2 percent gravel; common medium irregular nests of gypsum; slight effervescence; mildly alkaline; gradual wavy boundary.

BCy—30 to 42 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common medium irregular nests of gypsum; few fine irregular soft masses of lime; about 2 percent gravel; strong effervescence; moderately alkaline; gradual wavy boundary.

C—42 to 60 inches; dark grayish brown (2.5Y 4/2) loam, light gray (2.5Y 7/2) dry; massive; slightly hard, firm, slightly sticky and slightly plastic; about 2 percent gravel; common fine irregular soft masses of lime; slight effervescence; moderately alkaline.

The A horizon has value of 2 or 3 (3 to 5 dry). The E horizon has value of 2 to 5 (3 to 6 dry). It is loam or silt loam. In some pedons it has been mixed with the plow layer. The Bt horizon is clay, silty clay loam, silty clay, or clay loam. Some pedons do not have a By horizon. The C horizon is clay loam or loam.

Coe Series

The Coe series consists of deep, excessively drained soils on glacial outwash plains. These soils formed in glacial outwash sediments. Permeability is moderately rapid in the upper part of the profile and very rapid in the lower part. Slope ranges from 6 to 25 percent.

Typical pedon of Coe gravelly loam, 6 to 25 percent slopes, 720 feet east and 50 feet south of the northwest corner of sec. 21, T. 149 N., R. 60 W.

A—0 to 8 inches; very dark gray (10YR 3/1) gravelly loam, dark gray (10YR 4/1) dry; weak fine and medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; about 15 percent gravel-size shale fragments; neutral; clear smooth boundary.

2C1—8 to 14 inches; dark grayish brown (2.5Y 4/2) very gravelly loamy coarse sand, grayish brown (2.5Y 5/2) dry; single grain; loose, nonsticky and nonplastic; many fine and common very fine roots; about 50 percent gravel-size shale fragments; mildly alkaline; clear wavy boundary.

2C2—14 to 60 inches; dark gray (5Y 4/1) extremely gravelly coarse sand, light olive gray (5Y 6/2) dry; single grain; loose, nonsticky and nonplastic; few fine and very fine roots in the upper part; dark red (2.5YR 3/6) and very dark brown (10YR 2/2) stains on shale fragments; about 65 percent gravel-size shale fragments; mildly alkaline.

The mollic epipedon is 7 to 12 inches thick. The depth to the 2C horizon is 7 to 14 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The C horizon ranges from very gravelly loamy coarse sand to extremely gravelly sand.

Cresbard Series

The Cresbard series consists of deep, moderately well drained, moderately slowly permeable, alkali soils on glacial till plains. These soils formed in glacial till. Slope ranges from 0 to 6 percent.

These soils have slightly less clay in the subsoil than is definitive for the Cresbard series, but this difference does not alter the usefulness or behavior of the soils.

Typical pedon of Cresbard loam, in an area of Cresbard-Barnes loams, 3 to 6 percent slopes; 1,155 feet south and 120 feet east of the northwest corner of sec. 36, T. 154 N., R. 57 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; neutral; abrupt smooth boundary.

E—7 to 9 inches; very dark brown (10YR 2/2) loam, grayish brown (10YR 5/2) dry; weak very thin platy structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; slightly acid; abrupt wavy boundary.

B/E—9 to 12 inches; very dark grayish brown (10YR 3/2) clay loam (B) with black (10YR 2/1) faces of blocky peds and very dark brown (10YR 2/2) faces of prisms; silt coatings on faces of blocky peds (E), dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to strong fine and medium subangular blocky; hard, firm, sticky and plastic; few very fine roots; thin distinct clay films on faces of blocky peds; about 2 percent gravel; slightly acid; clear wavy boundary.

Bt—12 to 19 inches; dark grayish brown (2.5Y 4/2) clay loam with very dark grayish brown (10YR 3/2) faces of prisms; dark grayish brown (10YR 4/2) faces of prisms and blocky peds; when dry, grayish brown (10YR 5/2) interiors with strong medium prismatic structure parting to moderate medium angular blocky; hard, firm, sticky and plastic; few very fine roots; thin distinct clay films on faces of prisms and blocky peds; about 2 percent gravel; neutral; clear wavy boundary.

Bkyz1—19 to 32 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; weak coarse prismatic structure; hard, friable, sticky and plastic; few very fine roots; few dark reddish brown (5YR 3/4) iron concretions; about 2 percent gravel; common fine seams and masses of salts and gypsum; lime disseminated throughout; violent effervescence; strongly alkaline; gradual wavy boundary.

Bkyz2—32 to 40 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; few fine distinct dark yellowish brown (10YR 3/4) mottles; weak coarse prismatic structure; hard, friable, sticky and plastic; about 2 percent gravel; common nests of salts and gypsum; moderate fine irregular soft masses of lime; violent effervescence; strongly alkaline; abrupt wavy boundary.

2Cyz—40 to 52 inches; light brownish gray (2.5Y 6/2) and light olive brown (2.5Y 5/4) silt loam, light brownish gray (2.5Y 6/2) and light gray (2.5Y 7/2) dry; common medium distinct dark yellowish brown (10YR 4/4) mottles; massive; slightly hard, friable, sticky and plastic; about 5 percent gravel-size shale fragments; few masses of salts and gypsum; common large irregular seams of lime; strong effervescence; strongly alkaline; clear wavy boundary.

3Cyz—52 to 60 inches; olive brown (2.5Y 4/4) and grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) and pale yellow (2.5Y 7/4) dry; common medium distinct dark yellowish brown (10YR 4/4) mottles; massive; hard, friable, sticky and plastic; about 2 percent gravel; common masses of salts and gypsum; few large irregular seams of lime; slight effervescence; moderately alkaline.

The depth to free carbonates ranges from 19 to 26 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The E horizon has value of 2 to 4 (5 or 6 dry). It is loam or silt loam. In some areas plowing has mixed part or all of the E and B/E horizons with the surface layer. The Bt horizon has value of 2 to 4 (3 to 5 dry) and chroma of 1 to 3. The C horizon has value of 5 to 7 when dry. It is silt loam, clay loam, or loam. Some pedons do not have silt loam in the C horizon.

Divide Series

The Divide series consists of deep, somewhat poorly drained, highly calcareous soils on glacial outwash plains. These soils formed in glacial outwash sediments. Permeability is moderate in the upper part of the profile and very rapid in the lower part. Slope ranges from 0 to 3 percent.

Typical pedon of Divide loam, 0 to 3 percent slopes, 1,050 feet west and 315 feet south of the northeast corner of sec. 4, T. 149 N., R. 60 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine and medium roots; about 5 percent gravel; strong effervescence; moderately alkaline; abrupt smooth boundary.

Ak—8 to 12 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; about 5 percent gravel; few fine masses of lime; violent effervescence; moderately alkaline; abrupt wavy boundary.

Bk—12 to 22 inches; light brownish gray (2.5Y 6/2) loam, light gray (2.5Y 7/2) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine roots; about 5 percent gravel; common medium masses of lime; violent effervescence; moderately alkaline; clear smooth boundary.

2C1—22 to 26 inches; light olive brown (2.5Y 5/4) gravelly loamy coarse sand, light yellowish brown (2.5Y 6/4) dry; single grain; loose, nonsticky and nonplastic; few fine roots; about 20 percent gravel; strong effervescence; moderately alkaline; clear smooth boundary.

2C2—26 to 60 inches; olive brown (2.5Y 4/4) very gravelly coarse sand, light olive brown (2.5Y 5/4) dry; single grain; loose, nonsticky and nonplastic; about 35 percent gravel; slight effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick. The depth to the 2C horizon ranges from 20 to 40 inches.

The A horizon has value of 2 or 3 (3 to 5 dry). Some pedons do not have an Ak horizon. The Bk horizon has hue of 10YR or 2.5Y, value of 3 to 6 (5 to 8 dry), and chroma of 1 to 4. The 2C horizon has hue of 10YR or 2.5Y, value of 5 to 7 when dry, and chroma of 2 to 4.

Egeland Series

The Egeland series consists of deep, well drained, moderately rapidly permeable soils on glacial outwash plains. These soils formed in glacial outwash sediments. Slope ranges from 3 to 6 percent.

Typical pedon of Egeland sandy loam, 3 to 6 percent slopes, 660 feet north and 330 feet east of the southwest corner of sec. 3, T. 149 N., R. 61 W.

Ap—0 to 6 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine and medium roots; neutral; clear smooth boundary.

A—6 to 9 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; neutral; gradual wavy boundary.

Bw—9 to 14 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 5/3) dry; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; mildly alkaline; clear wavy boundary.

C1—14 to 36 inches; dark grayish brown (10YR 4/2) sandy loam, light brownish gray (10YR 6/2) dry; massive; slightly hard, very friable, nonsticky and slightly plastic; slight effervescence; moderately alkaline; gradual wavy boundary.

C2—36 to 60 inches; grayish brown (10YR 5/2) loamy sand, light gray (10YR 7/2) dry; massive; soft, very friable, nonsticky and nonplastic; slight effervescence; moderately alkaline.

The mollic epipedon is 12 to 16 inches thick. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 2 to 4 (4 or 5 dry) and chroma of 1 to 3. It is fine sandy loam or sandy loam. Some pedons have a Bk or BC horizon. The C horizon is sandy loam, fine sandy loam, loamy fine sand, or loamy sand.

Embden Series

The Embden series consists of deep, moderately well drained, moderately rapidly permeable soils on glacial outwash plains. These soils formed in glacial outwash sediments. Slope ranges from 0 to 3 percent.

Typical pedon of Embden fine sandy loam, 0 to 3 percent slopes, 400 feet south and 385 feet west of the northeast corner of sec. 17, T. 149 N., R. 61 W.

Ap—0 to 7 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; moderate medium and fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

A—7 to 15 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to moderate medium subangular blocky; soft, very friable, slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

Bw1—15 to 26 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; mildly alkaline; clear wavy boundary.

Bw2—26 to 30 inches; dark grayish brown (10YR 4/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; neutral; clear smooth boundary.

C1—30 to 55 inches; olive brown (2.5Y 4/4) fine sandy loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; strong effervescence; moderately alkaline; clear wavy boundary.

C2—55 to 60 inches; light olive brown (2.5Y 5/4) gravelly sandy loam, light yellowish brown (2.5Y 6/4) dry; massive; soft, friable, slightly sticky and slightly plastic; about 15 percent gravel; strong effervescence; moderately alkaline.

The mollic epipedon ranges from 18 to 28 inches thick. The A horizon has chroma of 0 or 1. The Bw horizon has value of 2 to 4 (3 to 5 dry) and chroma of 1 to 3. Some pedons have a Bk horizon. The C horizon is gravelly sandy loam, fine sandy loam, sand, fine sand, loam, or loamy sand below a depth of 40 inches.

Fordville Series

The Fordville series consists of deep, well drained soils on glacial outwash plains. These soils formed in glacial outwash sediments. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slope is 0 to 1 percent.

Typical pedon of Fordville loam, 1,400 feet north and 100 feet west of the southeast corner of sec. 8, T. 149 N., R. 61 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; about 5 percent granitic gravel; neutral; abrupt smooth boundary.
A—6 to 13 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; about 5 percent granitic gravel; neutral; clear wavy boundary.
Bw1—13 to 20 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; about 5 percent granitic gravel; neutral; gradual wavy boundary.
Bw2—20 to 22 inches; dark brown (10YR 3/3) loam, grayish brown (10YR 5/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; about 5 percent granitic gravel; neutral; abrupt wavy boundary.
Bk—22 to 30 inches; dark grayish brown (10YR 4/2) sandy loam, grayish brown (10YR 5/2) dry; single grain; loose, very friable, slightly sticky and slightly plastic; about 5 percent granitic gravel; few fine masses of lime; violent effervescence; mildly alkaline; gradual wavy boundary.
2C—30 to 60 inches; brown (10YR 4/3) gravelly coarse sand, pale brown (10YR 6/3) dry; single grain; loose; about 20 percent granitic gravel; strong effervescence; mildly alkaline.

The depth to the 2C horizon ranges from 20 to 40 inches. The A horizon has value of 2 or 3 (3 or 4 dry) and chroma of 1 or 2 when dry. Some pedons do not have a Bk horizon. Some have a stone line at the top of the 2C horizon.

Gardena Series

The Gardena series consists of deep, moderately well drained, moderately permeable soils on glacial lake plains. These soils formed in lacustrine sediments. Slope ranges from 0 to 6 percent.

Typical pedon of Gardena silt loam, 0 to 3 percent slopes, 1,850 feet east and 110 feet north of the southwest corner of sec. 34, T. 149 N., R. 61 W.

Ap—0 to 9 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine and medium roots; neutral; abrupt smooth boundary.
A—9 to 13 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; soft, very friable, slightly sticky and slightly plastic; common very fine roots; neutral; clear smooth boundary.
Bw1—13 to 19 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (2.5Y 4/2) dry; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; mildly alkaline; gradual wavy boundary.
Bw2—19 to 26 inches; dark grayish brown (2.5Y 4/2) silt loam, grayish brown (2.5Y 5/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; mildly alkaline; gradual wavy boundary.
C1—26 to 46 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; strong effervescence; moderately alkaline; abrupt wavy boundary.
2C2—46 to 60 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; common medium prominent dark red (2.5YR 3/6) mottles; massive; hard, friable, slightly sticky and slightly plastic; about 2 percent gravel; common medium soft masses of lime; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 18 to 29 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 2 to 4 (3 to 5 dry) and chroma of 1 to 3. Some pedons have a BC or Bk horizon. The C horizon is silt loam or very fine sandy loam. Some pedons do not have a 2C horizon.

Glyndon Series

The Glyndon series consists of deep, somewhat poorly drained, moderately rapidly permeable, highly calcareous soils on glacial lake plains. These soils formed in lacustrine sediments. Slope is 0 to 1 percent.

Typical pedon of Glyndon silt loam, 1,320 feet south and 195 feet east of the northwest corner of sec. 10, T. 149 N., R. 61 W.

Ap—0 to 6 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and medium roots; strong effervescence; moderately alkaline; abrupt smooth boundary.
A—6 to 12 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; moderate medium subangular blocky structure; hard, very friable, slightly sticky and

slightly plastic; common very fine and fine roots; strong effervescence; moderately alkaline; gradual wavy boundary.

Bk—12 to 22 inches; gray (10YR 5/1) silt loam, light gray (10YR 6/1) dry; weak medium subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; few very fine roots; common large masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

C1—22 to 26 inches; olive brown (2.5Y 4/4) silt loam, light yellowish brown (2.5Y 6/4) dry; few fine prominent very dusky red (2.5YR 2/2) and strong brown (7.5YR 5/6) mottles; massive; very hard, very friable, slightly sticky and slightly plastic; few very fine roots; slight effervescence; moderately alkaline; abrupt wavy boundary.

C2—26 to 60 inches; dark grayish brown (2.5Y 4/2) and olive brown (2.5Y 4/4) very fine sandy loam, light brownish gray (2.5Y 6/2) and light yellowish brown (2.5Y 6/4) dry; common medium prominent very dusky red (2.5YR 2/2) and strong brown (7.5YR 5/6) mottles; massive; soft, very friable, slightly sticky and nonplastic; slight effervescence; moderately alkaline.

The mollic epipedon is 10 to 14 inches thick. The A horizon has value of 3 to 5 when dry and chroma of 1 or 2. The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 8 dry), and chroma of 1 to 4. It is silt loam or very fine sandy loam. The C horizon has hue of 2.5Y or 5Y and value of 4 to 6 (5 to 7 dry). It is dominantly very fine sandy loam, very fine sand, or silt loam, but some pedons have thin strata of fine sand or coarse sand below a depth of 40 inches.

Hamar Series

The Hamar series consists of deep, poorly drained soils on glacial outwash plains. These soils formed in glacial outwash sediments. Permeability is moderately rapid in the upper part of the profile and moderately slow in the lower part. Slope is 0 to 1 percent.

Typical pedon of Hamar loamy sand, 1,255 feet north and 80 feet west of the southeast corner of sec. 36, T. 149 N., R. 59 W.

Ap—0 to 8 inches; black (10YR 2/1) loamy sand, dark gray (10YR 4/1) dry; weak medium and coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and very fine roots; neutral; abrupt smooth boundary.

A—8 to 12 inches; very dark brown (10YR 2/2) loamy sand, dark grayish brown (10YR 4/2) dry; few medium prominent strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine roots; neutral; gradual smooth boundary.

AC—12 to 18 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; common medium prominent brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; soft, loose, nonsticky and nonplastic; few very fine roots; neutral; clear smooth boundary.

C1—18 to 43 inches; dark grayish brown (2.5Y 4/2) sand, light brownish gray (2.5Y 6/2) dry; common medium prominent strong brown (7.5YR 5/6) mottles; soft, loose, nonsticky and nonplastic; mildly alkaline; clear wavy boundary.

2C2—43 to 60 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; many medium prominent strong brown (7.5YR 5/8) and few fine prominent dark brown (7.5YR 3/2) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; about 5 percent gravel-size shale fragments; slight effervescence; mildly alkaline.

The mollic epipedon is 12 to 18 inches thick. The depth to carbonates ranges from 30 to 50 inches.

The A horizon has value of 2 or 3 (3 to 5 dry). The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 or 2. Some pedons do not have a 2C horizon below a depth of 40 inches.

Hamerly Series

The Hamerly series consists of deep, somewhat poorly drained, moderately slowly permeable, highly calcareous soils on glacial till plains. These soils formed in glacial till. Slope ranges from 0 to 5 percent.

Typical pedon of Hamerly loam, 2 to 5 percent slopes, 455 feet west and 505 feet north of the southeast corner of sec. 31, T. 152 N., R. 60 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weak fine and very fine roots; about 2 percent gravel; slight effervescence; moderately alkaline; abrupt smooth boundary.

Bk—7 to 21 inches; light yellowish brown (2.5Y 6/4) clay loam, light gray (2.5Y 7/2) dry; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; about 2 percent gravel; lime disseminated throughout; strong effervescence; mildly alkaline; clear smooth boundary.

By—21 to 33 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; few fine prominent reddish brown (5YR 4/4) mottles; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; about 2 percent gravel; common nests of gypsum; few fine irregular soft masses of lime; slight effervescence; moderately alkaline; clear smooth boundary.

C1—33 to 45 inches; olive brown (2.5Y 4/4) and olive gray (5Y 5/2) loam, light yellowish brown (2.5Y 6/4) and light olive gray (5Y 6/2) dry; few fine prominent reddish brown (5YR 4/4) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; about 2 percent gravel; common fine irregular soft masses of lime; slight effervescence; moderately alkaline; gradual smooth boundary.

C2—45 to 60 inches; olive brown (2.5Y 4/4) and olive gray (5Y 5/2) loam, light yellowish brown (2.5Y 6/4) and light olive gray (5Y 6/2) dry; few fine prominent yellowish red (5YR 5/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; about 2 percent gravel; slight effervescence; mildly alkaline.

The soils are nonsaline to moderately saline. The mollic epipedon is 7 to 14 inches thick.

The A horizon has value of 2 or 3 (3 or 4 dry). Some pedons have an ABk horizon, which is 1 to 5 inches thick. The Bk and C horizons are loam or clay loam. The Bk horizon has value of 4 to 6 (5 to 8 dry) and chroma of 1 to 4. The C horizon has value of 4 to 6 (6 or 7 dry) and chroma of 2 to 4. Some pedons do not have a By horizon.

Kloten Series

The Kloten series consists of shallow, well drained, moderately permeable soils in stream valleys. These soils formed in material weathered from shale bedrock. Slope ranges from 9 to 25 percent.

Typical pedon of Kloten loam, in an area of Kloten-Buse loams, 9 to 25 percent slopes; 1,585 feet east and 365 feet north of the southwest corner of sec. 1, T. 154 N., R. 58 W.

A—0 to 7 inches; black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; weak fine and very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; about 2 percent shale channers; neutral; abrupt wavy boundary.

C—7 to 18 inches; very dark grayish brown (2.5Y 3/2) extremely channery loam, dark grayish brown (2.5Y 4/2) dry; weak very fine subangular blocky structure; loose, friable, slightly sticky and slightly plastic; common fine and very fine roots; olive gray (5Y 5/2) coatings on faces of horizontal shale fragments; dark brown (7.5YR 4/4) coatings on faces of vertical shale fragments; few shale channers in the upper part, increasing to about 85 percent in the lower part; neutral; clear wavy boundary.

R—18 inches; dark olive gray (5Y 3/2) shale bedrock.

The depth to shale bedrock ranges from 9 to 20 inches. The mollic epipedon is 7 to 10 inches thick.

The A horizon has value of 2 or 3 (3 to 5 dry). Some pedons have an AC horizon. The C horizon is loam, channery loam, extremely channery loam, clay loam, or channery clay loam. The content of shale channers increases with increasing depth. It ranges from 15 to 85 percent in the C horizon.

LaDelle Series

The LaDelle series consists of deep, moderately well drained, moderately permeable soils on flood plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of LaDelle silt loam, 410 feet north and 65 feet east of the southwest corner of sec. 27, T. 150 N., R. 61 W.

Ap—0 to 7 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; few very fine roots; neutral; abrupt smooth boundary.

A—7 to 12 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure parting to moderate fine angular blocky; hard, friable, sticky and plastic; few fine and very fine roots; many worm casts; neutral; clear smooth boundary.

Bw1—12 to 20 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable, sticky and plastic; few very fine roots; neutral; gradual smooth boundary.

Bw2—20 to 25 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; slight effervescence; neutral; clear wavy boundary.

Bw3—25 to 29 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable, sticky and plastic; strong effervescence; moderately alkaline; clear wavy boundary.

Ab—29 to 34 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable, sticky and plastic; few fine irregular threads of lime; slight effervescence; moderately alkaline; clear wavy boundary.

C—34 to 60 inches; very dark grayish brown (10YR 3/2) silty clay loam, gray (10YR 5/1) dry; massive; hard, friable, sticky and plastic; common fine irregular threads of lime; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 22 to 44 inches. The A horizon has value of 2 or 3 (3 or 4 dry). Some pedons do not have a Bw or Ab horizon. Some have flecks of salts below the A horizon. The C horizon is dominantly silty clay loam or silt loam, but some pedons have thin strata of sand below a depth of 40 inches.

Lallie Series

The Lallie series consists of deep, poorly drained, slowly permeable, saline soils on lake plains. These soils formed in lacustrine sediments. Slope is 0 to 1 percent.

Typical pedon of Lallie silty clay loam, saline, 2,250 feet east and 1,300 feet south of the northwest corner of sec. 35, T. 152 N., R. 61 W.

A—0 to 3 inches; very dark gray (5Y 3/1) silty clay loam, gray (5Y 5/1) dry; moderate medium granular structure; hard, firm, sticky and plastic; many very fine roots; strong effervescence; mildly alkaline; clear smooth boundary.

Cg1—3 to 32 inches; olive gray (5Y 5/2) silty clay loam, light olive gray (5Y 6/2) dry; few fine prominent brownish yellow (10YR 6/6) mottles; massive; very hard, firm, sticky and plastic; few very fine roots; few fine threads of salts; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg2—32 to 60 inches; olive gray (5Y 5/2) silty clay, light olive gray (5Y 6/2) dry; common medium prominent yellowish brown (10YR 5/6) mottles; massive; extremely hard, very firm, sticky and plastic; common nests of gypsum; strong effervescence; moderately alkaline.

The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5 when dry, and chroma of 1 or 2. It is 2 to 5 inches thick. Some pedons have an Ab horizon, which is as much as 8 inches thick. The C horizon has hue of 2.5Y or 5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 or 2. Some pedons are silt loam below a depth of 40 inches.

Lamoure Series

The Lamoure series consists of deep, poorly drained, moderately permeable soils on flood plains and in drainageways. These soils formed in alluvium. Slope is 0 to 1 percent.

These soils have slightly more sand in the control section than is definitive for the Lamoure series, but this difference does not alter the usefulness or behavior of the soils.

Typical pedon of Lamoure silty clay loam, 2,000 feet west and 465 feet north of the southeast corner of sec. 1, T. 154 N., R. 57 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; common medium prominent dark reddish brown (5YR 3/2) mottles; moderate fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and common fine roots; few threads of salts; slight effervescence; mildly alkaline; abrupt smooth boundary.

A1—8 to 17 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; common fine prominent dark reddish brown (5YR 3/2) mottles; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; few threads of salts; slight effervescence; mildly alkaline; clear wavy boundary.

A2—17 to 33 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; moderate coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; few fine flecks of salts; violent effervescence; mildly alkaline; gradual wavy boundary.

Cg—33 to 43 inches; black (5Y 2/1) sandy clay loam, dark gray (5Y 4/1) dry; common fine prominent dark reddish brown (5YR 3/4) mottles; massive; hard, friable, slightly sticky and slightly plastic; few fine roots in the upper part; slight effervescence; mildly alkaline; clear wavy boundary.

2Cg1—43 to 54 inches; dark gray (5Y 4/1) loamy sand, olive gray (5Y 5/2) dry; single grain; soft, very friable, nonsticky and nonplastic; mildly alkaline; clear wavy boundary.

2Cg2—54 to 60 inches; dark gray (5Y 4/1) loamy coarse sand, olive gray (5Y 4/2) dry; single grain; soft, very friable, nonsticky and nonplastic; about 5 percent gravel; mildly alkaline.

The thickness of the mollic epipedon ranges from 25 to 36 inches. The A horizon has value of 3 to 5 when dry. In some pedons it is not mottled. The Cg horizon has value of 2 to 5 (4 to 6 dry). It is sandy clay loam, silty clay loam, or loam. The 2Cg horizon is sandy loam, loamy sand, loamy coarse sand, sand, or gravelly sand. Some pedons do not have a 2Cg horizon. Some have an Ab horizon.

Maddock Series

The Maddock series consists of deep, well drained, rapidly permeable soils on glacial outwash plains and glacial lake plains. These soils formed in glacial outwash and lacustrine sediments. Slope ranges from 1 to 25 percent.

Typical pedon of Maddock loamy sand, 1 to 6 percent slopes, 1,655 feet west and 605 feet south of the northeast corner of sec. 34, T. 149 N., R. 60 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) loamy sand, gray (10YR 5/1) dry; weak fine and medium subangular blocky structure; soft, loose, nonsticky and nonplastic; few fine roots; about 2 percent gravel; mildly alkaline; abrupt smooth boundary.

A—6 to 12 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; weak fine and medium subangular blocky structure; soft, loose, nonsticky and nonplastic; few very fine roots; neutral; clear smooth boundary.

C1—12 to 41 inches; dark grayish brown (2.5Y 4/2) sand, light brownish gray (2.5Y 6/2) dry; single grain; soft, loose, nonsticky and nonplastic; mildly alkaline; clear wavy boundary.

C2—41 to 60 inches; light brownish gray (2.5Y 6/2) loamy very fine sand, light gray (2.5Y 7/2) dry; common medium prominent dark yellowish brown (10YR 4/6) mottles; single grain; soft, loose, nonsticky and nonplastic; few fine masses of lime; strong effervescence; moderately alkaline.

The epipedon is 10 to 16 inches thick. The A horizon has value of 2 or 3 (3 to 5 dry). It is loamy sand or loamy fine sand. The C horizon is loamy fine sand or sand. Some pedons have a 2C horizon, which has thin strata of silt, loam, or gravel. Some pedons have an AC or Bw horizon.

Mauvais Series

The Mauvais series consists of deep, somewhat poorly drained, moderately slowly permeable soils on former lakeshores. These soils formed in glacial till smoothed by wave action. Slope ranges from 1 to 9 percent.

These soils show slightly more horizon development than is definitive for the Mauvais series, but this difference does not alter the usefulness or behavior of the soils.

Typical pedon of Mauvais loam, in an area of Wamduska-Mauvais complex, 1 to 9 percent slopes; 1,040 feet west and 340 feet south of the northeast corner of sec. 27, T. 151 N., R. 60 W.

A—0 to 2 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; about 2 percent gravel; mildly alkaline; abrupt smooth boundary.

Bw1—2 to 11 inches; grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/4) loam, light brownish gray (2.5Y 6/2) and light yellowish brown (2.5Y 6/4) dry; few fine prominent yellowish red (5YR 4/6) and common medium prominent brown (7.5YR 4/4) mottles; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; many very fine roots; dark grayish brown (10YR 4/2), 1/8-inch-thick coatings on faces of prisms; about 5 percent gravel; slight effervescence; moderately alkaline; gradual wavy boundary.

Bw2—11 to 18 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; few fine prominent reddish brown (5YR 4/4) and many large prominent dark brown (7.5YR 4/4) mottles; moderate coarse prismatic structure parting to moderate fine subangular blocky; hard, firm, sticky and plastic; common very fine roots; dark grayish brown (10YR 4/2), 0.25-inch-thick coatings on faces of prisms; about 2 percent gravel; strong effervescence; moderately alkaline; clear irregular boundary.

Byz—18 to 37 inches; grayish brown (2.5Y 5/2) and olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) and light gray (2.5Y 7/2) dry; few fine prominent reddish brown (5YR 4/4) mottles; weak coarse prismatic structure; hard, friable, sticky and plastic; common very fine roots; reddish brown (5YR 4/3) coatings on faces of prisms; about 2 percent gravel; common fine threads and filaments and common medium soft masses of salts; 1.0- to 2.5-inch-wide vertical seams of gypsum crystals 10 to 15 inches apart; slight effervescence; moderately alkaline; clear irregular boundary.

Cy—37 to 60 inches; grayish brown (2.5Y 5/2) and olive brown (2.5Y 4/4) loam, light gray (2.5Y 7/2) and pale yellow (2.5Y 7/4) dry; common medium prominent dark reddish brown (5YR 3/4) and few medium prominent dark reddish brown (2.5YR 3/4) mottles; massive; hard, friable, sticky and plastic; about 2 percent gravel; common masses and vertical seams of very dusky red (2.5YR 2/2) manganese; vertical seams of gypsum crystals as much as 1 inch wide and 10 to 15 inches apart; slight effervescence; moderately alkaline.

The A horizon has value of 2 or 3 (3 or 4 dry). Some pedons do not have a Bw horizon. The C horizon has hue of 2.5Y or 5Y or is neutral in hue. It has value of 6 or 7 when dry and has chroma of 0 to 4. In some pedons it has thin strata of clay loam or sandy loam within a depth of 40 inches. Some pedons have strata of silt loam, fine sandy loam, silty clay, or silty clay loam below a depth of 40 inches. Some have a stone line within a depth of 40 inches. The C horizon has no gypsum in some pedons.

Miranda Series

The Miranda series consists of deep, somewhat poorly drained, very slowly permeable, alkali soils on glacial till plains. These soils formed in glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Miranda loam, in an area of Miranda-Cavour loams, 0 to 3 percent slopes; 1,205 feet west and 110 feet north of the southeast corner of sec. 31, T. 149 N., R. 59 W.

Oi—2 inches to 0; mat of roots and leaves; many very fine and fine roots; abrupt smooth boundary.

A—0 to 3 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate very fine and fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine and very fine roots; slightly acid; abrupt wavy boundary.

E—3 to 6 inches; very dark gray (10YR 3/1) loam, gray (10YR 6/1) dry; moderate medium subangular blocky structure parting to weak very thin and thin platy; slightly hard, very friable, slightly sticky and slightly plastic; many fine and very fine roots; neutral; abrupt wavy boundary.

Bt—6 to 10 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; strong medium columnar structure parting to weak fine and medium angular blocky; very hard, very firm, sticky and plastic; common very fine roots; common distinct clay films on faces of prisms; gray (10YR 6/1 dry) silt coatings (E) on the top of columns; mildly alkaline; abrupt wavy boundary.

Byz—10 to 16 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate coarse prismatic structure parting to weak medium subangular blocky; hard, friable, sticky and plastic; common very fine roots; many fine soft masses of salts and gypsum; moderately alkaline; clear wavy boundary.

Bkyz—16 to 24 inches; dark grayish brown (2.5Y 4/2) and light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) and light gray (2.5Y 7/2) dry; common medium distinct light yellowish brown (2.5Y 6/4) mottles; moderate coarse prismatic structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; a 0.5-inch-thick seam of strong brown (7.5YR 4/6) and dark brown (7.5YR 3/4) material at the lower boundary; a 3- to 5-inch-thick line of cobblestones at the lower boundary; common fine soft masses of salts and gypsum; few fine soft masses of lime in the upper part and disseminated lime in the lower part; strong effervescence; strongly alkaline; abrupt wavy boundary.

Cyz1—24 to 35 inches; olive gray (5Y 4/2), dark olive gray (5Y 3/2), and light gray (2.5Y 7/2) clay loam, olive gray (5Y 5/2 and 4/2) and light gray (2.5Y 7/2) dry; common medium and large prominent dark reddish brown (5YR 3/2 and 3/3) mottles; massive; slightly hard, friable, sticky and plastic; few very fine roots; about 2 percent gravel; few fine soft masses of lime; common fine soft masses of salts and gypsum; slight effervescence; moderately alkaline; clear wavy boundary.

Cyz2—35 to 48 inches; very dark gray (5Y 3/1) and olive gray (5Y 4/2) clay loam, gray (5Y 6/1) and light olive gray (5Y 6/2) dry; many fine and medium prominent dark reddish brown (5YR 3/2) mottles; massive; slightly hard, friable, sticky and plastic; few very fine roots; about 2 percent gravel; common medium and large soft masses of salts and gypsum; few fine soft masses of lime; slight effervescence; moderately alkaline; clear wavy boundary.

2Cr—48 to 60 inches; very dark gray (5Y 3/1) soft shale bedrock, light olive gray (5Y 6/2) dry; moderately alkaline.

The thickness of the solum ranges from 15 to 35 inches. The depth to shale bedrock is more than 40 inches. The depth to gypsum or salts is 8 to 16 inches.

The E horizon is loam or silt loam. The Bt horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2. Some pedons do not have an Oi or Bkyz horizon. The Cyz horizon has hue of 2.5Y or 5Y and chroma of 1 to 4. It is clay loam or loam. Some pedons do not have a 2Cr horizon.

Parnell Series

The Parnell series consists of deep, very poorly drained, slowly permeable soils on glacial till plains. These soils formed in alluvium and glacial till. Slope is 0 to 1 percent.

Typical pedon of Parnell silt loam, in an area of Parnell-Vallers complex, 0 to 3 percent slopes; 2,290 feet west and 150 feet north of the southeast corner of sec. 14, T. 154 N., R. 60 W.

A1—0 to 8 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; few fine prominent yellowish brown (10YR 5/8) mottles; moderate coarse subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; many very fine roots; mildly alkaline; abrupt smooth boundary.

A2—8 to 14 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; few fine prominent yellowish brown (10YR 5/8) mottles; moderate coarse subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; many very fine roots; mildly alkaline; clear smooth boundary.

E—14 to 16 inches; very dark gray (10YR 3/1) and black (10YR 2/1) silty clay loam, gray (10YR 5/1) dry; few fine prominent yellowish brown (10YR 5/8) mottles; weak thin platy structure; hard, very friable, sticky and plastic; common very fine roots; mildly alkaline; clear irregular boundary.

Bt1—16 to 24 inches; very dark grayish brown (2.5Y 3/2) clay loam, grayish brown (2.5Y 5/2) dry; weak medium prismatic structure parting to moderate fine subangular blocky; hard, firm, sticky and plastic;

common very fine roots; few faint clay films on faces of peds; mildly alkaline; gradual wavy boundary.

Bt2—24 to 37 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; moderate medium prismatic structure parting to weak medium subangular blocky; very hard, firm, sticky and plastic; few very fine roots; very few faint black clay films on faces of peds; mildly alkaline; gradual wavy boundary.

Bkg—37 to 46 inches; olive gray (5Y 5/2) silty clay, light gray (5Y 7/1) dry; few fine prominent yellowish brown (10YR 5/8) mottles; weak fine subangular blocky structure; extremely hard, firm, sticky and plastic; few very fine roots; few fine masses of lime; violent effervescence; moderately alkaline; abrupt smooth boundary.

Cg—46 to 60 inches; olive gray (5Y 5/2) loam, light olive gray (5Y 6/2) dry; many medium prominent black (10YR 2/1) mottles; massive; very hard, firm, sticky and slightly plastic; about 2 percent gravel; violent effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 24 to 36 inches. Some pedons have an O horizon, which is as much as 6 inches thick. The A horizon has value of 2 or 3 (3 or 4 dry). Some pedons do not have an E horizon. The Bt horizon has hue of 2.5Y or 5Y, value of 2 to 4, and chroma of 1 or 2. It is clay loam, silty clay loam, or silty clay. Some pedons have a BCg horizon. Some do not have a Bk horizon. The Cg horizon is loam, clay loam, silty clay loam, or silty clay.

Playmoor Series

The Playmoor series consists of deep, poorly drained, moderately slowly permeable, saline soils on glacial till plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Playmoor silty clay loam, saline, 2,575 feet north and 120 feet west of the southeast corner of sec. 10, T. 154 N., R. 57 W.

Az1—0 to 9 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and plastic; many fine and common medium roots; few fine threads of salts; slight effervescence; moderately alkaline; clear smooth boundary.

Az2—9 to 18 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; hard, friable, sticky and plastic; many fine roots; common fine threads of salts; slight effervescence; moderately alkaline; gradual wavy boundary.

Bz1—18 to 22 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common fine roots; few fine threads of salts; strong effervescence; moderately alkaline; clear wavy boundary.

Bz2—22 to 28 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; hard, friable, sticky and plastic; common fine roots; common fine masses of salts; common medium masses of lime; slight effervescence; moderately alkaline; gradual wavy boundary.

Ab—28 to 48 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; very hard, firm, sticky and plastic; few fine roots; few fine masses of salts; slight effervescence; mildly alkaline; clear wavy boundary.

2Cyzg—48 to 60 inches; olive gray (5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; common medium distinct black (N 2/0), few medium prominent dark reddish brown (5YR 3/4), and common medium prominent strong brown (7.5YR 5/6) mottles; massive; very hard, friable, slightly sticky and slightly plastic; about 2 percent gravel; common fine masses of salts; few medium masses of gypsum; slight effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 24 to 50 inches. The Az horizon has hue of 10YR, 2.5Y, or 5Y and value of 2 or 3 (3 to 5 dry). The Bz horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 3 to 5 when dry and has chroma of 0 or 1. Some pedons have a Bg horizon. The 2Cyzg horizon has hue of 2.5Y or 5Y, value of 2 to 4 (4 to 7 dry), and chroma of 1 or 2. It is loam, clay loam, or silty clay loam.

Renshaw Series

The Renshaw series consists of deep, somewhat excessively drained soils on glacial outwash plains and eskers. These soils formed in glacial outwash sediments. Permeability is moderately rapid in the upper part of the profile and very rapid in the lower part. Slope ranges from 1 to 6 percent.

Typical pedon of Renshaw loam, 1 to 6 percent slopes, 2,500 feet north and 275 feet west of the southeast corner of sec. 19, T. 150 N., R. 59 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine roots; about 5 percent gravel; slightly acid; abrupt smooth boundary.

Bw—8 to 15 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; about 5 percent gravel; neutral; gradual smooth boundary.

2C—15 to 60 inches; dark brown (10YR 4/3) very gravelly coarse sand, brown (10YR 5/3) dry; single grain; loose, nonsticky and nonplastic; about 40 percent gravel; strong effervescence; mildly alkaline.

The mollic epipedon is 12 to 16 inches thick. The depth to the 2C horizon is 14 to 20 inches.

The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 3 or 4 (4 or 5 dry) and chroma of 1 to 4. The 2C horizon is dominantly gravelly coarse sand or very gravelly coarse sand. In some pedons, however, it has thin strata of sandy loam or silt loam below a depth of 40 inches. In other pedons it has a stone line. Some pedons have a Bk horizon.

Sioux Series

The Sioux series consists of deep, excessively drained, very rapidly permeable soils on eskers, terraces, and glacial outwash plains. These soils formed in glacial outwash sediments. Slope ranges from 6 to 25 percent.

Typical pedon of Sioux loam, in an area of Sioux-Barnes loams, 6 to 15 percent slopes; 450 feet south and 400 feet east of the northwest corner of sec. 13, T. 154 N., R. 58 W.

A—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine and medium granular structure; soft, very friable, nonsticky and nonplastic; many medium and fine roots; about 10 percent gravel; strong effervescence; mildly alkaline; clear smooth boundary.

AC—8 to 12 inches; very dark grayish brown (10YR 3/2) very gravelly loam, grayish brown (10YR 5/2) dry; weak fine granular structure; loose, nonsticky and nonplastic; many fine and very fine roots; about 45 percent gravel; violent effervescence; moderately alkaline; clear smooth boundary.

C—12 to 60 inches; dark brown (10YR 4/3) very gravelly sand, light brownish gray (10YR 6/2) dry; single grain; loose, nonsticky and nonplastic; few fine roots; about 60 percent gravel; violent effervescence; moderately alkaline.

The thickness of the mollic epipedon and the depth to sand and gravel range from 8 to 14 inches. The A horizon has value of 2 or 3 (3 to 5 dry). The AC horizon is very gravelly loam, gravelly loam, or gravelly sandy loam. Some pedons do not have an AC horizon. The C horizon is dominantly the gravelly or very gravelly analogs of coarse sand or sand. In some pedons, however, it has thin lenses of gravel-size shale fragments, coarse sand, sand, or loamy coarse sand.

Southam Series

The Southam series consists of deep, very poorly drained, slowly permeable soils on glacial till plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Southam silty clay loam, 1,815 feet east and 330 feet north of the southwest corner of sec. 18, T. 153 N., R. 59 W.

Oi—2 inches to 0; undecomposed and partially decomposed roots, stems, and leaves; abrupt smooth boundary.

A1—0 to 6 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; massive; firm, sticky and plastic; few fine and common very fine roots; slight effervescence; mildly alkaline; clear wavy boundary.

A2—6 to 26 inches; black (10YR 2/1) silty clay loam, gray (10YR 5/1) dry; massive; firm, sticky and plastic; common very fine roots; slight effervescence; mildly alkaline; clear wavy boundary.

C1—26 to 36 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (10YR 7/1) dry; few fine distinct light olive brown (2.5Y 5/4) mottles; massive; extremely hard, firm, sticky and plastic; few very fine roots; violent effervescence; mildly alkaline; gradual wavy boundary.

C2—36 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (2.5Y 7/2) dry; common fine prominent yellowish brown (10YR 5/6) mottles; massive; very hard, firm, sticky and plastic; few very fine roots; violent effervescence; mildly alkaline.

Some pedons do not have an Oi horizon. The A horizon either has hue of 10YR or 5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2 or is neutral in hue and has value of 2 to 4 and chroma of 0. The C horizon has hue of 5Y or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 or 2. Some pedons have a 2C horizon, which is gravelly sandy loam or silt loam.

Svea Series

The Svea series consists of deep, well drained and moderately well drained, moderately slowly permeable soils on glacial till plains, on moraines, and in stream valleys. These soils formed in glacial till. Slope ranges from 0 to 25 percent.

Typical pedon of Svea loam, in an area of Svea-Buse loams, 3 to 6 percent slopes; 345 feet east and 120 feet north of the southwest corner of sec. 23, T. 154 N., R. 57 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine and medium and few coarse roots; about 2 percent gravel; mildly alkaline; abrupt smooth boundary.

A—6 to 11 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; about 2 percent gravel; neutral; gradual wavy boundary.

Bw1—11 to 17 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; few fine roots; about 2 percent gravel; neutral; gradual wavy boundary.

Bw2—17 to 24 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak medium prismatic structure parting to weak medium subangular blocky; hard, very friable, slightly sticky and slightly plastic; few fine roots; about 2 percent gravel; neutral; gradual wavy boundary.

Bw3—24 to 27 inches; dark brown (10YR 4/3) clay loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and plastic; few fine roots; about 2 percent gravel; mildly alkaline; gradual wavy boundary.

Bk—27 to 38 inches; light olive brown (2.5Y 5/4) clay loam, pale yellow (2.5Y 7/4) dry; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; about 2 percent gravel; common medium soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C—38 to 60 inches; light olive brown (2.5Y 5/4) clay loam, light yellowish brown (2.5Y 6/4) dry; few fine prominent dark reddish brown (5YR 3/4) mottles; massive; hard, friable, sticky and plastic; about 2 percent gravel; strong effervescence; moderately alkaline.

The mollic epipedon is 16 to more than 26 inches thick. The A horizon has value of 2 or 3. The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 4. The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6 (6 to 8 dry), and chroma of 2 to 4. The Bk and C horizons are clay loam or loam. Some pedons have thin lenses of very fine sand, silt, silt loam, silty clay loam, sandy loam, loamy sand, or sand below a depth of 40 inches. Some have a 1- to 4-inch-thick cobbly or gravelly layer between the Bw and Bk horizons.

Tonka Series

The Tonka series consists of deep, poorly drained, slowly permeable soils on glacial till plains. These soils formed in alluvium and glacial till. Slope is 0 to 1 percent.

Typical pedon of Tonka silt loam, in an area of Hamerly-Tonka complex, 0 to 3 percent slopes; 1,665 feet east and 250 feet south of the northwest corner of sec. 7, T. 152 N., R. 60 W.

Ap—0 to 7 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine, fine, and medium roots; neutral; abrupt smooth boundary.

A—7 to 10 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; neutral; abrupt smooth boundary.

E—10 to 16 inches; dark grayish brown (10YR 4/2) silt loam, light gray (10YR 7/2) dry; common medium distinct dark yellowish brown (10YR 4/4) mottles; moderate thin platy structure; slightly hard, friable, slightly sticky and nonplastic; few very fine and fine roots; neutral; abrupt wavy boundary.

Bt1—16 to 28 inches; very dark grayish brown (2.5Y 3/2) clay loam, grayish brown (2.5Y 5/2) dry; few fine faint dark brown (7.5YR 4/4) mottles; moderate fine angular blocky structure; hard, firm, sticky and plastic; few very fine roots; few thin distinct clay films on faces of peds; neutral; gradual smooth boundary.

Bt2—28 to 39 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; few fine prominent dark brown (7.5YR 4/4) mottles; weak fine angular blocky structure; hard, firm, sticky and plastic; few very fine roots; few thin faint clay films on faces of peds; about 2 percent gravel; mildly alkaline; gradual smooth boundary.

Cg—39 to 60 inches; olive gray (5Y 5/2) loam, light gray (5Y 7/2) dry; common medium prominent dark yellowish brown (10YR 4/4) mottles; massive; hard, friable, slightly sticky and slightly plastic; about 2 percent gravel; slight effervescence; mildly alkaline.

The A horizon has value of 2 or 3 (3 or 4 dry). The E horizon has hue of 10YR or 2.5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 or 2. It is loam, very fine sandy loam, or silt loam. The Bt horizon has hue of 10YR or 2.5Y, value of 2 to 4 (4 to 6 dry), and chroma of 1 or 2. It is silty clay loam, clay loam, clay, or silty clay. Some pedons have a BC horizon. Some have a Bk horizon. The Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 to 4. It is loam, silty clay loam, or clay loam.

Vallers Series

The Vallers series consists of deep, poorly drained, moderately slowly permeable, highly calcareous soils on glacial till plains. These soils formed in glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Vallers loam, in an area of Parnell-Vallers complex, 0 to 3 percent slopes; 2,480 feet west and 235 feet north of the southeast corner of sec. 14, T. 154 N., R. 60 W.

Ap—0 to 8 inches; black (N 2/0) loam, very dark gray (N 3/0) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; common fine flecks of salts; strong effervescence; moderately alkaline; abrupt smooth boundary.

Bk1—8 to 12 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (N 6/0) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, sticky and plastic; few very fine roots; about 2 percent gravel; common fine soft masses of lime; violent effervescence; moderately alkaline; clear smooth boundary.

Bk2—12 to 18 inches; light brownish gray (2.5Y 6/2) silty clay loam, light gray (2.5Y 7/2) dry; few fine prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; common fine soft masses of lime; violent effervescence; moderately alkaline; gradual smooth boundary.

C1—18 to 23 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; few fine prominent yellowish brown (10YR 5/8) mottles; massive; hard, very friable, slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; strong effervescence; moderately alkaline; clear smooth boundary.

C2—23 to 60 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; many medium prominent yellowish brown (10YR 5/8) mottles; massive; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; strong effervescence; moderately alkaline.

The soils are slightly saline or moderately saline. The thickness of the mollic epipedon ranges from 7 to 25 inches.

The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 (3 or 4 dry) and chroma of 0 or 1. Some pedons have an ABk horizon. The Bk horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 3 to 6 (5 to 8 dry) and chroma of 2 or less. It is loam, sandy clay loam, silty clay loam, or clay loam. Some pedons have gypsum in the Bk or C horizon.

Vang Series

The Vang series consists of deep, well drained soils on glacial outwash plains. These soils formed in glacial outwash sediments. Permeability is moderate in the upper part of the profile and very rapid in the lower part. Slope is 0 to 1 percent.

Typical pedon of Vang loam, 1,715 feet south and 115 feet west of the northeast corner of sec. 22, T. 149 N., R. 59 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate coarse and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and few medium roots; about 5 percent gravel-size shale fragments; neutral; abrupt smooth boundary.

A—6 to 15 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; about 5 percent gravel-size shale fragments; neutral; clear smooth boundary.

Bw1—15 to 20 inches; very dark grayish brown (2.5Y 3/2) clay loam, grayish brown (2.5Y 5/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, sticky and plastic; few very fine roots; about 5 percent gravel-size shale fragments; neutral; gradual wavy boundary.

Bw2—20 to 24 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; slightly hard, very friable, sticky and plastic; few very fine roots; about 5 percent gravel-size shale fragments; neutral; gradual wavy boundary.

Bw3—24 to 27 inches; dark grayish brown (2.5Y 4/2) gravelly clay loam, light brownish gray (2.5Y 6/2) dry; weak fine granular structure; hard, very friable, sticky and plastic; few very fine roots; about 20 percent gravel-size shale fragments; neutral; gradual wavy boundary.

2C—27 to 60 inches; very dark gray (5Y 3/1) extremely gravelly sand, light olive gray (5Y 6/2) dry; common medium prominent dark yellowish brown (10YR 3/6) and very dark brown (10YR 2/2) mottles; single grain; loose; about 70 percent gravel-size shale fragments; slight effervescence; mildly alkaline.

The depth to the 2C horizon ranges from 20 to 40 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (4 to 6 dry), and chroma of 1 to 3. It is loam or clay loam in the upper part and gravelly loam or gravelly clay loam in the lower part. Some pedons have a BC or Bk horizon.

Walsh Series

The Walsh series consists of deep, well drained, moderately permeable soils in stream valleys. These soils formed in colluvium. Slope ranges from 1 to 9 percent.

Typical pedon of Walsh loam, 1 to 6 percent slopes, 1,415 feet east and 1,235 feet south of the northwest corner of sec. 30, T. 150 N., R. 60 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium and fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and fine and few medium and coarse roots; neutral; abrupt smooth boundary.

A—6 to 12 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and few medium and coarse roots; neutral; gradual wavy boundary.

Bw1—12 to 18 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, sticky and plastic; common very fine and few medium roots; neutral; gradual wavy boundary.

Bw2—18 to 26 inches; very dark grayish brown (2.5Y 3/2) loam, grayish brown (2.5Y 5/2) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, sticky and plastic; common very fine and few fine roots; neutral; clear wavy boundary.

Bw3—26 to 36 inches; very dark grayish brown (2.5Y 3/2) loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; slightly hard, very friable, sticky and plastic; few fine roots; neutral; abrupt smooth boundary.

C1—36 to 46 inches; dark grayish brown (2.5Y 4/2) channery loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard, friable, sticky and plastic; few fine roots; about 20 percent shale channers; common medium irregular soft masses of lime; moderately alkaline; abrupt smooth boundary.

C2—46 to 55 inches; dark grayish brown (2.5Y 4/2) channery loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard, friable, sticky and plastic; few fine roots; about 20 percent shale channers; common fine soft masses of lime; moderately alkaline; abrupt smooth boundary.

C3—55 to 60 inches; dark grayish brown (2.5Y 4/2) loam, light yellowish brown (2.5Y 6/3) dry; massive; soft, friable, sticky and plastic; few fine roots; about 2 percent shale channers; few fine soft masses of lime; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 26 inches. The A horizon has value of 2 or 3. The Bw horizon has value of 2 to 4 (3 to 6 dry) and chroma of 1 to 3. Some pedons have a BC horizon. Some have a 2C horizon of gravelly sand below a depth of 40 inches.

Wamduska Series

The Wamduska series consists of deep, excessively drained, rapidly permeable soils on lake plains. These soils formed in beach sediments. Slope ranges from 1 to 45 percent.

Typical pedon of Wamduska loamy coarse sand, in an area of Wamduska-Mauvais complex, 1 to 9 percent slopes; 1,730 feet south and 875 feet east of the northwest corner of sec. 28, T. 151 N., R. 60 W.

Oi—2 inches to 0; black (10YR 2/1) and very dark grayish brown (10YR 3/2), partially decomposed leaves, roots, and twigs; many very fine and few medium and coarse roots; abrupt smooth boundary.

A—0 to 3 inches; very dark gray (10YR 3/1) loamy coarse sand, dark grayish brown (10YR 4/2) dry; single grain; loose, very friable, nonsticky and nonplastic; many very fine and few fine and medium roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

C1—3 to 7 inches; dark grayish brown (2.5Y 4/2) gravelly loamy coarse sand, grayish brown (2.5Y 5/2) dry; single grain; loose, nonsticky and nonplastic; many very fine and few fine and medium roots; about 35 percent gravel; slight effervescence; moderately alkaline; abrupt smooth boundary.

C2—7 to 18 inches; dark grayish brown (10YR 4/2) very gravelly coarse sand, light brownish gray (10YR 6/2) dry; single grain; loose, nonsticky and nonplastic; common very fine and few medium roots; about 40 percent gravel; slight effervescence; mildly alkaline; clear smooth boundary.

C3—18 to 25 inches; dark grayish brown (2.5Y 4/2) very gravelly coarse sand, light brownish gray (2.5Y 6/2) dry; single grain; loose, nonsticky and nonplastic; common very fine and few fine roots; about 55 percent gravel; slight effervescence; mildly alkaline; abrupt wavy boundary.

C4—25 to 32 inches; very dark grayish brown (2.5Y 3/2) gravelly coarse sand, grayish brown (2.5Y 5/2) dry; single grain; loose, nonsticky and nonplastic; common very fine and few fine, medium, and coarse roots; about 20 percent gravel; slight effervescence; mildly alkaline; abrupt wavy boundary.

C5—32 to 57 inches; dark brown (7.5YR 4/4), dark grayish brown (10YR 4/2), and dark brown (10YR 4/3) gravelly coarse sand, brown (7.5YR 5/4), grayish brown (10YR 5/2), and brown (10YR 5/3) dry; single grain; loose, nonsticky and nonplastic; few very fine, fine, and medium roots; about 15 percent gravel; slight effervescence; moderately alkaline; abrupt wavy boundary.

Ab—57 to 60 inches; black (10YR 2/1) gravelly loamy coarse sand, dark gray (10YR 4/1) dry; massive; loose, very friable, nonsticky and nonplastic; few very fine roots; about 5 percent gravel; slight effervescence; moderately alkaline.

The depth to carbonates ranges from 0 to 45 inches. The content of gravel ranges from 15 to 35 percent between depths of 10 and 40 inches. It is more than 35 percent in at least one subhorizon.

The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 (1 or 2 dry). It is 1 to 6 inches thick. It is sandy loam or loamy coarse sand. Some pedons do not have an Ab or Oi horizon. The C horizon is sand to very gravelly very coarse sand. Some pedons have a 2C horizon of loam or clay loam below a depth of 40 inches.

Zell Series

The Zell series consists of deep, well drained, moderately permeable soils on glacial lake plains. These soils formed in lacustrine sediments. Slope ranges from 6 to 25 percent.

Typical pedon of Zell silt loam, in an area of Zell-Maddock complex, 6 to 25 percent slopes; 1,915 feet east and 1,015 feet north of the southwest corner of sec. 29, T. 149 N., R. 60 W.

A—0 to 5 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; soft, very friable, nonsticky and slightly plastic; common very fine and few fine roots; few fine soft masses of lime; neutral; clear smooth boundary.

AB—5 to 10 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate medium and fine prismatic structure parting to moderate medium subangular blocky; soft, very friable, nonsticky and slightly plastic; many very fine and few medium roots; strong effervescence; mildly alkaline; gradual smooth boundary.

Bk1—10 to 20 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; weak coarse prismatic structure parting to weak medium subangular blocky; soft, very friable, slightly sticky and slightly plastic; common very fine roots; common medium soft masses of lime; violent effervescence; mildly alkaline; clear smooth boundary.

Bk2—20 to 26 inches; light olive brown (2.5Y 5/4), stratified very fine sandy loam, light yellowish brown (2.5Y 6/4) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; soft, very friable, nonsticky and slightly plastic; few very fine roots; few fine soft masses of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

C1—26 to 42 inches; light olive brown (2.5Y 5/4), stratified silt loam, light yellowish brown (2.5Y 6/4) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; massive; soft, very friable, nonsticky and slightly plastic; few fine roots to a depth of about 30 inches; few medium soft masses of lime; moderately alkaline; gradual wavy boundary.

C2—42 to 60 inches; light olive brown (2.5Y 5/4), stratified very fine sandy loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct yellowish brown (10YR 5/6) mottles; massive; soft, very friable, nonsticky and nonplastic; slight effervescence; moderately alkaline.

The mollic epipedon is 7 to 13 inches thick. The A horizon has value of 2 or 3 (3 or 4 dry). The AB horizon has chroma of 2 or 3. It is silt loam or very fine sandy loam. The C horizon has value of 4 to 6 (6 to 8 dry) and chroma of 2 to 4. Some pedons have thin strata of gravel below a depth of 40 inches.

Formation of the Soils

Soil forms through processes acting on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time that the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for the transformation of the parent material into a soil. Some time is always required for the differentiation of soil horizons. Usually, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

Parent Material

The soils in the survey area formed mainly in glacial drift. The advancing glacier picked up rocks and soil and ground and mixed them. The receding glacier deposited the material as the ice melted. Some soils, such as Barnes and Svea, formed in unsorted material, or glacial till. Other soils, such as Lallie and Gardena, formed in lacustrine sediments, or glacial material deposited by water in glacial lakes. Others, such as Arvilla and Renshaw, formed in glacial outwash, or material deposited by glacial meltwater. Kloten soils formed in material weathered from shale bedrock that was exposed on the sides of valleys cut by glacial streams.

Climate

Climate directly and indirectly affects soil formation. Precipitation, temperature, and wind directly affect the weathering and reworking of soil material. The climate indirectly affects soil formation through its effects on the amount and kind of vegetation and animal life on or in the soil.

In addition to weathering the soil material, precipitation and temperature affect the leaching and redistribution of carbonates and clay particles and the accumulation of organic matter in the soil. Freezing and thawing help to break down soil particles in the parent material, thereby providing more surface area for chemical processes. Cool temperatures affect the content of organic matter by slowing the decay of plant material and animal remains.

The survey area has a continental, semiarid climate characterized by long, cold winters and short, warm summers. Most of the precipitation falls during the growing season and is distributed in an erratic pattern. The climate is fairly uniform throughout the county.

Slight climatic fluctuations since the glaciers receded have caused fluctuations in the water level of Stump Lake. Young soils, such as Lallie and Mauvais, are alternately exposed and inundated by the fluctuating lake levels.

Plant and Animal Life

The soils in the survey area formed mainly under grassland vegetation. Grasses provide a plentiful supply of organic matter, which improves the chemical and physical properties of the soil. The fibrous roots of these grasses penetrate the soil to a depth of several feet, making it more porous and more granular. As a result of these changes in the soil, less water runs off the surface and more moisture is available for increased microbiological activity. The decay of the plants improves the available water capacity, tilth, and fertility of the soil. The decayed organic matter, accumulating over long periods, gives the surface layer its dark color.

Micro-organisms feed on undecomposed organic matter and convert it into humus from which plants can obtain nutrients for increased growth. Bacteria and different kinds of fungi attack leaves and other forms of organic matter. Insects, earthworms, and small burrowing animals help to mix the humus with the soil.

Human activities greatly affect soil formation. Management measures can alter soil drainage. They can help to control erosion, thus maintaining fertility. Poor management can increase the susceptibility to erosion and thus result in an unproductive soil.

Relief

The slope of the soils in the survey area ranges from level to very steep. The degree of slope and the shape of the surface affect each soil through their effects on runoff and internal drainage.

On the steeper soils, such as Buse, most of the precipitation is lost as runoff. Vegetation is sparse, leaching is restricted, and profile development is slow. Because of their position on the landscape, Svea and other soils in the lower areas receive extra moisture. As a result, plant growth, leaching, and the rate of profile development are increased.

Soils that formed in depressions and on flats vary widely in profile development, depending on the degree of wetness. Tonka soils, which are in shallow depressions, exhibit an advanced degree of horizonation because of the alternate wet and dry cycles that occur in the depressions. Southam soils, which are in deep depressions, are continuously wet and have a very thick surface layer. The horizonation in these soils is a result of sedimentary processes rather than soil-forming processes (*3*). Hamerly soils, which are mainly on flats, have accumulated lime in the upper part. As the water table rises, the lime moves to the surface through capillary action.

Time

The formation of a soil is a very slow process. Much time is required for the processes of soil formation to act on the parent material and to form distinct horizons within the soil profile. Approximately 10,000 years have passed since the last glacier receded from the survey area. In geologic terms the soils in the county are young.

More time has been available for the formation of Svea soils on glacial till plains than for the formation of Lallie soils on lake plains adjacent to Stump Lake. Svea soils have well defined horizons and a high organic matter content, whereas Lallie soils do not have distinct horizons and have a low organic matter content. The forces of soil formation have been continually acting on the parent material of Barnes soils. In contrast, Lallie soils were recently exposed as a result of the receding waters of Stump Lake.

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Glossary

Abandoned beaches. Beaches formed in an earlier time and now at an elevation, perhaps 50 to 100 feet, above the existing lake level.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a channer.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Diversion. A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fine textured soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

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.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Salty water (in tables.) Water that is too salty for consumption by livestock.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to soil blowing and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. The E horizon.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 9 inches (10 to 23 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. An A horizon 10 or more inches thick.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-81 at Petersburg, North Dakota)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	11.9	-8.5	1.7	41	-36	0	0.60	0.20	0.93	3	6.6
February----	18.8	-2.0	8.4	44	-29	0	.36	.16	.54	2	4.4
March-------	30.8	10.8	20.8	59	-24	29	.80	.17	1.28	2	6.7
April-------	49.3	28.2	38.8	84	2	138	1.40	.32	2.24	4	3.0
May---------	65.0	39.7	52.4	90	21	399	2.22	1.03	3.24	6	.2
June--------	74.5	50.3	62.4	94	35	672	3.35	2.12	4.45	7	.0
July--------	80.0	54.4	67.2	96	39	843	2.72	1.50	3.79	6	.0
August------	79.5	52.0	65.8	97	37	800	2.41	1.17	3.47	5	.0
September---	67.6	41.8	54.7	93	24	441	2.10	.82	3.16	5	.1
October-----	55.2	31.4	43.3	85	12	192	1.16	.41	1.77	3	1.4
November----	34.7	16.3	25.5	66	-13	18	.73	.21	1.14	2	4.5
December----	19.6	.3	10.0	44	-30	0	.45	.18	.68	2	5.2
Yearly:											
Average---	48.9	27.1	37.6	---	---	---	---	---	---	---	---
Extreme---	---	---	---	98	-36	---	---	---	---	---	---
Total-----	---	---	---	---	---	3,532	18.30	15.29	21.28	47	32.1

* 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 (40 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-81 at Petersburg, North Dakota)

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--	June 11	June 23	July 3
2 years in 10 later than--	May 25	June 5	June 15
5 years in 10 later than--	Apr. 22	May 2	May 11
First freezing temperature in fall:			
1 year in 10 earlier than--	Aug. 30	Aug. 17	Aug. 7
2 years in 10 earlier than--	Sept. 14	Sept. 2	Aug. 23
5 years in 10 earlier than--	Oct. 13	Oct. 3	Sept. 24

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-81 at Petersburg, North Dakota)

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	138	118	102
8 years in 10	146	126	109
5 years in 10	162	141	122
2 years in 10	178	157	137
1 year in 10	187	166	145

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
2	Parnell silt loam	9,385	1.6
3	Playmoor silty clay loam, saline	6,745	1.2
4	Southam silty clay loam	14,250	2.5
5	Hamerly-Tonka complex, 0 to 3 percent slopes	68,250	11.8
7	Parnell-Vallers complex, 0 to 3 percent slopes	48,105	8.4
8	Svea loam	14,140	2.5
10	Svea loam, 1 to 3 percent slopes	13,790	2.4
11B	Svea-Buse loams, 3 to 6 percent slopes	125,945	21.8
11C	Svea-Buse loams, 6 to 9 percent slopes	37,830	6.6
12B	Barnes-Svea loams, 3 to 6 percent slopes	9,845	1.7
13D	Buse-Svea loams, 9 to 15 percent slopes	8,790	1.5
13E	Buse-Svea loams, 15 to 25 percent slopes	5,370	0.9
14D	Sioux-Barnes loams, 6 to 15 percent slopes	6,720	1.2
15	Borup silt loam	1,305	0.2
17	Borup silt loam, saline	1,325	0.2
20	Hamerly loam, 0 to 2 percent slopes	28,110	4.9
20B	Hamerly loam, 2 to 5 percent slopes	60,175	10.4
21	Vallers and Hamerly loams, saline, 0 to 3 percent slopes	25,515	4.4
22	Vallers loam, 0 to 3 percent slopes	2,170	0.4
23	Cavour-Cresbard loams, 0 to 3 percent slopes	3,670	0.6
24	Svea-Cresbard loams, 0 to 3 percent slopes	12,570	2.2
25	Miranda-Cavour loams, 0 to 3 percent slopes	1,650	0.3
26B	Cresbard-Barnes loams, 3 to 6 percent slopes	11,530	2.0
27	Hamar loamy sand	410	0.1
28E	Wamduska sandy loam, 9 to 45 percent slopes, extremely stony	955	0.2
29B	Maddock loamy sand, 1 to 6 percent slopes	1,540	0.3
30	Embden fine sandy loam, 0 to 3 percent slopes	2,015	0.4
31B	Egeland sandy loam, 3 to 6 percent slopes	865	0.2
32	Gardena silt loam, 0 to 3 percent slopes	1,280	0.2
32B	Gardena silt loam, 3 to 6 percent slopes	735	0.1
33	Glyndon silt loam	910	0.2
34	LaDelle silt loam	1,400	0.2
35	LaDelle silt loam, channeled	2,395	0.4
36B	Arvilla sandy loam, 0 to 6 percent slopes	2,435	0.4
37	Fordville loam	1,105	0.2
38B	Renshaw loam, 1 to 6 percent slopes	2,665	0.5
39E	Sioux loam, 6 to 25 percent slopes	1,080	0.2
40	Divide loam, 0 to 3 percent slopes	2,135	0.4
41	Vang loam	490	0.1
42B	Brantford loam, 1 to 6 percent slopes	990	0.2
43E	Coe gravelly loam, 6 to 25 percent slopes	1,275	0.2
44B	Walsh loam, 1 to 6 percent slopes	1,245	0.2
44C	Walsh loam, 6 to 9 percent slopes	535	0.1
45E	Zell-Maddock complex, 6 to 25 percent slopes	1,110	0.2
46C	Wamduska-Mauvais complex, 1 to 9 percent slopes	3,720	0.6
47	Lallie silty clay loam, saline	2,205	0.4
48B	Barnes-Renshaw loams, 1 to 6 percent slopes	6,345	1.1
70E	Kloten-Buse loams, 9 to 25 percent slopes	4,325	0.8
73	Lamoure silty clay loam	3,095	0.5
	Water	10,915	1.9
	Total	575,360	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS

(Yields generally are those that can be expected under a high level of management. For poorly drained and very poorly drained soils, however, the yields are those that can be expected in undrained areas. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Spring wheat	Barley	Oats	Flax	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Lbs	Tons
2 Parnell	---	---	---	---	---	---
3 Playmoor	---	---	---	---	---	0.8
4 Southam	---	---	---	---	---	---
5 Hamerly-Tonka	27	44	57	14	1,350	2.2
7 Parnell-Vallers	---	---	---	---	---	2.4
8, 10 Svea	37	60	79	19	1,850	3.0
11B Svea-Buse	29	49	64	15	1,500	2.4
11C Svea-Buse	26	42	55	13	1,300	2.0
12B Barnes-Svea	34	55	72	17	1,700	2.7
13D Buse-Svea	---	---	---	---	---	1.4
13E Buse-Svea	---	---	---	---	---	---
14D Sioux-Barnes	---	---	---	---	---	1.0
15 Borup	17	28	36	9	850	1.4
17 Borup	---	---	---	---	---	---
20 Hamerly	33	54	70	17	1,650	2.7
20B Hamerly	29	47	62	15	1,450	2.3
21 Vallers and Hamerly	14	23	30	7	700	1.1
22 Vallers	17	28	36	9	850	1.4
23 Cavour-Cresbard	19	31	40	10	950	1.5
24 Svea-Cresbard	34	55	72	17	1,700	2.8

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Spring wheat	Barley	Oats	Flax	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Lbs	Tons
25: Miranda-Cavour	---	---	---	---	---	0.6
26B: Cresbard-Barnes	28	46	60	14	1,400	2.3
27: Hamar	12	20	26	6	600	1.0
28E: Wamduska	---	---	---	---	---	---
29B: Maddock	19	31	40	10	950	1.5
30: Embden	28	46	60	14	1,400	2.3
31B: Egeland	25	41	53	13	1,250	2.0
32: Gardena	40	65	85	20	2,000	3.2
32B: Gardena	36	59	77	18	1,800	2.9
33: Glyndon	35	57	74	18	1,750	2.8
34: LaDelle	38	62	81	19	1,900	3.0
35: LaDelle	---	---	---	---	---	---
36B: Arvilla	17	28	55	9	850	1.4
37: Fordville	26	42	55	13	1,300	2.1
38B: Renshaw	20	33	43	10	1,000	1.6
39E: Sioux	---	---	---	---	---	---
40: Divide	26	42	55	13	1,300	2.1
41: Vang	26	42	55	13	1,300	2.1
42B: Brantford	21	34	47	10	1,050	1.7
43E: Coe	---	---	---	---	---	---
44B: Walsh	38	62	81	19	1,900	3.0

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Spring wheat	Barley	Oats	Flax	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Lbs	Tons
44C----------------------- Walsh	28	46	60	14	1,400	2.3
45E----------------------- Zell-Maddock	---	---	---	---	---	0.6
46C----------------------- Wamduska-Mauvais	---	---	---	---	---	0.9
47------------------------ Lallie	---	---	---	---	---	0.8
48B----------------------- Barnes-Renshaw	25	41	53	13	1,250	2.0
70E----------------------- Kloten-Buse	---	---	---	---	---	---
73------------------------ Lamoure	20	33	43	10	1,000	1.6

TABLE 6.--RANGELAND PRODUCTIVITY

(Only the soils that support rangeland vegetation suitable for grazing are listed)

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable Lb/acre	Average Lb/acre	Unfavorable Lb/acre
2 Parnell	Wetland	6,600	6,000	4,800
3 Playmoor	Saline Lowland	4,100	3,500	2,800
7*:				
Parnell	Wetland	6,600	6,000	4,800
Vallers	Saline Lowland	4,000	3,500	3,000
13D*, 13E*:				
Buse	Thin Upland	2,700	2,400	1,800
Svea	Silty	3,000	2,700	2,500
14D*:				
Sioux	Very Shallow	1,400	1,200	900
Barnes	Silty	3,000	2,750	2,500
17 Borup	Saline Lowland	4,000	3,500	3,000
21*:				
Vallers	Saline Lowland	4,000	3,500	3,000
Hamerly	Saline Lowland	4,000	3,500	3,000
25*:				
Miranda	Thin Claypan	1,300	1,100	900
Cavour	Claypan	2,200	2,000	1,700
28E Wamduska	Very Shallow	1,400	1,100	900
35 LaDelle	Overflow	6,000	5,000	3,500
39E Sioux	Very Shallow	1,400	1,200	900
43E Coe	Very Shallow	1,400	1,100	900
45E*:				
Zell	Thin Upland	3,000	2,500	1,700
Maddock	Sands	3,000	2,800	2,600
46C*:				
Wamduska	Very Shallow	1,400	1,100	900
Mauvais	Subirrigated	5,200	4,700	4,200
47 Lallie	Saline Lowland	4,000	3,500	3,000

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
70E*:				
Kloten	Shallow	2,200	2,000	1,700
Buse	Thin Upland	2,700	2,400	1,800
73 Lamoure	Subirrigated	5,800	5,300	4,200

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
2 Parnell	American plum	Eastern redcedar, redosier dogwood, Siberian peashrub, common chokecherry, lilac, Amur honeysuckle.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow	Eastern cottonwood.
3. Playmoor					
4. Southam					
5*:					
Hamerly	---	Redosier dogwood, ponderosa pine, Amur honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Tonka	---	Eastern redcedar, common chokecherry, lilac, Amur honeysuckle, redosier dogwood, Siberian peashrub, American plum.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
7*:					
Parnell	American plum	Eastern redcedar, redosier dogwood, Siberian peashrub, common chokecherry, lilac, Amur honeysuckle.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow	Eastern cottonwood.
Vallers	Siberian peashrub, silver buffaloberry.	---	Siberian elm, green ash, Russian-olive.	---	---
8, 10 Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Amur honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
11B*:					
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Amur honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
Buse	Siberian peashrub, Amur honeysuckle, lilac.	Ponderosa pine, Russian-olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm, green ash.	---	---
11C*:					
Svea	---	Lilac, Siberian peashrub, redosier dogwood, eastern redcedar, Amur honeysuckle, American plum.	Bur oak, Siberian crabapple, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Buse	Siberian peashrub, Amur honeysuckle, lilac.	Ponderosa pine, Russian-olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm, green ash.	---	---
12B*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Amur honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Amur honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
13D*:					
Buse.					
Svea	---	Lilac, Siberian peashrub, redosier dogwood, eastern redcedar, Amur honeysuckle, American plum.	Bur oak, Siberian crabapple, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
13E*:					
Buse.					
Svea.					
14D*:					
Sioux.					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Amur honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
15 Borup	American plum	Eastern redcedar, common chokecherry, lilac, Amur honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
17 Borup	Siberian peashrub, silver buffaloberry.	Green ash	Siberian elm, Russian-olive.	---	---
20, 20B Hamerly	---	Redosier dogwood, ponderosa pine, Amur honeysuckle, Peking cotoneaster, eastern redcedar, Americn plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
21*:					
Vallers	Siberian peashrub, silver buffaloberry.	---	Siberian elm, green ash, Russian-olive.	---	---
Hamerly	Silver buffaloberry, Siberian peashrub.	---	Russian-olive, green ash, Siberian elm.	---	---
22 Vallers	American plum	Eastern redcedar, common chokecherry, lilac, Amur honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
23*:					
Cavour	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian-olive, eastern redcedar.	---	---	---
Cresbard	Amur honeysuckle, Peking cotoneaster.	Russian-olive, common chokecherry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
24*:					
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Amur honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
Cresbard	Amur honeysuckle, Peking cotoneaster.	Russian-olive, common chokecherry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
25*:					
Miranda.					
Cavour	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian-olive, eastern redcedar.	---	---	---
26B*:					
Cresbard	---	Common chokecherry, eastern redcedar, Amur honeysuckle, Siberian peashrub, lilac, American plum.	Green ash, ponderosa pine, bur oak, Manchurian crabapple, Russian-olive, Black Hills spruce.	---	---
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Amur honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
27 Hamar	American plum	Amur honeysuckle, redosier dogwood, common chokecherry, Siberian peashrub, lilac.	Black Hills spruce, green ash, Siberian crabapple, eastern redcedar.	Golden willow	Eastern cottonwood.
28E. Wamduska					
29B Maddock	---	Silver buffaloberry, common chokecherry, Siberian peashrub, eastern redcedar, Amur honeysuckle, American plum, Siberian crabapple, lilac.	Bur oak, green ash, ponderosa pine, Russian-olive.	---	---
30 Embden	---	Peking cotoneaster, ponderosa pine, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub, Amur honeysuckle, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
31B Egeland	Silver buffaloberry, Amur honeysuckle.	Manchurian crabapple, eastern redcedar, common chokecherry, Siberian peashrub, lilac, American plum.	Green ash, bur oak, ponderosa pine, Russian-olive.	---	---
32, 32B Gardena	---	Amur honeysuckle, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
33----------------- Glyndon	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Amur honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.
34----------------- LaDelle	---	Ponderosa pine, Amur honeysuckle, eastern redcedar, common chokecherry, Siberian peashrub, American plum, Peking cotoneaster.	Black Hills spruce, green ash, Manchurian crabapple.	Golden willow-----	Eastern cottonwood.
35. LaDelle					
36B---------------- Arvilla	Amur honeysuckle, Siberian peashrub, lilac, silver buffaloberry.	Green ash, Russian-olive, Siberian crabapple, eastern redcedar, Rocky Mountain juniper, common chokecherry.	Ponderosa pine----	---	---
37----------------- Fordville	Siberian peashrub, Amur honeysuckle, silver buffaloberry, lilac.	Rocky Mountain juniper, green ash, Siberian crabapple, common chokecherry, Russian-olive, eastern redcedar.	Ponderosa pine----	---	---
38B---------------- Renshaw	Silver buffaloberry, Amur honeysuckle, Siberian peashrub, lilac.	Green ash, eastern redcedar, Siberian crabapple, Rocky Mountain juniper, common chokecherry.	Ponderosa pine, Russian-olive.	---	---
39E. Sioux					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
40. Divide	---	Redosier dogwood, ponderosa pine, Amur honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
41. Vang	Lilac, Siberian peashrub, Amur honeysuckle, silver buffaloberry.	Siberian crabapple, green ash, Russian-olive, common chokecherry, eastern redcedar, Rocky Mountain juniper.	Ponderosa pine	---	---
42B. Brantford	Lilac, Siberian peashrub, Amur honeysuckle, silver buffaloberry.	Siberian crabapple, green ash, Russian-olive, common chokecherry, eastern redcedar, Rocky Mountain juniper.	Ponderosa pine	---	---
43E. Coe					
44B, 44C. Walsh	---	Amur honeysuckle, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
45E*:					
Zell.					
Maddock.					
46C*:					
Wamduska.					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
46C*:					
Mauvais	---	Russian-olive, common chokecherry, eastern redcedar, lilac, silver buffaloberry, Siberian peashrub, Amur honeysuckle, Peking cotoneaster.	Siberian elm, green ash, ponderosa pine, Siberian crabapple.	---	---
47. Lallie					
48B*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Amur honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Renshaw	Silver buffaloberry, Amur honeysuckle, Siberian peashrub, lilac.	Green ash, eastern redcedar, Siberian crabapple, Rocky Mountain juniper, common chokecherry.	Ponderosa pine, Russian-olive.	---	---
70E*:					
Kloten.					
Buse.					
73 Lamoure	American plum	Eastern redcedar, redosier dogwood, Siberian peashrub, Amur honeysuckle, common chokecherry, lilac.	Green ash, Black Hills spruce, Manchurian crabapple.	Golden willow	Eastern cottonwood.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe")

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
2 Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
3 Playmoor	Severe: flooding, wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, flooding, excess salt.	Severe: wetness.
4 Southam	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
5*:				
Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
7*:				
Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
Vallers	Severe: wetness, excess humus.	Severe: wetness, excess humus, excess salt.	Severe: excess humus, wetness, excess salt.	Severe: wetness, excess humus.
8 Svea	Slight	Slight	Moderate: small stones.	Slight.
10 Svea	Slight	Slight	Moderate: slope.	Slight.
11B*:				
Svea	Slight	Slight	Moderate: slope.	Slight.
Buse	Slight	Slight	Moderate: slope, small stones.	Slight.
11C*:				
Svea	Slight	Slight	Severe: slope.	Slight.
Buse	Slight	Slight	Severe: slope.	Slight.
12B*:				
Barnes	Slight	Slight	Moderate: slope.	Slight.
Svea	Slight	Slight	Moderate: slope, small stones.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
13D*:				
Buse	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Svea	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
13E*:				
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Svea	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
14D*:				
Sioux	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Barnes	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
15 Borup	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
17 Borup	Severe: flooding, wetness, excess humus.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
20 Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
20B Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight.
21*:				
Vallers	Severe: flooding, wetness, excess humus.	Severe: wetness, excess humus, excess salt.	Severe: excess humus, wetness, excess salt.	Severe: wetness, excess humus.
Hamerly	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Slight.
22 Vallers	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
23*:				
Cavour	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
24*:				
Svea	Slight	Slight	Slight	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
24*:				
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
25*:				
Miranda	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Cavour	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
26B*:				
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Barnes	Slight	Slight	Moderate: slope.	Slight.
27 Hamar	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
28E Wamduska	Severe: slope, large stones.	Severe: slope, large stones.	Severe: large stones, slope, small stones.	Severe: large stones, slope.
29B Maddock	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
30 Embden	Slight	Slight	Slight	Slight.
31B Egeland	Slight	Slight	Moderate: slope.	Slight.
32 Gardena	Slight	Slight	Slight	Slight.
32B Gardena	Slight	Slight	Moderate: slope.	Slight.
33 Glyndon	Slight	Slight	Slight	Slight.
34 LaDelle	Severe: flooding.	Slight	Slight	Slight.
35 LaDelle	Severe: flooding.	Slight	Moderate: flooding.	Slight.
36B Arvilla	Slight	Slight	Moderate: slope.	Slight.
37 Fordville	Slight	Slight	Slight	Slight.
38B Renshaw	Slight	Slight	Moderate: slope.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
39E Sioux	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
40 Divide	Slight	Slight	Slight	Slight.
41 Vang	Slight	Slight	Slight	Slight.
42B Brantford	Slight	Slight	Moderate: slope, small stones.	Slight.
43E Coe	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope, small stones.	Moderate: slope.
44B Walsh	Slight	Slight	Moderate: slope, small stones.	Slight.
44C Walsh	Slight	Slight	Severe: slope.	Slight.
45E*:				
Zell	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Maddock	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too sandy, slope.
46C*:				
Wamduska	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
Mauvais	Severe: wetness.	Moderate: wetness, excess salt.	Severe: wetness.	Moderate: wetness.
47 Lallie	Severe: flooding, ponding.	Severe: ponding, excess salt.	Severe: ponding.	Severe: ponding.
48B*:				
Barnes	Slight	Slight	Moderate: slope.	Slight.
Renshaw	Slight	Slight	Moderate: slope.	Slight.
70E*:				
Kloten	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Moderate: slope.
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
73-------------------- Lamoure	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor")

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife	Rangeland wildlife
2------------------ Parnell	Fair	Fair	Poor	Poor	Good	Good	Fair	Good	Poor.
3------------------ Playmoor	Poor	Poor	Fair	Very poor	Good	Good	Poor	Good	Fair.
4------------------ Southam	Very poor	Very poor	Very poor	Very poor	Good	Good	Very poor	Good	Very poor.
5*:									
Hamerly-----------	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Tonka-------------	Good	Good	Fair	Poor	Good	Good	Good	Good	Poor.
7*:									
Parnell-----------	Fair	Fair	Poor	Poor	Good	Good	Fair	Good	Poor.
Vallers-----------	Fair	Fair	Very poor	Fair	Good	Good	Fair	Good	Poor.
8, 10-------------- Svea	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
11B*:									
Svea--------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse--------------	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
11C*:									
Svea--------------	Fair	Good	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
Buse--------------	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
12B*:									
Barnes------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Svea--------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
13D*:									
Buse--------------	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Svea--------------	Poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
13E*:									
Buse--------------	Poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Svea--------------	Poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
14D*:									
Sioux-------------	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
Barnes------------	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
15, 17------------- Borup	Fair	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba- ceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
20----------------- Hamerly	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
20B---------------- Hamerly	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
21*:									
Vallers-----------	Fair	Fair	Very poor	Fair	Good	Good	Fair	Good	Poor.
Hamerly-----------	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Fair.
22----------------- Vallers	Fair	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
23*:									
Cavour------------	Poor	Poor	Poor	Very poor	Very poor	Very poor	Poor	Very poor	Poor.
Cresbard----------	Good	Fair	Good	Poor	Very poor	Very poor	Good	Very poor	Good.
24*:									
Svea--------------	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Cresbard----------	Good	Fair	Good	Poor	Very poor	Very poor	Good	Very poor	Good.
25*:									
Miranda-----------	Poor	Poor	Very poor	Very poor	Poor	Poor	Poor	Poor	Very poor.
Cavour------------	Poor	Poor	Poor	Very poor	Very poor	Very poor	Poor	Very poor	Poor.
26B*:									
Cresbard----------	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Good.
Barnes------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
27----------------- Hamar	Poor	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair.
28E---------------- Wamduska	Very poor	Very poor	Poor	Good	Very poor	Very poor	Very poor	Very poor	Fair.
29B---------------- Maddock	Fair	Good	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
30----------------- Embden	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
31B---------------- Egeland	Fair	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Good.
32----------------- Gardena	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
32B---------------- Gardena	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
33----------------- Glyndon	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba-ceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
34----------------- LaDelle	Good	Good	Fair	Good	Very poor	Very poor	Good	Very poor	Fair.
35----------------- LaDelle	Poor	Good	Fair	Good	Poor	Poor	Poor	Poor	Fair.
36B---------------- Arvilla	Fair	Good	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
37----------------- Fordville	Fair	Good	Good	Fair	Very poor	Very poor	Fair	Very poor	Good.
38B---------------- Renshaw	Poor	Fair	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
39E---------------- Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
40----------------- Divide	Fair	Fair	Good	Fair	Fair	Very poor	Fair	Poor	Fair.
41----------------- Vang	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
42B---------------- Brantford	Fair	Fair	Good	Poor	Poor	Very poor	Fair	Very poor	Fair.
43E---------------- Coe	Very poor	Poor	Fair	Poor	Very poor	Very poor	Poor	Very poor	Fair.
44B---------------- Walsh	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
44C---------------- Walsh	Fair	Good	Fair	Fair	Poor	Very poor	Fair	Very poor	Fair.
45E*:									
Zell--------------	Very poor	Fair	Fair	Fair	Very poor	Very poor	Very poor	Very poor	Fair.
Maddock-----------	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
46C*:									
Wamduska----------	Poor	Poor	Poor	Good	Very poor	Very poor	Poor	Very poor	Fair.
Mauvais-----------	Poor	Fair	Poor	Fair	Fair	Very poor	Poor	Poor	Poor.
47----------------- Lallie	Poor	Poor	Poor	Very poor	Poor	Good	Poor	Fair	Very poor.
48B*:									
Barnes------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Renshaw-----------	Poor	Fair	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
70E*:									
Kloten------------	Poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Buse--------------	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
73----------------- Lamoure	Good	Good	Fair	Fair	Fair	Fair	Good	Fair	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
2 Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
3 Playmoor	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.
4 Southam	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
5*:					
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, shrink-swell.
7*:					
Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
Vallers	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
8 Svea	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
10 Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
11B*, 11C*:					
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope.	Severe: low strength.
Buse	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell.
12B*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
12B*:					
Svea	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
13D*:					
Buse	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, shrink-swell.
Svea	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
13E*:					
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Svea	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
14D*:					
Sioux	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Barnes	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, shrink-swell.
15 Borup	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: frost action.
17 Borup	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, frost action.
20, 20B Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
21*:					
Vallers	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, frost action.
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
22 Vallers	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
23*:					
Cavour	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
23*:					
Cresbard	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
24*:					
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
Cresbard	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
25*:					
Miranda	Moderate: wetness.	Moderate: shrink-swell, wetness.	Severe: wetness.	Moderate: shrink-swell, wetness.	Severe: low strength.
Cavour	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
26B*:					
Cresbard	Moderate: too clayey.	Severe: shrink-swell.	Moderate: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell.
27 Hamar	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
28E Wamduska	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
29B Maddock	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
30 Embden	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
31B Egeland	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
32 Gardena	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.
32B Gardena	Moderate: wetness.	Slight	Moderate: wetness.	Moderate: slope.	Severe: frost action.
33 Glyndon	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Severe: frost action.
34 LaDelle	Moderate: wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, frost action.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
35----------------- LaDelle	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.
36B--------------- Arvilla	Severe: cutbanks cave.	Slight-----------	Slight-----------	Slight------------	Slight.
37----------------- Fordville	Severe: cutbanks cave.	Slight-----------	Slight-----------	Slight------------	Slight.
38B--------------- Renshaw	Severe: cutbanks cave.	Slight-----------	Slight-----------	Slight------------	Slight.
39E--------------- Sioux	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
40----------------- Divide	Severe: cutbanks cave.	Slight-----------	Moderate: wetness.	Slight------------	Moderate: low strength, frost action.
41----------------- Vang	Severe: cutbanks cave.	Slight-----------	Slight-----------	Slight------------	Moderate: frost action.
42B--------------- Brantford	Severe: cutbanks cave.	Slight-----------	Slight-----------	Slight------------	Slight.
43E--------------- Coe	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
44B--------------- Walsh	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
44C--------------- Walsh	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
45E*:					
Zell-------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope, frost action.
Maddock----------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
46C*:					
Wamduska---------	Severe: cutbanks cave.	Slight-----------	Slight-----------	Moderate: slope.	Slight.
Mauvais----------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
47---------------- Lallie	Severe: ponding.	Severe: flooding, ponding, shrink-swell.	Severe: flooding, ponding, shrink-swell.	Severe: flooding, ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
48B*:					
Barnes-----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, shrink-swell.
Renshaw----------	Severe: cutbanks cave.	Slight-----------	Slight-----------	Slight------------	Slight.
70E*:					
Kloten-----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Buse-------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
73---------------- Lamoure	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
2 Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
3 Playmoor	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
4 Southam	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
5*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
7*:					
Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
8 Svea	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
10 Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
11B*:					
Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Buse	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
11C*:					
Svea	Severe: percs slowly.	Severe: slope.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
11C*:					
Buse	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
12B*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Svea	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
13D*:					
Buse	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Svea	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
13E*:					
Buse	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Svea	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
14D*:					
Sioux	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
15, 17 Borup	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness, seepage, too sandy.	Severe: seepage, wetness.	Poor: wetness.
20, 20B Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
21*:					
Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
22 Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
23*:					
Cavour	Severe: percs slowly.	Slight	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
Cresbard	Severe: percs slowly.	Moderate: wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
24*:					
Svea	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Cresbard	Severe: percs slowly.	Moderate: wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
25*:					
Miranda	Severe: wetness, percs slowly.	Moderate: seepage.	Severe: seepage, excess sodium.	Moderate: wetness.	Poor: excess sodium.
Cavour	Severe: percs slowly.	Slight	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
26B*:					
Cresbard	Severe: percs slowly.	Moderate: slope.	Severe: excess sodium.	Slight	Poor: hard to pack, excess sodium.
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
27 Hamar	Severe: wetness, percs slowly,	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
28E Wamduska	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
29B Maddock	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
30 Embden	Moderate: wetness.	Severe: seepage.	Severe: seepage, wetness.	Severe: seepage.	Fair: too sandy.
31B Egeland	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
32------------------ Gardena	Moderate: wetness.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Good.
32B----------------- Gardena	Moderate: wetness.	Moderate: seepage, slope, wetness.	Severe: wetness.	Moderate: wetness.	Good.
33------------------ Glyndon	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Fair: too sandy, wetness.
34------------------ LaDelle	Moderate: flooding, wetness, percs slowly.	Moderate: seepage.	Severe: wetness.	Moderate: flooding, wetness.	Poor: hard to pack.
35------------------ LaDelle	Severe: flooding.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Poor: hard to pack.
36B----------------- Arvilla	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
37------------------ Fordville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: small stones, too sandy, seepage.
38B----------------- Renshaw	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
39E----------------- Sioux	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
40------------------ Divide	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
41------------------ Vang	Severe: poor filter.	Severe: seepage.	Severe: too sandy, seepage.	Severe: seepage.	Poor: too sandy, seepage, small stones.
42B----------------- Brantford	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, small stones, too sandy.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
43E: Coe	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
44B: Walsh	Moderate: wetness, percs slowly.	Moderate: seepage, slope, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
44C: Walsh	Moderate: wetness, percs slowly.	Severe: slope.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
45E*:					
Zell	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Maddock	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
46C*:					
Wamduska	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Mauvais	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
47: Lallie	Severe: flooding, ponding, percs slowly.	Severe: flooding.	Severe: flooding, ponding, too clayey.	Severe: flooding, ponding.	Poor: too clayey, hard to pack, ponding.
48B*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Renshaw	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
70E*:					
Kloten	Severe: seepage, thin layer, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: thin layer, slope, area reclaim.
Buse	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
73: Lamoure	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
2 Parnell	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
3 Playmoor	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
4 Southam	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
5*:				
Hamerly	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
7*:				
Parnell	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Vallers	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
8 Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
10 Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
11B*, 11C*:				
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
12B*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
13D*:				
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
13E*:				
Buse	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
14D*:				
Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
15 Borup	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
17 Borup	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
20, 20B Hamerly	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
21*:				
Vallers	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
Hamerly	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.
22 Vallers	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
23*:				
Cavour	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salt, excess sodium.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
23*: Cresbard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess sodium.
24*: Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Cresbard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess sodium.
25*: Miranda	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, excess sodium.
Cavour	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salt, excess sodium.
26B*: Cresbard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, excess sodium.
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
27 Hamar	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
28E Wamduska	Poor: slope.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
29B Maddock	Good	Probable	Improbable: too sandy.	Poor: too sandy.
30 Embden	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
31B Egeland	Good	Probable	Improbable: too sandy.	Good.
32, 32B Gardena	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
33 Glyndon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
34, 35 LaDelle	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
36B Arvilla	Good	Probable	Probable	Poor: small stones, area reclaim.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
37 Fordville	Good	Probable	Probable	Fair: thin layer.
38B Renshaw	Good	Probable	Probable	Poor: small stones, area reclaim.
39E Sioux	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
40 Divide	Fair: wetness.	Probable	Probable	Poor: small stones, area reclaim.
41 Vang	Good	Probable	Probable	Poor: area reclaim, small stones.
42B Brantford	Good	Probable	Probable	Poor: area reclaim, small stones.
43E Coe	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
44B, 44C Walsh	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
45E*:				
Zell	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Maddock	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
46C*:				
Wamduska	Good	Probable	Probable	Poor: small stones, area reclaim.
Mauvais	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, excess salt.
47 Lallie	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
48B*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
48B*:				
Renshaw	Good	Probable	Probable	Poor: small stones, area reclaim.
70E*:				
Kloten	Poor: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, slope.
Buse	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
73 Lamoure	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
2 Parnell	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
3 Playmoor	Slight	Severe: hard to pack, wetness.	Flooding, frost action, excess salt.	Wetness, flooding, excess salt.	Wetness	Wetness, excess salt.
4 Southam	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, excess salt, erodes easily.
5*:						
Hamerly	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
7*:						
Parnell	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
Vallers	Slight	Severe: piping, wetness.	Frost action, excess salt.	Wetness, excess salt.	Wetness	Wetness, excess salt.
8, 10 Svea	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
11B*, 11C*:						
Svea	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Buse	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
12B*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Svea	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
13D*, 13E*:						
Buse	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Svea	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
14D*:						
Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, slope.	Slope, too sandy.	Droughty, slope.
Barnes	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
15 Borup	Severe: seepage.	Severe: piping, wetness.	Frost action, cutbanks cave.	Wetness	Wetness	Wetness.
17 Borup	Severe: seepage.	Severe: piping, wetness.	Frost action, cutbanks cave, excess salt.	Wetness, excess salt.	Wetness	Wetness, excess salt.
20 Hamerly	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
20B Hamerly	Moderate: seepage, slope.	Severe: piping.	Frost action, slope.	Wetness, slope.	Erodes easily, wetness.	Erodes easily.
21*:						
Vallers	Slight	Severe: piping, wetness.	Frost action, excess salt.	Wetness, excess salt.	Wetness	Wetness, excess salt.
Hamerly	Moderate: seepage.	Severe: piping.	Frost action, excess salt.	Wetness, excess salt.	Erodes easily, wetness.	Excess salt, erodes easily.
22 Vallers	Slight	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
23*:						
Cavour	Slight	Severe: excess sodium.	Deep to water	Percs slowly, rooting depth.	Erodes easily, percs slowly.	Excess sodium, erodes easily, rooting depth.
Cresbard	Slight	Severe: excess sodium.	Deep to water	Percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.
24*:						
Svea	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Cresbard	Slight	Severe: excess sodium.	Deep to water	Percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.
25*:						
Miranda	Moderate: seepage.	Severe: excess sodium.	Percs slowly, excess salt.	Wetness, percs slowly.	Wetness, percs slowly.	Excess sodium, percs slowly.
Cavour	Slight	Severe: excess sodium.	Deep to water	Percs slowly, rooting depth.	Erodes easily, percs slowly.	Excess sodium, erodes easily, rooting depth.
26B*:						
Cresbard	Moderate: slope.	Severe: excess sodium.	Deep to water	Slope, percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
26B*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
27 Hamar	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, fast intake, soil blowing.	Wetness, too sandy, soil blowing.	Wetness.
28E Wamduska	Severe: seepage, slope.	Severe: seepage.	Deep to water	Slope, droughty, rooting depth.	Slope, too sandy.	Slope, droughty, rooting depth.
29B Maddock	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
30 Embden	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing	Soil blowing	Favorable.
31B Egeland	Severe: seepage.	Severe: piping, seepage.	Deep to water	Soil blowing, slope, droughty.	Soil blowing, too sandy.	Droughty.
32 Gardena	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
32B Gardena	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
33 Glyndon	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness	Wetness	Favorable.
34 LaDelle	Moderate: seepage.	Severe: hard to pack.	Deep to water	Favorable	Favorable	Favorable.
35 LaDelle	Moderate: seepage.	Severe: hard to pack.	Deep to water	Flooding	Favorable	Favorable.
36B Arvilla	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
37 Fordville	Severe: seepage.	Severe: seepage.	Deep to water	Favorable	Too sandy	Favorable.
38B Renshaw	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy	Droughty.
39E Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, slope.	Slope, too sandy.	Droughty, slope.
40 Divide	Severe: seepage.	Severe: seepage.	Cutbanks cave	Wetness	Wetness, too sandy.	Favorable.
41 Vang	Severe: seepage.	Severe: seepage.	Deep to water	Favorable	Too sandy	Favorable.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
42B---------------- Brantford	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy, large stones.	Droughty, large stones.
43E---------------- Coe	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, rooting depth.	Slope, large stones, too sandy.	Large stones, slope, droughty.
44B, 44C----------- Walsh	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope-----------	Erodes easily	Erodes easily.
45E*:						
Zell--------------	Severe: slope.	Severe: piping.	Deep to water	Slope-----------	Slope, erodes easily.	Slope, erodes easily.
Maddock-----------	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
46C*:						
Wamduska----------	Severe: seepage.	Severe: seepage.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty, rooting depth.
Mauvais-----------	Moderate: slope.	Severe: piping, wetness.	Frost action, slope.	Wetness, slope.	Wetness---------	Wetness, excess salt.
47---------------- Lallie	Slight-----------	Severe: hard to pack, ponding.	Ponding, percs slowly, flooding.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, excess salt, erodes easily.
48B*:						
Barnes------------	Moderate: slope.	Severe: piping.	Deep to water	Slope-----------	Erodes easily	Erodes easily.
Renshaw-----------	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy-------	Droughty.
70E*:						
Kloten------------	Severe: seepage, slope.	Severe: piping, thin layer.	Deep to water	Slope, thin layer.	Slope, area reclaim.	Slope, area reclaim.
Buse--------------	Severe: slope.	Severe: piping.	Deep to water	Slope-----------	Slope, erodes easily.	Slope, erodes easily.
73---------------- Lamoure	Moderate: seepage.	Severe: hard to pack, wetness.	Flooding, frost action.	Wetness, flooding.	Wetness---------	Wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
2----------------Parnell	0-14	Silt loam--------	OL, ML	A-4	0	100	100	90-100	70-90	25-40	2-10
	14-40	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	40-60	Loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
3----------------Playmoor	0-18	Silty clay loam	CL, CH, MH, ML	A-6, A-7	0	100	100	95-100	80-100	35-60	12-25
	18-28	Silt loam, silty clay loam.	CL, CH, MH, ML	A-6, A-7	0	100	100	90-100	80-100	35-60	12-25
	28-48	Silt loam, silty clay loam.	CL, CH, MH, ML	A-6, A-7	0	100	100	95-100	85-100	35-60	12-25
	48-60	Stratified loamy sand to silty clay loam.	CL, CH, MH, ML	A-6, A-7	0	100	100	90-100	70-100	35-60	12-25
4----------------Southam	0-6	Silty clay loam	CL	A-6, A-7	0	100	95-100	90-100	85-100	30-50	10-25
	6-26	Silty clay, clay, silty clay loam.	CL, CH	A-7	0	100	95-100	90-100	85-100	40-75	15-50
	26-60	Silty clay, silty clay loam, clay.	CL, CH	A-6, A-7	0	100	95-100	90-100	80-100	30-75	10-50
5*:											
Hamerly---------	0-9	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
	9-21	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	21-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	60-75	20-45	5-25
Tonka-----------	0-16	Silt loam--------	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-35	5-15
	16-39	Silty clay loam, clay loam, clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	39-60	Silty clay loam, clay loam, loam.	CL, CL-ML	A-6, A-7, A-4	0-3	90-100	85-100	75-100	55-90	25-50	5-30
7*:											
Parnell---------	0-14	Silt loam--------	OL, ML	A-4	0	100	100	90-100	70-90	25-40	2-10
	14-46	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	46-60	Loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
Vallers---------	0-8	Loam-------------	OL, ML	A-4	0	95-100	90-100	80-90	65-80	25-40	3-10
	8-18	Silty clay loam	CL	A-6	0	95-100	90-100	90-95	70-80	30-40	10-20
	18-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-100	85-95	60-75	20-40	5-20
8----------------Svea	0-17	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	17-36	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	36-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-50	5-30

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
10 Svea	0-15	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	15-37	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	37-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-85	20-50	5-30
11B*: Svea	0-11	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	11-38	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	38-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-85	20-50	5-30
Buse	0-7	Loam	ML, CL, CL-ML	A-4, A-6, A-7	0	90-100	85-95	70-95	55-90	20-45	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-90	60-85	25-40	5-20
11C*: Svea	0-14	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	14-40	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	40-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-85	20-50	5-30
Buse	0-8	Loam	ML, CL, CL-ML	A-4, A-6, A-7	0	90-100	85-95	70-95	55-90	20-45	3-20
	8-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-90	60-85	25-40	5-20
12B*: Barnes	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-26	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	26-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Svea	0-10	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	10-34	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	34-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-50	5-30
13D*: Buse	0-9	Loam	ML, CL, CL-ML	A-4, A-6, A-7	0	90-100	85-95	70-95	55-90	20-45	3-20
	9-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-90	60-85	25-40	5-20
Svea	0-11	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	11-36	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	36-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-50	5-30
13E*: Buse	0-8	Loam	ML, CL, CL-ML	A-4, A-6, A-7	0	90-100	85-95	70-95	55-90	20-45	3-20
	8-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-90	60-85	25-40	5-20
Svea	0-16	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	16-39	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	39-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-50	5-30

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
14D*:											
Sioux----------	0-8	Loam------------	ML, CL	A-4, A-6	0-5	95-100	85-100	70-90	55-75	30-40	5-15
	8-12	Gravelly loam, very gravelly loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	12-60	Extremely gravelly sand, very gravelly loamy sand, very gravelly sand.	GM, GP, SM, SP	A-1	0	25-75	20-60	5-35	0-25	<25	NP-5
Barnes----------	0-8	Loam------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	8-23	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	23-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
15--------------- Borup	0-12	Silt loam--------	ML	A-4	0	100	100	95-100	70-95	20-34	NP-7
	12-34	Very fine sandy loam, silt loam, sandy clay loam.	ML	A-4	0	100	100	90-100	60-95	<30	NP-5
	34-60	Silty clay loam, very fine sand, very fine sandy loam, silt loam.	ML	A-4	0	100	100	85-100	50-90	<30	NP-5
17--------------- Borup	0-11	Silt loam--------	OL, ML	A-4	0	100	100	95-100	70-95	20-34	NP-7
	11-30	Very fine sandy loam, loamy very fine sand, silt loam.	ML	A-4	0	100	100	90-100	60-95	20-30	NP-7
	30-60	Loamy very fine sand, very fine sand, very fine sandy loam.	ML, CL-ML	A-4	0	100	100	85-100	50-90	15-30	NP-7
20--------------- Hamerly	0-9	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
	9-26	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	26-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	60-75	20-45	5-25
20B-------------- Hamerly	0-7	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
	7-33	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	33-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	60-75	20-45	5-25
21*:											
Vallers---------	0-9	Loam------------	OL, ML	A-4	0	95-100	90-100	80-90	65-80	25-40	3-10
	9-24	Clay loam--------	CL	A-6	0	95-100	90-100	90-95	70-80	30-40	10-20
	24-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-100	85-95	60-75	20-40	5-20
Hamerly---------	0-9	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	25-40	5-20
	9-21	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	25-45	5-20
	21-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	25-45	5-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
22---------------- Vallers	0-8	Loam-------------	OL, ML	A-4	0	95-100	90-100	80-90	50-80	30-40	4-10
	8-23	Clay loam, silty clay loam, loam.	CL	A-6	0	95-100	90-100	80-95	50-80	30-40	11-20
	23-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-100	85-95	60-85	20-40	5-20
23*: Cavour----------	0-7	Loam-------------	ML, CL, MH	A-4, A-6, A-7	0	100	95-100	85-100	60-85	30-55	5-20
	7-30	Clay, clay loam, silty clay loam.	CL, CH, MH, ML	A-7	0	100	95-100	90-100	70-95	40-65	15-30
	30-60	Clay loam, loam	CL, CH	A-7, A-6	0-5	95-100	95-100	85-100	60-85	35-65	12-35
Cresbard--------	0-8	Loam-------------	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	8-30	Clay loam, silty clay, clay.	CL, CH	A-7	0	100	100	90-100	70-90	40-60	15-30
	30-60	Clay loam, loam	CL, CH, ML, MH	A-6, A-7	0-5	100	100	85-100	60-80	35-55	10-27
24*: Svea------------	0-11	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	11-35	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	35-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-85	20-50	5-30
Cresbard--------	0-11	Loam-------------	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	11-28	Clay loam, silty clay, clay.	CL, CH	A-7	0	100	100	90-100	70-90	40-60	15-30
	28-40	Clay loam, silty clay, clay.	CL, CH	A-7	0	100	100	85-100	70-90	40-60	15-30
	40-60	Clay loam, loam	CL, CH, ML, MH	A-6, A-7	0-5	100	100	85-100	60-80	35-55	10-27
25*: Miranda---------	0-6	Loam-------------	CL-ML, CL, ML	A-4, A-6	0	100	100	85-95	60-85	25-40	5-15
	6-24	Loam, clay loam	CL, ML	A-6, A-7	0-5	95-100	95-100	85-95	50-80	30-50	10-20
	24-48	Loam, clay loam	CL, ML	A-6, A-7	0-5	95-100	95-100	85-95	50-80	30-50	10-20
	48-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
Cavour----------	0-8	Loam-------------	ML, CL, MH	A-4, A-6, A-7	0	100	95-100	85-100	60-85	30-55	5-20
	8-31	Clay, clay loam, silty clay loam.	CL, CH, MH, ML	A-7	0	100	95-100	90-100	70-95	40-65	15-30
	31-60	Clay loam, loam	CL, CH	A-7, A-6	0-5	95-100	95-100	85-100	60-85	35-65	12-35
26B*: Cresbard--------	0-9	Loam-------------	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	9-40	Clay loam, loam	CL, ML	A-7, A-6	0	100	100	90-100	70-95	35-50	10-25
	40-60	Clay loam, loam, silt loam	CL, CH, ML, MH	A-6, A-7	0-5	100	100	85-100	60-80	35-55	10-30
Barnes----------	0-8	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	8-23	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	23-40	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	40-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
27-------------- Hamar	0-12	Loamy sand-------	SM, SM-SC	A-2, A-4	0	100	100	85-100	15-40	<25	NP-5
	12-43	Loamy fine sand, loamy sand, sand.	SM, SM-SC	A-2, A-4	0	100	100	85-100	15-40	<25	NP-5
	43-60	Clay loam, loam.	CL, MH, ML	A-7, A-6	0	100	90-100	95-100	85-95	45-75	15-45
28E------------- Wamduska	0-1	Extremely stony sandy loam.	SM, SM-SC	A-2, A-4	15-75	75-100	70-80	45-80	25-40	20-30	NP-7
	1-7	Gravelly loamy coarse sand, very gravelly sand.	GM, SM	A-2, A-4	0	60-90	50-80	45-70	25-50	20-35	NP-7
	7-60	Stratified very gravelly sand to very gravelly coarse sand.	GM, GP, SM, SP	A-1, A-2	0	25-90	10-80	5-35	0-25	---	NP
29B------------- Maddock	0-12	Loamy sand-------	SM	A-2	0	100	100	50-80	15-35	---	NP
	12-60	Loamy sand, sand, loamy very fine sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	60-100	5-35	---	NP
30-------------- Embden	0-15	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-95	30-65	<35	NP-10
	15-30	Fine sandy loam, sandy loam.	SM	A-2, A-4	0	100	100	60-85	30-50	---	NP
	30-60	Fine sandy loam, gravelly sandy loam, loamy fine sand.	SM	A-2, A-4	0	100	80-100	50-80	15-50	---	NP
31B------------- Egeland	0-9	Sandy loam-------	SM, SM-SC	A-2, A-4	0	100	95-100	75-100	30-50	<30	NP-7
	9-14	Sandy loam, fine sandy loam.	SM, SM-SC	A-2, A-4	0	95-100	85-100	70-100	15-50	<30	NP-7
	14-60	Loamy sand, loamy fine sand, sandy loam.	SM, SP-SM, SM-SC	A-2, A-4	0	95-100	85-100	70-100	10-45	<25	NP-5
32-------------- Gardena	0-13	Silt loam--------	ML	A-4	0	100	100	75-95	60-90	25-40	NP-10
	13-60	Silt loam, very fine sandy loam, loam.	ML	A-4	0	100	100	75-95	55-90	20-40	NP-10
32B------------- Gardena	0-15	Silt loam--------	ML	A-4	0	100	100	75-95	60-90	25-40	NP-10
	15-60	Silt loam, very fine sandy loam, loam.	ML	A-4	0	100	100	75-95	55-90	20-40	NP-10
33-------------- Glyndon	0-12	Silt loam--------	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	12-22	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
	22-60	Silt loam, very fine sand, very fine sandy loam.	ML, SM, SC, CL	A-4	0	100	100	85-100	35-75	10-30	NP-10
34-------------- LaDelle	0-7	Silt loam--------	ML, CL	A-4, A-6, A-7	0	100	100	90-100	75-100	30-45	5-20
	7-29	Silt loam, silty clay loam, loam.	CL, ML, MH, CH	A-6, A-7	0	100	100	90-100	75-100	30-55	10-25
	29-60	Stratified silt loam to silty clay loam.	CL, ML, CL-ML	A-4, A-6, A-7	0	100	100	90-100	75-100	25-50	5-25

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
35----------------- LaDelle	0-23	Silt loam--------	ML, CL	A-4, A-6, A-7	0	100	100	90-100	75-100	30-45	5-20
	23-60	Stratified silt loam to clay loam.	CL, ML, CL-ML	A-4, A-6, A-7	0	100	100	90-100	75-100	25-50	5-25
36B---------------- Arvilla	0-15	Sandy loam-------	SM, SC, SM-SC	A-2, A-4, A-6	0	95-100	90-100	50-80	20-45	10-40	NP-15
	15-60	Gravelly coarse sand, coarse sand, very gravelly coarse sand.	SP-SM, GP, SP, GP-GM	A-1, A-2, A-3	0	35-100	25-100	10-60	0-10	---	NP
37----------------- Fordville	0-13	Loam-------------	ML, CL	A-4, A-6, A-7	0	100	100	70-85	55-75	30-45	5-20
	13-22	Loam, silt loam, clay loam.	CL, ML	A-4, A-6, A-7	0	100	95-100	70-95	55-80	30-45	5-20
	22-30	Loam, clay loam, sandy loam.	CL, ML, SM, SC	A-4, A-6	0	95-100	90-100	65-90	40-55	25-40	3-15
	30-60	Gravelly loamy sand, gravelly sand, gravelly coarse sand.	SW, SW-SM, SM	A-1	0	65-85	45-70	15-45	0-15	<25	NP-5
38B---------------- Renshaw	0-8	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	90-100	70-100	50-75	30-40	5-15
	8-15	Loam, sandy clay loam, gravelly loam.	SM-SC, SC, ML, CL	A-4, A-6	0-5	95-100	55-100	45-90	35-70	25-40	3-15
	15-60	Gravelly loamy sand, very gravelly coarse sand, gravelly sand.	SW, SM, SW-SM, GW-GM	A-1	0-5	45-95	30-80	10-50	0-15	<25	NP-5
39E---------------- Sioux	0-8	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	85-100	70-90	55-75	30-40	5-15
	8-12	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	12-60	Extremely gravelly sand, very gravelly loamy sand, very gravelly sand.	GM, GP, SM, SP	A-1	0	25-75	20-60	5-35	0-25	<25	NP-5
40----------------- Divide	0-12	Loam-------------	CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-85	25-40	5-20
	12-22	Loam, clay loam, gravelly loam.	CL, CL-ML	A-4, A-6	0-3	95-100	80-100	60-90	55-80	20-40	5-20
	22-60	Stratified loamy coarse sand to very gravelly sand	GM, SM, GP-GM, SP-SM	A-1	0-5	25-75	15-65	10-40	5-25	---	NP
41----------------- Vang	0-15	Loam-------------	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	85-100	60-80	25-45	5-15
	15-27	Loam, clay loam, gravelly loam.	ML, CL, SM, SC	A-4, A-6, A-7	0	65-100	50-100	40-100	35-80	25-45	5-15
	27-60	Sand and gravel	SP-SM, SM, GM, GP-GM	A-1, A-2	5-25	50-95	30-75	15-60	10-30	---	NP

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
42B---------------- Brantford	0-14	Loam----------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	80-90	60-80	15-35	3-15
	14-60	Sand and gravel	SM, GP-GM, SP-SM, GM	A-1, A-2	5-25	50-95	30-75	15-60	10-30	<35	NP-10
43E---------------- Coe	0-8	Gravelly loam----	SM, GM-GC, SM-SC, GM	A-4, A-2	0-10	50-80	40-70	30-60	25-50	<25	NP-5
	8-60	Extremely gravelly coarse sand, very gravelly loamy coarse sand.	SM, GP-GM, SP-SM, GM	A-1, A-2	5-25	50-95	30-75	15-60	10-30	---	NP
44B, 44C--------- Walsh	0-12	Loam----------------	CL-ML, CL	A-4, A-6	0	95-100	85-100	80-100	60-95	25-40	5-20
	12-60	Loam, silt loam, channery loam.	CL-ML, CL	A-4, A-6, A-7	0	95-100	85-100	80-100	60-95	25-50	5-30
45E*: Zell--------------	0-5	Silt loam----------	CL, ML	A-4, A-6	0	100	95-100	85-100	80-100	30-40	5-15
	5-26	Silt loam, very fine sandy loam, loam.	CL, ML, CL-ML	A-4, A-6	0	100	95-100	85-100	70-100	25-40	5-15
	26-60	Silt loam, very fine sandy loam, loam.	ML, CL-ML	A-4	0	100	95-100	85-100	60-100	<30	NP-7
Maddock----------	0-13	Loamy fine sand	SM	A-2	0	100	100	50-80	15-35	---	NP
	13-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	60-100	5-35	---	NP
46C*: Wamduska---------	0-3	Loamy coarse sand	SP-SM, SM, SM-SC	A-1, A-2-4, A-3	0-5	95-100	90-100	30-75	5-15	<20	NP-7
	3-7	Gravelly loamy coarse sand, very gravelly sand.	GM, SM	A-2, A-4	0	60-90	50-80	45-70	25-50	20-35	NP-7
	7-57	Stratified gravelly sand to very gravelly coarse sand.	GM, GP, SM, SP	A-1	0	25-90	10-80	5-35	0-25	---	NP
	57-60	Gravelly loamy coarse sand.	SM-SC, SM, SC	A-2, A-4	0	95-100	90-100	60-80	30-45	10-30	NP-10
Mauvais----------	0-2	Loam----------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	70-80	20-40	5-20
	2-60	Loam, clay loam, silty clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	90-100	85-100	75-95	55-80	25-45	5-25
47---------------- Lallie	0-3	Silty clay loam	CL	A-6, A-7	0	100	100	85-100	60-95	25-50	10-25
	3-60	Silty clay loam, silty clay, clay.	CL, CH	A-7	0	100	95-100	90-100	85-100	45-95	20-60
48B*: Barnes-----------	0-7	Loam----------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-24	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	24-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
48B*:											
Renshaw----------	0-7	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	90-100	70-100	50-75	30-40	5-15
	7-14	Loam, sandy clay loam, gravelly loam.	SM-SC, SC, ML, CL	A-4, A-6	0-5	95-100	55-100	45-90	35-70	25-40	3-15
	14-60	Gravelly loamy sand, very gravelly loamy sand, gravelly sand.	SW, SM, SW-SM, GW-GM	A-1	0-5	45-95	30-80	10-50	0-15	<25	NP-5
70E*:											
Kloten----------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-10	90-100	90-100	85-95	60-90	20-40	5-20
	7-18	Extremely channery loam, channery loam.	CL, CL-ML	A-4, A-6	0-10	90-100	80-100	70-95	60-90	20-40	5-20
	18-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
Buse------------	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6, A-7	0	90-100	85-95	70-95	55-90	20-45	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-90	60-85	25-40	5-20
73--------------- Lamoure	0-8	Silty clay loam	CL, CH, MH, ML	A-7	0	100	100	95-100	85-100	45-70	20-35
	8-43	Clay loam, silt loam, sandy clay loam.	CL, ML	A-6, A-7	0	95-100	95-100	90-100	75-100	30-50	10-20
	43-60	Stratified sand to silty clay loam.	CL, SC	A-6, A-7	0	95-100	95-100	70-95	35-90	30-50	10-25

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
2----------------- Parnell	0-14	0.6-2.0	0.22-0.24	6.1-7.8	<2	Low--------	0.28	5	6
	14-40	0.06-0.2	0.13-0.19	6.1-7.8	<2	High-------	0.28		
	40-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High-------	0.28		
3----------------- Playmoor	0-18	0.2-2.0	0.16-0.19	7.4-8.4	4-16	Moderate	0.28	5	4L
	18-28	0.2-2.0	0.16-0.19	7.4-8.4	4-16	Moderate	0.28		
	28-48	0.2-2.0	0.14-0.17	7.4-8.4	4-16	Moderate	0.28		
	48-60	0.2-2.0	0.14-0.17	7.4-8.4	4-16	Moderate	0.28		
4----------------- Southam	0-6	0.2-0.6	0.18-0.23	6.6-8.4	2-8	Moderate	0.37	5	4
	6-26	0.06-0.2	0.14-0.20	6.6-8.4	2-8	High-------	0.28		
	26-60	0.06-0.6	0.13-0.17	7.4-9.0	2-8	High-------	0.28		
5*:									
Hamerly----------	0-9	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
	9-21	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	21-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Tonka------------	0-16	0.6-2.0	0.18-0.23	5.6-7.8	<2	Low--------	0.32	5	6
	16-39	0.06-0.2	0.14-0.19	5.6-7.8	<2	High-------	0.43		
	39-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		
7*:									
Parnell----------	0-14	0.6-2.0	0.22-0.24	6.1-7.8	<2	Low--------	0.28	5	6
	14-46	0.06-0.2	0.13-0.19	6.1-8.4	<2	High-------	0.28		
	46-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High-------	0.28		
Vallers----------	0-8	0.6-2.0	0.14-0.16	7.4-8.4	4-16	Low--------	0.28	5	4L
	8-18	0.2-0.6	0.10-0.13	7.4-8.4	4-16	Low--------	0.28		
	18-60	0.2-0.6	0.11-0.13	7.4-8.4	4-16	Low--------	0.28		
8----------------- Svea	0-17	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	6
	17-36	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28		
	36-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
10---------------- Svea	0-15	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	6
	15-37	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28		
	37-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
11B*:									
Svea-------------	0-11	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	6
	11-38	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28		
	38-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Buse-------------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
11C*:									
Svea-------------	0-14	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	6
	14-40	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28		
	40-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Buse-------------	0-8	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	8-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
12B*:									
Barnes----------	0-7	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	7-26	0.6-2.0	0.15-0.19	6.1-8.4	<4	Moderate	0.28		
	26-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Svea-----------	0-10	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	0.28	5	6
	10-34	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28		
	34-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
13D*:									
Buse------------	0-9	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	9-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Svea------------	0-11	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	0.28	5	6
	11-36	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28		
	36-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
13E*:									
Buse------------	0-8	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	8-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Svea------------	0-16	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	0.28	5	6
	16-39	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28		
	39-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
14D*:									
Sioux-----------	0-8	0.6-2.0	0.18-0.20	6.6-8.4	<2	Low-------	0.28	2	5
	8-12	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low-------	0.20		
	12-60	>6.0	0.03-0.06	7.4-8.4	<2	Low-------	0.10		
Barnes----------	0-8	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	8-23	0.6-2.0	0.15-0.19	6.1-8.4	<4	Moderate	0.28		
	23-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
15--------------- Borup	0-12	2.0-6.0	0.20-0.23	7.4-8.4	<4	Low-------	0.28	5	4L
	12-34	2.0-6.0	0.17-0.20	7.4-8.4	<4	Low-------	0.28		
	34-60	0.6-20	0.15-0.19	7.4-8.4	2-8	Low-------	0.28		
17--------------- Borup	0-11	2.0-6.0	0.13-0.15	7.4-8.4	4-16	Low-------	0.28	5	4L
	11-30	2.0-6.0	0.11-0.13	7.9-8.4	4-16	Low-------	0.28		
	30-60	0.6-20	0.09-0.13	7.9-8.4	4-16	Low-------	0.28		
20--------------- Hamerly	0-9	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
	9-26	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	26-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
20B-------------- Hamerly	0-7	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
	7-33	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	33-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
21*:									
Vallers---------	0-9	0.6-2.0	0.14-0.16	7.4-8.4	4-16	Low-------	0.28	5	4L
	9-24	0.2-0.6	0.10-0.13	7.4-8.4	4-16	Low-------	0.28		
	24-60	0.2-0.6	0.11-0.13	7.4-8.4	4-16	Low-------	0.28		
Hamerly---------	0-9	0.6-2.0	0.12-0.15	7.4-8.4	4-16	Moderate	0.28	5	4L
	9-21	0.6-2.0	0.10-0.13	7.4-8.4	4-16	Moderate	0.28		
	21-60	0.2-2.0	0.10-0.13	7.4-8.4	4-16	Moderate	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
22---------------- Vallers	0-8	0.6-2.0	0.22-0.24	7.4-8.4	<4	Low--------	0.28	5	4L
	8-23	0.2-0.6	0.15-0.19	7.4-8.4	<4	Moderate	0.28		
	23-60	0.2-0.6	0.17-0.19	7.4-8.4	<4	Low--------	0.28		
23*:									
Cavour-----------	0-7	0.6-2.0	0.18-0.22	6.1-7.8	<2	Moderate	0.37	3	6
	7-30	<0.2	0.10-0.16	6.6-9.0	4-16	High-------	0.37		
	30-60	0.06-0.6	0.11-0.15	7.4-9.0	8-16	Moderate	0.37		
Cresbard---------	0-8	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low--------	0.32	3	6
	8-30	0.06-0.6	0.11-0.14	5.6-7.3	2-4	High-------	0.32		
	30-60	0.2-0.6	0.16-0.20	7.4-9.0	2-8	Moderate	0.32		
24*:									
Svea-------------	0-11	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	6
	11-35	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28		
	35-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Cresbard---------	0-11	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low--------	0.32	3	6
	11-28	0.06-0.6	0.11-0.14	5.6-7.3	2-4	High-------	0.32		
	28-40	0.06-0.6	0.11-0.15	6.1-8.4	2-4	High-------	0.32		
	40-60	0.2-0.6	0.16-0.20	7.4-9.0	2-8	Moderate	0.32		
25*:									
Miranda----------	0-6	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low--------	0.32	1	6
	6-24	<0.06	0.14-0.18	6.6-9.0	2-8	Moderate	0.32		
	24-48	<0.06	0.13-0.17	7.9-9.0	4-16	Moderate	0.32		
	48-60	---	---	---	---	-----------	----		
Cavour-----------	0-8	0.6-2.0	0.18-0.22	6.1-7.8	<2	Moderate	0.37	3	6
	8-31	<0.2	0.10-0.16	6.6-9.0	4-16	High-------	0.37		
	31-60	0.06-0.6	0.11-0.15	7.4-9.0	8-16	Moderate	0.37		
26B*:									
Cresbard---------	0-9	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low--------	0.32	3	6
	9-40	0.2-0.6	0.14-0.17	5.6-9.0	2-4	Moderate	0.32		
	40-60	0.2-0.6	0.16-0.20	7.4-9.0	2-8	Moderate	0.32		
Barnes-----------	0-8	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low--------	0.28	5	6
	8-23	0.6-2.0	0.15-0.19	6.1-8.4	<4	Moderate	0.28		
	23-40	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
	40-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
27---------------- Hamar	0-12	2.0-20	0.10-0.12	6.6-7.8	<2	Low--------	0.17	5	2
	12-43	2.0-20	0.10-0.12	6.6-8.4	<2	Low--------	0.17		
	43-60	0.2-2.0	0.13-0.20	7.4-8.4	<2	High-------	0.37		
28E--------------- Wamduska	0-1	2.0-6.0	0.08-0.12	6.6-7.8	<2	Low--------	0.24	2	8
	1-7	6.0-20	0.06-0.10	6.6-8.4	<2	Low--------	0.20		
	7-60	6.0-20	0.03-0.06	6.6-8.4	<2	Low--------	0.10		
29B--------------- Maddock	0-12	6.0-20	0.08-0.12	6.6-7.8	<2	Low--------	0.17	5	2
	12-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low--------	0.17		
30---------------- Embden	0-15	2.0-6.0	0.13-0.18	6.6-7.3	<2	Low--------	0.20	5	3
	15-30	2.0-6.0	0.12-0.17	6.6-7.8	<2	Low--------	0.20		
	30-60	2.0-6.0	0.06-0.16	7.4-8.4	<2	Low--------	0.20		
31B--------------- Egeland	0-9	2.0-6.0	0.11-0.17	5.6-7.3	<2	Low--------	0.20	5	3
	9-14	2.0-6.0	0.09-0.15	6.1-7.8	<2	Low--------	0.20		
	14-60	2.0-6.0	0.08-0.10	6.6-8.4	<2	Low--------	0.20		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
32-------------- Gardena	0-13	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	5
	13-60	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low--------	0.43		
32B------------- Gardena	0-15	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	5
	15-60	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low--------	0.43		
33-------------- Glyndon	0-12	0.6-2.0	0.20-0.23	7.4-9.0	<4	Low--------	0.28	4	4L
	12-22	0.6-6.0	0.17-0.20	7.4-9.0	<4	Low--------	0.28		
	22-60	2.0-6.0	0.15-0.19	7.4-9.0	<4	Low--------	0.28		
34-------------- LaDelle	0-7	0.6-2.0	0.18-0.22	6.6-7.8	<2	Moderate	0.28	5	6
	7-29	0.6-2.0	0.18-0.22	6.6-8.4	<4	Moderate	0.28		
	29-60	0.6-2.0	0.18-0.22	7.4-8.4	<4	Moderate	0.28		
35-------------- LaDelle	0-23	0.6-2.0	0.18-0.22	6.6-7.8	<2	Moderate	0.28	5	6
	23-60	0.6-2.0	0.18-0.22	7.4-8.4	<4	Moderate	0.28		
36B------------- Arvilla	0-15	2.0-6.0	0.13-0.15	6.6-8.4	<2	Low--------	0.20	3	3
	15-60	6.0-20	0.02-0.05	7.4-8.4	<2	Low--------	0.10		
37-------------- Fordville	0-13	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low--------	0.24	4	6
	13-22	0.6-2.0	0.18-0.21	6.1-7.8	<2	Moderate	0.24		
	22-30	0.6-6.0	0.12-0.18	6.1-7.8	<2	Low--------	0.24		
	30-60	6.0-20	0.03-0.06	7.4-8.4	<2	Low--------	0.10		
38B------------- Renshaw	0-8	0.6-2.0	0.18-0.20	6.1-7.8	<2	Low--------	0.28	3	6
	8-15	0.6-6.0	0.11-0.18	6.6-8.4	<2	Low--------	0.28		
	15-60	>6.0	0.03-0.06	6.6-8.4	<2	Low--------	0.10		
39E------------- Sioux	0-8	0.6-2.0	0.18-0.20	6.6-8.4	<2	Low--------	0.28	2	5
	8-12	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low--------	0.20		
	12-60	>6.0	0.03-0.06	7.4-8.4	<2	Low--------	0.10		
40-------------- Divide	0-12	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.28	4	4L
	12-22	0.6-2.0	0.16-0.19	7.4-8.4	<2	Low--------	0.28		
	22-60	>6.0	0.03-0.07	7.4-8.4	<2	Low--------	0.10		
41-------------- Vang	0-15	0.6-2.0	0.17-0.21	6.1-7.3	<2	Low--------	0.28	4	6
	15-27	0.6-2.0	0.15-0.19	6.6-7.8	<2	Low--------	0.28		
	27-60	>6.0	0.02-0.04	6.6-8.4	<2	Low--------	0.10		
42B------------- Brantford	0-14	0.6-2.0	0.17-0.22	6.6-7.8	<2	Low--------	0.28	3	5
	14-60	>20	0.02-0.05	7.4-8.4	<2	Low--------	0.10		
43E------------- Coe	0-8	0.6-6.0	0.10-0.18	6.6-7.8	<2	Low--------	0.15	2	8
	8-60	>20	0.02-0.05	7.4-8.4	<2	Low--------	0.15		
44B, 44C--------- Walsh	0-12	0.6-2.0	0.20-0.24	6.1-7.3	<2	Moderate	0.28	5	6
	12-60	0.6-2.0	0.14-0.22	6.1-8.4	<2	Moderate	0.43		
45E*:									
Zell------------	0-5	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low--------	0.32	5	4L
	5-26	0.6-2.0	0.15-0.20	7.4-8.4	<2	Low--------	0.43		
	26-60	0.6-2.0	0.15-0.20	7.4-8.4	<2	Low--------	0.43		
Maddock---------	0-13	6.0-20	0.08-0.12	6.6-7.8	<2	Low--------	0.17	5	2
	13-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low--------	0.17		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
46C*:									
Wamduska--------	0-3	6.0-20	0.06-0.10	6.6-7.8	<2	Low-------	0.15	2	2
	3-7	6.0-20	0.06-0.10	6.6-8.4	<2	Low-------	0.20		
	7-57	6.0-20	0.03-0.06	6.6-8.4	<2	Low-------	0.10		
	57-60	6.0-20	0.13-0.15	6.6-8.4	<2	Low-------	0.20		
Mauvais---------	0-2	0.6-2.0	0.17-0.19	6.6-8.4	2-8	Low-------	0.32	5	4L
	2-60	0.2-0.6	0.12-0.16	7.4-8.4	2-8	Moderate	0.32		
47--------------- Lallie	0-3	0.06-0.2	0.12-0.19	6.6-9.0	4-16	Moderate	0.37	5	7
	3-60	0.06-0.2	0.10-0.19	7.4-9.0	4-16	High------	0.37		
48B*:									
Barnes----------	0-7	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	7-24	0.6-2.0	0.15-0.19	6.1-8.4	<4	Moderate	0.28		
	24-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Renshaw---------	0-7	0.6-2.0	0.18-0.20	6.1-7.8	<2	Low-------	0.28	3	6
	7-14	0.6-6.0	0.11-0.18	6.6-8.4	<2	Low-------	0.28		
	14-60	>6.0	0.03-0.06	6.6-8.4	<2	Low-------	0.10		
70E*:									
Kloten----------	0-7	0.6-2.0	0.17-0.22	6.1-7.8	<2	Moderate	0.32	2	6
	7-18	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.10		
	18-60	---	---	---	---	----------	----		
Buse------------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
73--------------- Lamoure	0-8	0.2-2.0	0.19-0.22	7.4-8.4	<4	Moderate	0.28	5	4L
	8-43	0.2-2.0	0.17-0.20	7.4-8.4	<4	Moderate	0.28		
	43-60	0.2-2.0	0.09-0.18	7.4-8.4	<4	Low-------	0.28		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "rare," "brief," and "apparent" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydro-logic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Bedrock: Depth	Bedrock: Hardness	Potential frost action	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft			In				
2----------------- Parnell	C/D	None---------	---	---	+2-2.0	Apparent	Jan-Dec	>60	---	High-----	High-----	Low.
3----------------- Playmoor	C/D	Frequent----	Brief-----	Mar-Jun	0.5-3.5	Apparent	Sep-Jun	>60	---	High-----	High-----	High.
4----------------- Southam	D	None---------	---	---	+5-1.0	Apparent	Jan-Dec	>60	---	High-----	High-----	Low.
5*:												
Hamerly----------	C	None---------	---	---	2.0-4.0	Apparent	Apr-Jun	>60	---	High-----	High-----	Low.
Tonka------------	C/D	None---------	---	---	+.5-1.0	Apparent	Apr-Jun	>60	---	High-----	High-----	Low.
7*:												
Parnell----------	C/D	None---------	---	---	+2-2.0	Apparent	Jan-Dec	>60	---	High-----	High-----	Low.
Vallers----------	C	None---------	---	---	0-1.0	Apparent	Apr-Jul	>60	---	High-----	High-----	Moderate.
8----------------- Svea	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
10---------------- Svea	B	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High-----	Low.
11B*, 11C*:												
Svea-------------	B	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High-----	Low.
Buse-------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
12B*:												
Barnes-----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
Svea-------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
13D*, 13E*:												
Buse-------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
Svea-------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
14D*:												
Sioux------------	A	None---------	---	---	>6.0	---	---	>60	---	Low------	Low------	Low.
Barnes-----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
15----------------- Borup	B/D	Rare---------	---	---	1.0-2.5	Apparent	Apr-Jul	>60	---	High-----	High-----	Low.
17----------------- Borup	B/D	Rare---------	---	---	0-1.0	Apparent	Apr-Jul	>60	---	High-----	High-----	Moderate.
20, 20B------------ Hamerly	C	None---------	---	---	2.0-4.0	Apparent	Apr-Jun	>60	---	High-----	High-----	Low.
21*:												
Vallers-----------	C	Rare---------	---	---	0-1.0	Apparent	Apr-Jul	>60	---	High-----	High-----	Moderate.
Hamerly-----------	C	None---------	---	---	2.0-4.0	Apparent	Sep-Jun	>60	---	High-----	High-----	Moderate.
22----------------- Vallers	C	None---------	---	---	1.0-2.5	Apparent	Nov-Jun	>60	---	High-----	High-----	Low.
23*:												
Cavour------------	D	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High-----	Moderate.
Cresbard----------	C	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High-----	Moderate.
24*:												
Svea--------------	B	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High-----	Low.
Cresbard----------	C	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High-----	Moderate.
25*:												
Miranda-----------	D	None---------	---	---	2.0-4.0	Apparent	Apr-Jul	40-60	Soft	Moderate	High-----	Moderate.
Cavour------------	D	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High-----	Moderate.
26B*:												
Cresbard----------	C	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Moderate.
Barnes------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
27----------------- Hamar	A/D	None---------	---	---	0-2.0	Apparent	Oct-Jun	>60	---	Moderate	High-----	Low.
28E---------------- Wamduska	A	None---------	---	---	>6.0	---	---	>60	---	Low------	Moderate	Low.
29B---------------- Maddock	A	None---------	---	---	>6.0	---	---	>60	---	Low------	Moderate	Low.
30----------------- Embden	B	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High-----	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
31B: Egeland	B	None	---	---	>6.0	---	---	>60	---	Low	Moderate	Low.
32, 32B: Gardena	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	High	Moderate	Low.
33: Glyndon	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	>60	---	High	High	Low.
34: LaDelle	B	Rare	---	---	4.0-6.0	Apparent	Oct-Jun	>60	---	High	High	Low.
35: LaDelle	B	Occasional	Brief	Apr-Jun	4.0-6.0	Apparent	Oct-Jun	>60	---	High	High	Low.
36B: Arvilla	A	None	---	---	>6.0	---	---	>60	---	Low	Moderate	Low.
37: Fordville	B	None	---	---	>6.0	---	---	>60	---	Low	Moderate	Low.
38B: Renshaw	B	None	---	---	>6.0	---	---	>60	---	Low	Moderate	Low.
39E: Sioux	A	None	---	---	>6.0	---	---	>60	---	Low	Low	Low.
40: Divide	B	None	---	---	2.5-5.0	Apparent	Apr-Jun	>60	---	Moderate	High	Low.
41: Vang	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
42B: Brantford	B	None	---	---	>6.0	---	---	>60	---	Low	Moderate	Low.
43E: Coe	A	None	---	---	>6.0	---	---	>60	---	Low	Moderate	Low.
44B, 44C: Walsh	B	None	---	---	4.0-6.0	Apparent	Mar-Jun	>60	---	Moderate	High	Low.
45E*:												
Zell	B	None	---	---	>6.0	---	---	>60	---	High	High	Moderate.
Maddock	A	None	---	---	>6.0	---	---	>60	---	Low	Moderate	Low.
46C*:												
Wamduska	A	None	---	---	>6.0	---	---	>60	---	Low	Moderate	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
46C*:												
Mauvais----------	C	None--------	---	---	1.0-4.0	Apparent	Apr-Oct	>60	---	High-----	High-----	Low.
47---------------- Lallie	D	Frequent----	Brief-----	Apr-Jul	+1-1.0	Apparent	Apr-Jun	>60	---	High-----	High-----	Low.
48B*:												
Barnes-----------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
Renshaw----------	B	None--------	---	---	>6.0	---	---	>60	---	Low------	Moderate	Low.
70E*:												
Kloten-----------	D	None--------	---	---	>6.0	---	---	9-20	Soft	Moderate	High-----	Low.
Buse-------------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
73---------------- Lamoure	C	Frequent----	Brief-----	Mar-Oct	0-2.0	Apparent	Oct-Jun	>60	---	High-----	High-----	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--ENGINEERING INDEX TEST DATA

(Dashes indicate data were not available. LL means liquid limit; PI, plasticity index; MD, maximum dry density; OM, optimum moisture; and NP, nonplastic)

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution								LL	PI	Moisture density	
			Percentage passing sieve--					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			MD	OM
											Pct		Lb/ft^3	Pct
Buse loam: (S82ND-063-125)														
Bk------ 7 to 20	A-7-6(12)	CL	99	98	94	87	73	---	34	---	41	20	110	16
C2------ 34 to 44	A-6(7)	CL	99	97	91	81	61	---	21	---	36	16	114	15
Hamerly loam: (S82ND-063-126)														
Bk------ 7 to 21	A-7-6(10)	CL	99	95	91	81	63	---	31	---	42	20	112	15
C1------ 33 to 45	A-6(9)	CL	100	98	91	79	60	---	25	---	39	20	114	14
Mauvais loam: (S82ND-063-118)														
Bw2----- 11 to 18	A-6(7)	CL	99	96	90	86	56	---	24	---	39	18	112	15
Cy------ 37 to 60	A-7-6(10)	CL	99	96	91	87	58	---	---	---	43	22	110	16
Vallers loam: (S83ND-063-132)														
ABk----- 9 to 15	A-6(11)	CL	100	99	96	84	70	---	40	---	38	20	116	14
C2------ 38 to 60	A-4(8)	CL	100	100	98	94	83	---	23	---	27	9	122	12
Wamduska loamy coarse sand: (S82ND-063-119)														
C5------ 32 to 57	A-1-6(0)	SM	96	90	80	32	13	---	1	---	---	NP	114	15

TABLE 18.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Arvilla	Sandy, mixed Udic Haploborolls
Barnes	Fine-loamy, mixed Udic Haploborolls
Borup	Coarse-silty, frigid Typic Calciaquolls
Brantford	Fine-loamy over sandy or sandy-skeletal, mixed Udic Haploborolls
Buse	Fine-loamy, mixed Udorthentic Haploborolls
Cavour	Fine, montmorillonitic Udic Natriborolls
Coe	Sandy-skeletal, mixed Udorthentic Haploborolls
*Cresbard	Fine, montmorillonitic Glossic Udic Natriborolls
Divide	Fine-loamy over sandy or sandy-skeletal, frigid Aeric Calciaquolls
Egeland	Coarse-loamy, mixed Udic Haploborolls
Embden	Coarse-loamy, mixed Pachic Udic Haploborolls
Fordville	Fine-loamy over sandy or sandy-skeletal, mixed Pachic Udic Haploborolls
Gardena	Coarse-silty, mixed Pachic Udic Haploborolls
Glyndon	Coarse-silty, frigid Aeric Calciaquolls
Hamar	Sandy, mixed, frigid Typic Haplaquolls
Hamerly	Fine-loamy, frigid Aeric Calciaquolls
Kloten	Loamy, mixed Lithic Haploborolls
LaDelle	Fine-silty, mixed Cumulic Udic Haploborolls
Lallie	Fine, montmorillonitic (calcareous), frigid Typic Fluvaquents
*Lamoure	Fine-silty, mixed (calcareous), frigid Cumulic Haplaquolls
Maddock	Sandy, mixed Udorthentic Haploborolls
*Mauvais	Fine-loamy, mixed (calcareous), frigid Aeric Haplaquents
Miranda	Fine-loamy, mixed Leptic Natriborolls
Parnell	Fine, montmorillonitic, frigid Typic Argiaquolls
Playmoor	Fine-silty, mixed (calcareous), frigid Cumulic Haplaquolls
Renshaw	Fine-loamy over sandy or sandy-skeletal, mixed Udic Haploborolls
Sioux	Sandy-skeletal, mixed Udorthentic Haploborolls
Southam	Fine, montmorillonitic (calcareous), frigid Cumulic Haplaquolls
Svea	Fine-loamy, mixed Pachic Udic Haploborolls
Tonka	Fine, montmorillonitic, frigid Argiaquic Argialbolls
Vallers	Fine-loamy, frigid Typic Calciaquolls
Vang	Fine-loamy over sandy or sandy-skeletal, mixed Pachic Udic Haploborolls
Walsh	Fine-loamy, mixed Pachic Udic Haploborolls
Wamduska	Sandy, mixed, frigid Typic Udorthents
Zell	Coarse-silty, mixed Udorthentic Haploborolls

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