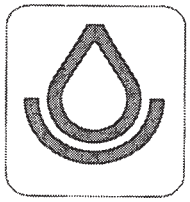
SOIL SURVEY OF

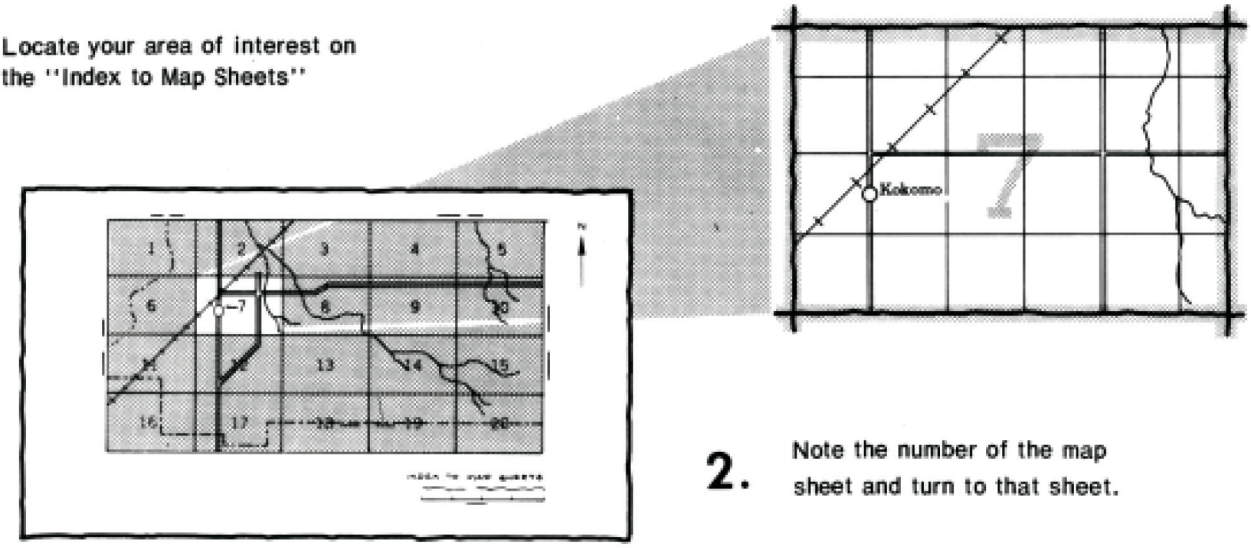
Pierce County, North Dakota



United States Department of Agriculture
Soil Conservation Service
In cooperation with
North Dakota Agricultural Experiment Station

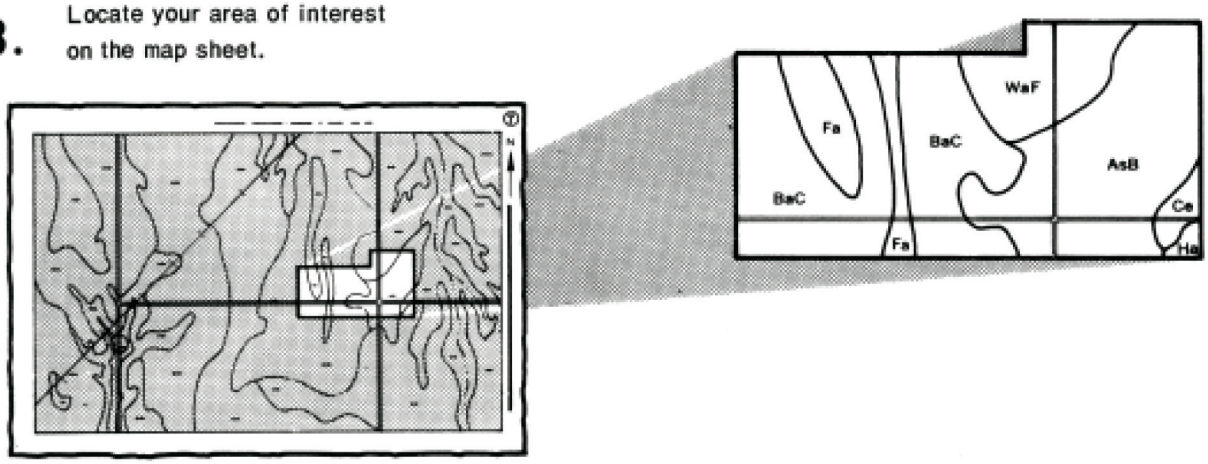
HOW TO USE

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

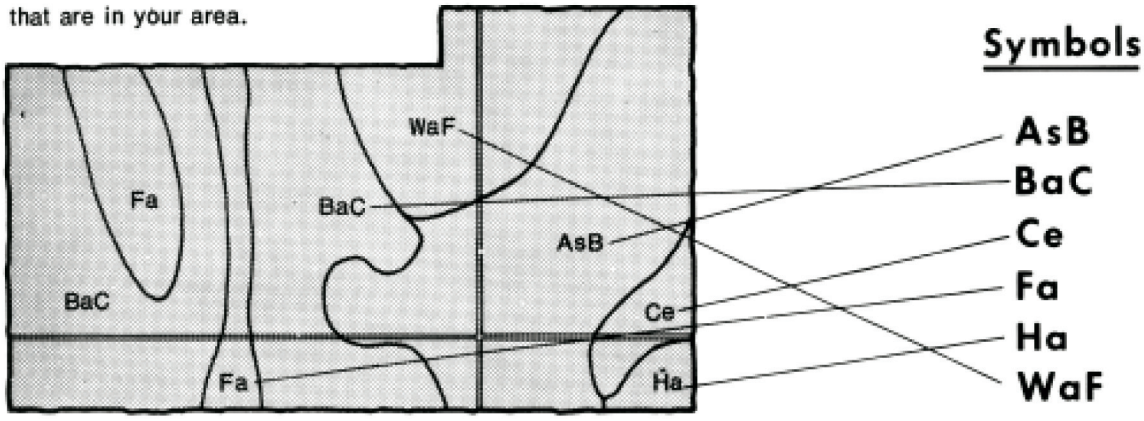


2. Note the number of the map sheet and turn to that sheet.

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

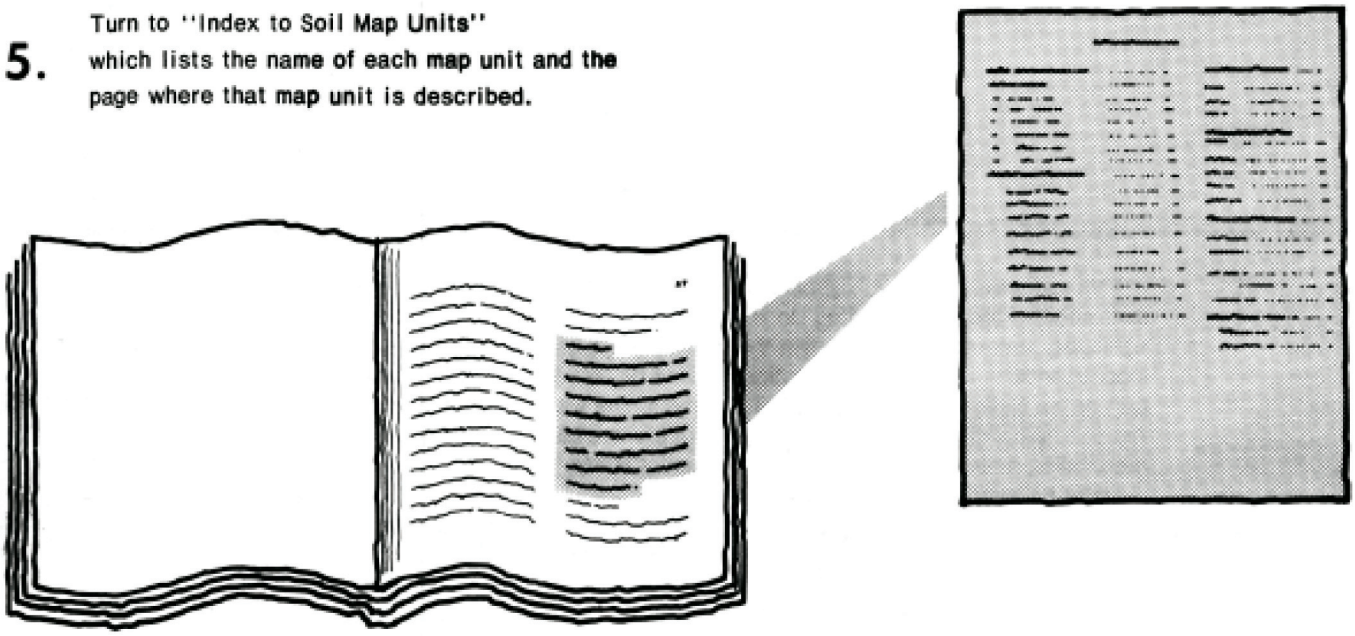


4. List the map unit symbols that are in your area.

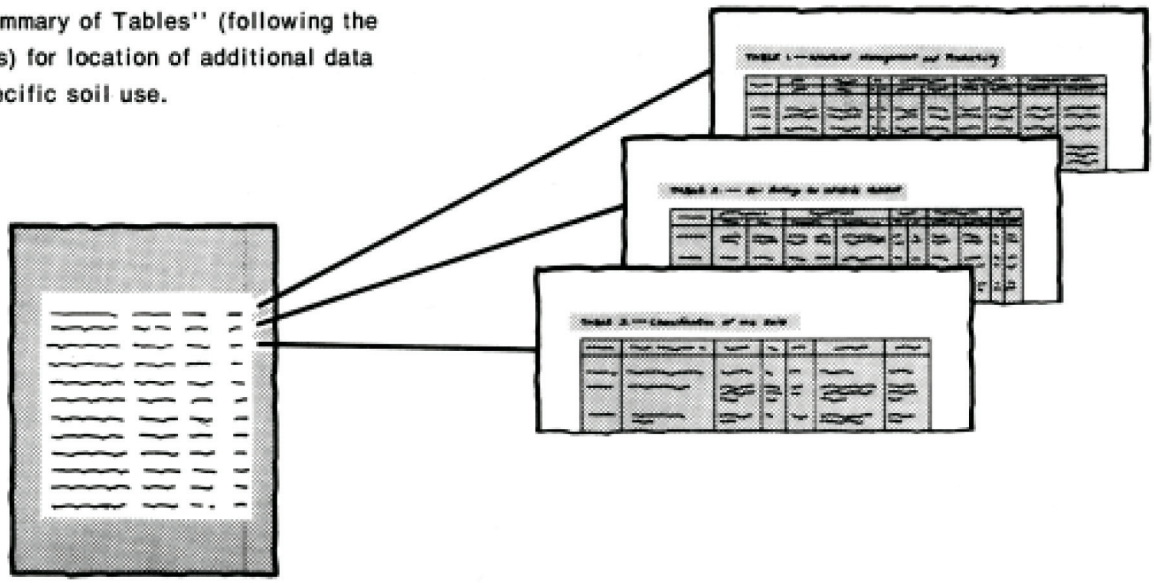


THIS SOIL SURVEY

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



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



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

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

Major fieldwork for this soil survey was completed in the period 1970-74. Soil names and descriptions were approved in 1975. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1975. This survey was made cooperatively by the Soil Conservation Service and the North Dakota Agricultural Experiment Station. It is part of the technical assistance furnished to the Pierce County Soil Conservation District. Financial assistance was provided by the Pierce County Board of Commissioners.

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

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Issued August 1978

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Foreword

The Soil Survey of Pierce County, North Dakota, contains much information useful in any land-planning program. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

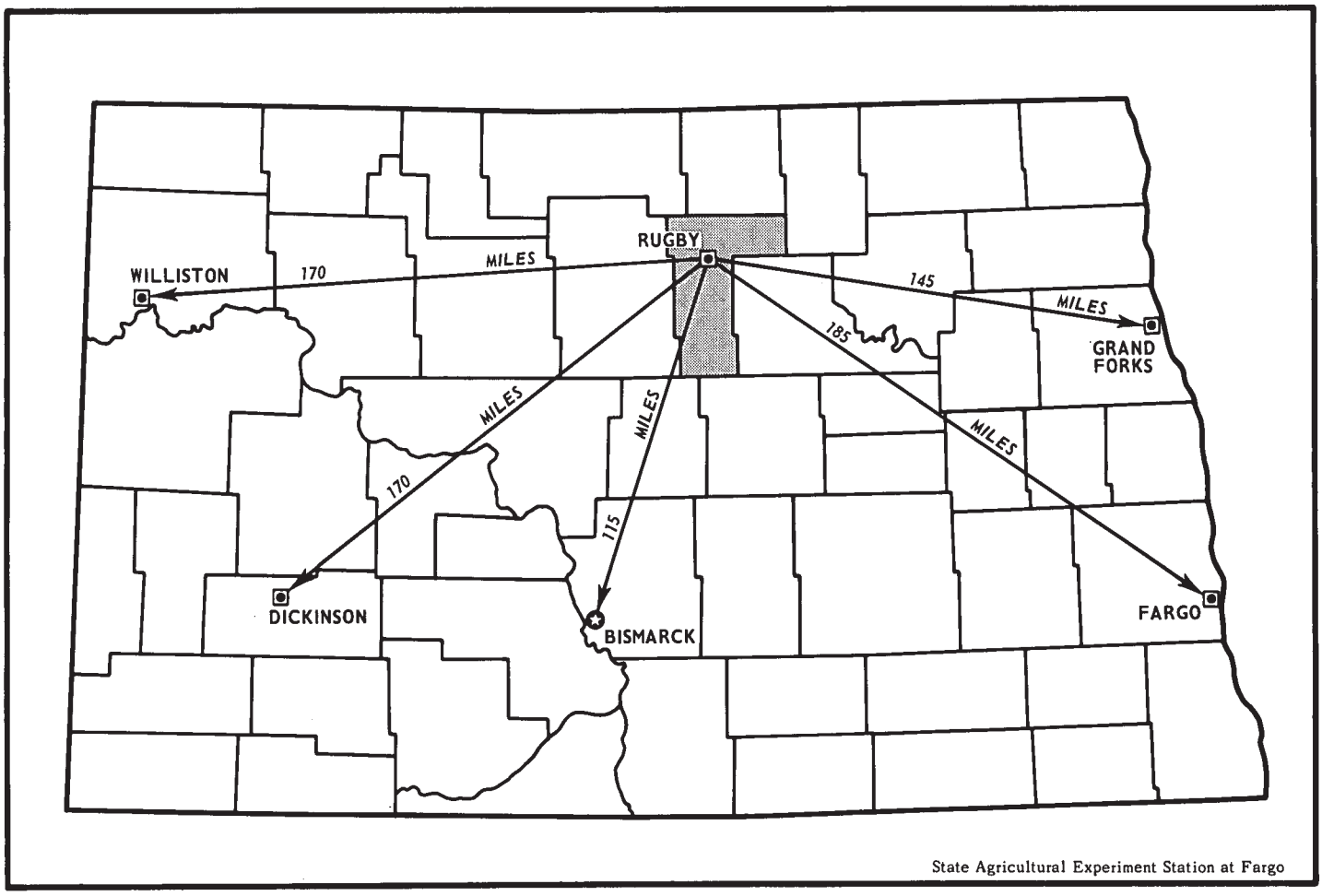
This soil survey has been prepared for many different users. Farmers, ranchers, foresters, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders, and homebuyers can use it to plan land use, select sites for construction, develop soil resources, or identify any special practices that may be needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the soil survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be shallow to bedrock. They may be too unstable to be used as a foundation for buildings or roads. Very clayey or wet soils are poorly suited to 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 kind of soil is shown on detailed soil maps. Each kind of soil in the survey area is described, and much information is given about each soil for specific uses. Additional information or assistance in using this publication can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

This soil survey can be useful in the conservation, development, and productive use of soil, water, and other resources.

Allen L. Fisk
State Conservationist
Soil Conservation Service



Location of Pierce County in North Dakota.

SOIL SURVEY OF PIERCE COUNTY, NORTH DAKOTA

By James H. Thiele, Terry L. Berogan, Lynn M. DesLauriers, Lawrence P. Haugen, Leonard A. Neubauer, and Robert L. Howey, Soil Conservation Service

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

PIERCE COUNTY is in the north-central part of North Dakota (see facing page). Rugby, the county seat, at the geographical center of North America, has a population of 3,125. The county has a total area of 693,120 acres, or 1,083 square miles.

The county lies entirely in the Drift Prairie Region of North Dakota. The soils are mainly derived from material originating from glacial till, glacial lakes, and glacial outwash sediment. Most of the county is gently rolling prairie broken by low hills and ridges with a few sharp peaks (fig. 1). Along the western edge of the county, near the beach areas of old Glacial Lake Souris, the soils are sandy. Just to the east of the sandy area is a long narrow level area, which was an extension of Lake Souris. It extends across the county from north to south, to the east of Rugby. The elevation ranges from about 1,460 feet in the extreme northwest corner to 1,750 feet in the south-central part of the county.

General nature of the county

This part of the survey provides general information on the climate of Pierce County and the settlement, natural resources, and farming.

Climate

Pierce County is usually warm in summer with frequent spells of hot weather and occasional cool days. It is very cold in winter, when Arctic air frequently surges over the county. Most precipitation falls during the warm period and is normally heaviest late in spring and early in summer. Winter snowfall is normally not too heavy, and it is blown into drifts.

Table 1 gives data on temperature and precipitation for the survey area, as recorded at Rugby, North Dakota, for the period 1951 to 1974. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 9 degrees F, and the average daily minimum temperature is -1. The lowest temperature on record, which occurred at Rugby on January 28, 1951, is -38 degrees. In summer the average temperature is 68 degrees, and the average daily maximum temperature is 81. The highest recorded temperature, which occurred on July 20, 1960, is 105 degrees.

Growing degree days, shown in table 1, 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.

Of the total annual precipitation, 13 inches, or 76 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 11 inches. The heaviest 1-day rainfall during the period of record was 2.70 inches at Rugby on August 24, 1968. Thunderstorms occur on about 24 days each year, and most occur in summer.

Average seasonal snowfall is 40 inches. The greatest snow depth at any one time during the period of record was 30 inches. On the average, 50 days have at least 1 inch of snow on the ground, but the number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 55 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The percentage of possible sunshine is 72 in summer and 52 in winter. The prevailing wind is from the southwest. Average windspeed is highest, 12 miles per hour, in April.

Several times each winter, snowstorms and high wind bring blizzard conditions to the county. Hail during summer thunderstorms occurs in small, scattered areas.

Climatic data in this section were specially prepared for the Soil Conservation Service by the National Climatic Center, Asheville, North Carolina.

Settlement

The first three settlements in Pierce County were established in 1885. One was in Antelope Valley, just northwest of Rugby, another was east of Round Lake, and the third was near Hurricane Lake. In 1889, Rugby was selected as the county seat.

In 1890, the population of Pierce County was 905. By 1910 it had increased to 9,740. In 1970, it was 6,323.

Rugby, the county seat and the largest town, had a population of 3,125 in 1972. Other communities in the county are Wolford, Barton, Silva, Balta, Orrin, and Selz.

Natural resources

Soil is the most important natural resource in the county. The crops produced and the livestock that graze the grassland are marketable products derived from the soil.

There is no lignite coal or salt in commercial quantities in Pierce County. Many wells have been drilled, but none have produced commercial oil or gas.

As a result of the glaciation that has occurred in this county, there are several areas of sandy and gravelly outwash materials favorable for commercial excavation.

Areas of water more than 40 acres in size make up about 4 percent of the county. Much of the surface water, however, is saline and is not used by livestock. There are three large underground aquifers in the county. One is in the extreme south end of the county, another is in the central part, and the third is just east of Rugby. Most of the ground water bearing material is sand, sandstone, gravel, gravelly sand, and shale. The aquifer in the southern part of the county could be important to irrigation development, depending on the water quality (*3*).

Farming

The first settlers in Pierce County were mainly farmers. The few ranches were mainly in the southern part of the county. The period of ranching was of comparatively short duration. The first Soil Conservation District was established in 1947.

The principal crop in Pierce County is wheat. Flax, barley, and oats are other main crops. Alfalfa is an important feed crop. Flax is grown for seed; straw is an important by-product. Barley is grown for feed and for malting. Wheat is mainly used for milling.

The number of farms has decreased steadily from 1,154 in 1936, to 956 in 1956, to about 750 in 1975. About 70 percent of the county, or 490,350 acres, is cropland, and 21 percent, or 147,399 acres, is range and pasture.

How this survey was made

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

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

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

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

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

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

General soil map for broad land use planning

The general soil map at the back of this publication shows, in color, map units that have a distinct pattern of soils and of relief and drainage. Each map unit is a unique

natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

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

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

As a result of changes in series concept, differing soil patterns, and map unit design, some of the boundaries and soil series names on the Pierce County general soil map do not match those on the general soil map of Wells County.

Map unit descriptions

1. Swenoda-Hecla-Embden-Stirum

Level to gently rolling, well drained, moderately well drained, and poorly drained, moderately coarse and coarse textured soils formed in material weathered from eolian sands, glacial till, and sandy glacial outwash

Areas of this level to gently rolling map unit are in the western and northern parts of the county. These areas are old glacial outwash and glacial till plains.

This unit makes up about 26 percent of the county. It is about 20 percent Swenoda soils (fig. 2), 17 percent Hecla soils, 12 percent Embden soils, 12 percent Stirum soils, and 39 percent soils of minor extent.

Local relief is slight. Swenoda soils are at the higher elevations, Stirum soils are in swales, on flats, or adjacent to drainageways, and Hecla and Embden soils are in the intermediate areas.

Swenoda soils are well drained and moderately well drained, Hecla and Embden soils are moderately well drained, and Stirum soils are poorly drained. All have a seasonal high water table early in spring. The surface layer of Swenoda, Embden, and Stirum soils is fine sandy loam and that of the Hecla soil is loamy fine sand. The hazard of soil blowing is high.

Minor in this unit are the excessively drained Serden soils, the well drained Maddock and Dickey soils, the well drained and moderately well drained Towner soils, the moderately well drained Aylmer soils, and the marshy Aquolls. Also in this unit are areas of water.

About 50 percent of the unit is used for crops, and the rest for pasture and hay. Low available water capacity and the related tendency toward droughtiness are the main limitations for farming. The seasonal high water table and the related wetness are the principal limitations for most other uses.

The potential for cultivated farm crops is poor on Hecla soils and very poor on Stirum soils, but fair to good on the rest of the unit. Stirum soils are generally not suited to any kind of cultivated crop.

The potential for urban, residential, and recreational use is poor on Stirum soils, but good on the rest. The wetness limitation on Stirum soils is difficult to overcome.

The potential for openland and rangeland wildlife habitat is poor on Stirum soils, but fair to good on the rest of the unit. Stirum soils, however, have fair potential for wetland wildlife habitat.

2. Gardena

Level to undulating, moderately well drained, medium textured soils formed in material weathered from glacial lacustrine sediment

Areas of this level to undulating map unit are in the northwestern part of the county. These areas are old glacial lake plains.

This unit makes up about 12 percent of the county. It is about 63 percent Gardena soils (fig. 3) and 37 percent soils of minor extent.

Local relief is slight. Gardena soils are moderately well drained and have a seasonal high water table early in spring. The surface layer is silt loam. The hazard of soil blowing is moderate.

Minor in this unit are the well drained Eckman soils, the moderately well drained Cathay soils, the somewhat poorly drained Glyndon soils, the poorly drained Tonka soils, and the marshy Aquolls. Also in this unit are areas of water.

Nearly all the acreage is cropland. There are few limitations for the production of cultivated crops. Gardena soils are among the most productive in the county. The seasonal high water table and the related wetness and frost action are the main limitations for most other uses.

The potential is good for cultivated farm crops.

The potential is good for urban, residential, and recreational use. The seasonal high water table can be lowered if the soil is adequately drained.

The potential is good to fair for openland and rangeland wildlife habitat.

The potential for wetland wildlife habitat is good on Tonka soils and the marshy Aquolls but poor on the rest of the unit.

3. Barnes-Svea-Hamerly

Level to gently rolling, well drained to somewhat poorly drained, medium textured soils formed in material weathered from loam and clay loam glacial till

Areas of this level to gently rolling map unit are in the northeastern part of the county. These areas are old glacial till plains.

This unit makes up about 10 percent of the county. It is about 25 percent Barnes soils (fig. 4), 21 percent Svea soils, 14 percent Hamerly soils, and 40 percent minor soils or water.

Local relief is slight. Barnes soils are at the higher elevations, Hamerly soils are at the lower elevations, and Svea soils at the intermediate elevations. Barnes soils are well drained, Svea soils are moderately well drained, and Hamerly soils somewhat poorly drained. The Svea and Hamerly soils have a seasonal high water table early in spring. All of these soils have a loamy surface layer. The hazard of soil blowing is low to moderate.

Minor in this unit are the well drained Buse soils, the poorly drained Tonka soils, the very poorly drained Parnell soils, and the marshy Aquolls. Also in this unit are areas of water.

Nearly all the acreage is cropland. Tonka and Parnell soils and Aquolls are used for pasture, hay, or wetland wildlife. The hazards of soil blowing and water erosion are the main limitations of the major soils for farming. The seasonal high water table of the Svea and Hamerly soils and the moderately slow permeability of all the soils are the principal limitations for most other uses.

The potential is good for cultivated crops.

The potential is good to fair for urban, residential, and recreational use. The seasonal high water table and the moderately slow permeability can be overcome with, for example, adequate foundation drainage for buildings and enlarged absorption fields for septic tanks.

The potential is good to fair for openland and rangeland wildlife habitat. The potential for wetland and wildlife is good on Tonka and Parnell soils and on Aquolls but poor to fair on the rest of the unit.

4. Arvilla

Level to undulating, somewhat excessively drained, medium textured and moderately coarse textured soils formed in material weathered from loamy alluvium, sand, and gravel

Areas of this level to undulating map unit are in the southern part of the county. These areas are old glacial outwash plains.

This unit makes up about 1 percent of the county. It is about 80 percent Arvilla soils and 20 percent minor soils or water.

Local relief is slight. Arvilla soils are somewhat excessively drained and contain large amounts of sand and gravel in the substratum. The surface layer is sandy loam, fine sandy loam, or loam. The hazard of soil blowing is high.

Minor in this association are the excessively drained Sioux soils and the somewhat poorly drained Divide soils.

Nearly all the acreage is cropland. Low available water capacity, the related droughtiness, and the hazard of soil blowing are the main limitations for cultivated crops. Limitations are few for most other uses, but seepage is a major limitation for reservoirs, ponds, or lagoons.

The potential is poor for cultivated farm crops.

The potential is good to fair for urban, residential, and recreational use. Pollution of ground water supply is a hazard if the soils are used for onsite sewage disposal.

The potential is fair to poor for openland and rangeland wildlife habitat. It is poor for wetland wildlife. The potential is fair as a source of sand and gravel because of the content of excess fines.

5. Emrick-Heimdal-Fram

Level to undulating, well drained to somewhat poorly drained, medium textured soils formed in material weathered from loam and sandy loam glacial till

Areas of this level to undulating map unit are in the central and southern parts of the county. These areas are old glacial till plains.

This unit makes up about 23 percent of the county. It is about 40 percent Emrick soils (fig. 5), 20 percent Heimdal soils, 15 percent Fram soils, and 25 percent soils of minor extent or water.

Local relief is slight. Heimdal soils are at the higher elevations, Fram soils are at the lower elevations, and Emrick soils at the intermediate elevations. Emrick soils are moderately well drained, Heimdal soils are well drained, and Fram soils somewhat poorly drained. Fram soils have a seasonal high water table early in spring. All of these soils have a loamy surface layer. The hazard of soil blowing is moderate.

Minor in this unit are the well drained Esmond soils on knobs, the moderately well drained Cathay soils on intermediate slopes, the poorly drained Vallers and Tonka soils in depressions, and the marshy Aquolls. Also in this unit are areas of water.

Most of the acreage is cropland. Tonka and Vallers soils and Aquolls are used for pasture, hay, or wetland wildlife. The hazards of soil blowing and water erosion are the main limitations of the major soils for farming. The seasonal high water table of the Fram soils and the moderate permeability of all the soils are the principal limitations for most other uses.

The potential is good for cultivated farm crops.

The potential for urban, residential, and recreational uses is good on the Emrick and Heimdal soils and fair on the Fram soils. The seasonal high water table limitation can be overcome with, for example, adequate foundation drainage for buildings and enlarged absorption fields for septic tanks.

The potential is good to fair for openland and rangeland wildlife habitat. The potential for wetland wildlife habitat is good on Vallers and Tonka soils and on Aquolls but poor to fair on the rest of the unit.

6. Heimdal-Esmond-Emrick

Undulating to steep, well drained and moderately well drained, medium textured soils formed in material weathered from loam and sandy loam glacial till

This undulating to steep map unit occurs as scattered areas throughout the county. These areas are parts of old glacial till plains.

This unit makes up about 26 percent of the county. It is about 22 percent Heimdal soils (fig. 6), 17 percent Esmond soils, 13 percent Emrick soils, and 48 percent minor soils or water.

Local relief is moderate. Esmond soils are at the higher elevations, Emrick soils are at lower elevations, and Heimdal soils at the intermediate elevations. Heimdal and Esmond soils are well drained, and Emrick soils are moderately well drained. All the major soils have a loamy surface layer. The hazard of soil blowing is moderate.

Minor in this unit are the poorly drained Stirum and Tonka soils, the poorly and very poorly drained Borup soils, the very poorly drained Parnell soil, and the marshy Aquolls. Also in this unit are areas of water.

Most of the undulating, gently rolling, and nonstony acreage is cropland. The rolling steep, and stony areas are used for pasture or hay. The minor Borup, Stirum, Tonka, and Parnell soils and the Aquolls are used mainly for pasture, hay, or wetland wildlife production. The hazards of soil blowing and water erosion are the main limitations for farming in the nonstony, undulating, and gently rolling areas. The slope, the stoniness, and the moderate permeability are the principal limitations for most other uses.

The potential is good to poor for cultivated crops. The stony areas are not suited to any kind of cultivation.

The potential is good to fair for urban, residential, and recreational use. Slope is the chief limitation.

The potential is good to poor for openland and rangeland wildlife habitat. The potential for wetland wildlife habitat is good on Tonka, Parnell, and Borup soils and Aquolls but poor on the rest of the unit.

7. Gardena-Overly

Level to undulating, moderately well drained, medium textured and moderately fine textured soils formed in material weathered from glacial lake sediment

Areas of this level to undulating map unit are in the northeastern part of the county. These areas are old glacial lake plains.

This unit makes up about 2 percent of the county. It is about 34 percent Gardena soils, 26 percent Overly soils, and 40 percent minor soils or water.

Local relief is very slight. Both soils are moderately well drained. The surface layer of Gardena soils is silt loam, and that of Overly soils silty clay loam. The hazard of soil blowing is low to moderate.

Minor in this unit are the somewhat poorly drained Bearden soils, the poorly drained and very poorly drained Hegne soils, and the marshy Aquolls. Also in this unit are areas of water.

Nearly all the unit is cropland. The soils have few limitations for the production of cultivated crops. Gardena and Overly soils are among the most productive in the county. The seasonal high water table and the related wetness and frost action are the main limitations for most other uses.

The potential is good for cultivated farm crops.

The potential is good for urban, residential, and recreational use. The seasonal high water table can be lowered if the soil is adequately drained. The frost action limitation can be overcome by deep placement of footings for buildings and suitable base materials for roads and streets.

The potential is good to fair for openland and rangeland habitat. It is poor for wetland habitat.

Broad land use considerations

The general soil map is most useful for determining the general outline of areas that are suitable for cropland, urban, wildlife, or recreational use; it cannot be used for the selection of sites for specific structures. Deciding which land should be used for urban development or, for example, which land should be preserved for cropland is an issue of increasing concern in the State and in the survey area. The 1967 Conservation Needs Inventory shows 75.7 percent of the land in Pierce County used for crops, 18.6 percent range, 4.3 percent pasture, 0.2 percent forest, and 1.2 percent other uses. In general, the soils that have a good potential for cultivated crops also have good potential for urban development. The information about specific soils in this survey can be helpful in planning future land use patterns in Pierce County.

Large areas where the soils are so unfavorable that urban or recreational development is prohibitive are not extensive in Pierce County. The Arvilla unit is made up of soils that are rapidly permeable. There is a possibility of ground water contamination if the soils are used for onsite sewage disposal. All of the units contain small included acreages of poorly and very poorly drained soils. The included soils are so wet that the potential is poor for urban uses.

The Gardena and the Gardena-Overly units are the most productive soils for the production of cultivated crops and have the highest potential. The Emrick-Heimdal-Fram and the Barnes-Svea-Hamerly units are highly productive and have good potential. The Arvilla unit is the least productive of all the units and has low potential. The Swenoda-Hecla-Embden-Stirum and the Heimdal-Esmond-Emrick units are productive and have fair potential.

Soil maps for detailed planning

The map units shown on the detailed soil maps at the back of this publication represent the kinds of soil in the survey area. They are described in this section. The descriptions together with the soil maps can be useful in determining the potential of a soil and in managing it for food and fiber production; in planning land use and

developing soil resources; and in enhancing, protecting, and preserving the environment. More information for each map unit, or soil, is given in the section "Use and management of the soils."

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

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

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

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

Some map units are made up of two or more dominant kinds of soil. Such map units are called soil complexes, soil associations, and undifferentiated groups.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Hamerly-Tonka complex, 0 to 3 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because there is little value in separating them. The pattern and proportion of the soils are not uniform. An area shown on the map has at least one of the dominant (named) soils or may have all of them. Heimdal and Emrick very stony loams, 3 to 9 percent slopes, is an undifferentiated group in this survey area.

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

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

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

1—Tonka silt loam. This level, poorly drained soil is in shallow depressions and basins. Areas generally range from 3 to 20 acres.

Typically, the surface layer is very dark gray silt loam about 11 inches thick. The subsurface layer, from 11 to 24 inches, is dark gray silt loam. The subsoil, from 24 to 37 inches, is silty clay loam. It is very dark gray in the upper part and dark gray in the lower part. The underlying material to a depth of 60 inches is dark grayish brown clay loam.

Included with this soil in mapping are small areas of Parnell soils, generally less than one-half acre in size. These soils are in the lowest part of some depressions and are very poorly drained. They make up 15 percent or less of the unit.

Permeability is slow, and available water capacity is high. Runoff is ponded. Tilth is good. The organic-matter content and fertility are high.

Most areas of this soil are farmed. Some are used for hay and pasture. The soil has fair potential for cultivated crops; good potential for hay, pasture, and trees; and poor potential for most engineering uses.

If drained, this soil is suited to small grain and flax. Undrained areas are often ponded in spring, thus delaying or preventing tillage and seeding. Good tilth is easy to maintain. The hazard of soil blowing is slight and is easily controlled under crop residue management.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

If drained, this soil is well suited to trees and shrubs in windbreaks and environmental plantings. Unless drained, it is generally not suited to trees. All climatically adapted species grow well.

This soil is poorly suited to building site development and to most onsite waste disposal. The depth to the seasonal high water table and the duration are severe limitations. The slow percolation rate is a problem in septic tank absorption fields but can be overcome by enlarging the field. The seasonal high water table can be lowered by drainage. The soil is well suited to sewage lagoons.

This soil has good potential for the development of wetland wildlife habitat. Most areas are surrounded by soils

having good potential for crops and vegetation in support of wetland wildlife.

The included Parnell soil is wetter and is ponded longer than this soil. It seldom can be drained because it lacks suitable outlets. Capability subclass IIw.

2—Parnell silty clay loam. This level, very poorly drained soil is in depressions. Slopes are smooth and flat to slightly concave. Areas generally range from 3 to 25 acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsoil, from 8 to 46 inches, is silty clay. It is black in the upper part and very dark gray in the lower part. The underlying material to a depth of 60 inches is olive gray clay loam.

Included with this soil in mapping are small areas of Tonka and Vallers soils that are generally less than one-half acre. These soils are in the shallower parts of depressions and are poorly drained. They make up 15 percent or less of the unit.

Permeability is slow, and available water capacity is high. Runoff is ponded. Tilth is fair. The organic-matter content and fertility are high.

Most areas are used for pasture, hay, or wildlife habitat. The potential is poor for cultivated crops, fair for pasture and hay, and poor for most engineering uses.

If drained, this soil is well suited to small grain and flax. Because this unit lacks suitable outlets, most areas are undrained. Ponding commonly prevents tillage and seeding. Good tilth is easy to maintain. The hazard of soil blowing is slight and is easily controlled under crop residue management.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods keep the pasture in good condition.

This soil is generally not suited to windbreak and environmental plantings. If this soil is adequately drained, however, all climatically adapted species of trees and shrubs grow well.

This soil is generally not suited to building site development and onsite waste disposal. The seasonal high water table, the ponding, the shrink-swell potential, and the slow permeability require costly design, installation, and maintenance. The Parnell soil in this survey area is not used for building sites or most related uses.

This soil has good potential for wetland wildlife habitat. Most areas are surrounded by soils having good potential for crops and vegetation in support of wetland wildlife.

The included Tonka and Vallers soils are poorly drained. They are wetter for a shorter period of time, however, than Parnell soils. Capability subclass Vw.

3—Colvin silty clay loam, wet. This level, very poorly drained soil is in deep depressions on lake plains. Most areas are circular or oval and generally range from 5 to more than 50 acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. The underlying material from 8 to 19 inches is grayish brown and light brownish gray silty clay loam, from 19 to 36 inches olive gray silty clay loam, from 36 to 52 inches gray loam, and from 52 to 60 inches olive gray silty clay loam. In some places the surface layer is thinner and contains less lime.

Permeability is moderately slow, and available water capacity is high. Runoff is ponded. Tilth is fair. The organic-matter content and fertility are high.

Most areas are in native grass, pasture, or hay. The potential is poor for cultivated crops, fair for pasture and hay, and poor for most engineering uses.

This soil is generally not suited to small grain and flax. Because it lacks suitable outlets, most areas are undrained. The seasonal high water table and ponding prevent or delay tillage and seeding. The hazard of soil blowing is slight in cultivated areas and is easily controlled under crop residue management.

Keeping this soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods keep the pasture in good condition and maintain the desirable native grass species. In some years, areas of this soil are too wet to harvest hay.

This soil is generally not suited to windbreak and environmental plantings. It is too wet for most climatically adapted tree and shrub species. If this soil is drained, however, all adapted species of trees and shrubs grow well.

This soil is generally not suited to building site development and onsite waste disposal. The seasonal high water table, the moderately slow permeability, and the ponding require costly design, installation, and maintenance. The Colvin soil in this survey area is not used for building sites or most related uses.

This soil has good potential for wetland wildlife habitat. Most areas are near soils having good potential for crops and vegetation in support of wetland wildlife. Capability subclass Vw.

7—Fossum soils, saline. These level, poorly drained, moderately saline soils are in shallow depressions on lacustrine plains and glacial outwash plains. Areas generally range from 5 to more than 50 acres and are generally irregular in shape.

Typically, the surface layer is about 22 inches thick. It is black fine sandy loam in the upper part, very dark gray loamy fine sand in the middle part, and very dark grayish brown loamy fine sand in the lower part. The underlying material to a depth of 60 inches is grayish brown fine sand. In some places the soil is slightly saline and in others strongly saline.

Permeability is rapid, and available water capacity is low. Runoff is very slow. Tilth is good. The organic-matter content is moderate, and fertility is low.

Most areas are in hay or pasture, but some are in crops. The potential is poor for cultivated crops and trees, fair for pasture and hay, and poor for most engineering uses.

If cultivated, these soils have a high hazard of soil blowing. Intensive crop residue management, buffer strips, stripcropping, and wind barriers are needed. Wet-

ness often delays tillage and seeding in spring. Drainage is seldom feasible because of the lack of suitable outlets. The moderate salt content reduces yields and limits the choice of crops to such salt-tolerant plants as barley. Summer fallow increases the salt content in the surface layer.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition and maintain desirable native grasses. A good surface cover is needed to control soil blowing.

These soils are generally not suited to windbreak and environmental plantings because of the seasonal high water table and the salt content.

These soils are generally not suited to building site development and to onsite waste disposal. The seasonal high water table, the ponding, and the seepage require costly design, installation, and maintenance. The Fossum soil in this survey area is not used for building sites or related use.

These soils have good potential for wetland wildlife habitat. Most areas are surrounded by soils having fair potential for crops and vegetation in support of wetland wildlife. Capability subclass Vw.

12—Hegne silty clay. This level, poorly drained soil is on concave to flat glacial lake plains. Areas generally range from 20 to more than 175 acres.

Typically, the surface layer is black silty clay about 8 inches thick. The underlying material to a depth of 60 inches is silty clay. It is dark olive gray in the upper part, olive gray in the middle part, and olive in the lower part. In some places the depth to lime is more than 16 inches.

Permeability is slow, and available water capacity is high. Runoff is medium. Tilth is poor. The organic-matter content and fertility are high.

Most areas are farmed. The potential is good for cultivated crops, pasture, hay, and trees and poor for most engineering uses.

This soil is suited to small grain and flax, but a seasonal high water table delays tillage and seeding in spring. It can be tilled within only a narrow range of moisture content because it is very sticky wet and very hard dry. Fall plowing and freezing, thawing, wetting, and drying in winter improve tilth of the surface layer.

Fall plowing generally leaves this soil in good condition for seedbed preparation in spring, but it also increases the hazard of soil blowing. The hazard of soil blowing is moderate and can be controlled with buffer strips, stripcropping, and windbreaks or under crop residue management.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition. Restriction of grazing in wet periods prevents compaction of the surface layer and disruption of the plants.

This soil is well suited to windbreak and environmental plantings. All climatically adapted species of trees and shrubs grow well.

This soil is poorly suited to building site development and most onsite waste disposal. It is well suited to sewage lagoons. The slow percolation rate, the seasonal high water table, and the shrink-swell potential require costly design, installation, and maintenance. The slow percolation rate, a problem in septic tank absorption fields, can be overcome by enlarging the field. The seasonal water table can be lowered by drainage if suitable outlets are available, but these outlets are generally difficult to locate. Frost action breaks up roads and streets but can be overcome by replacing the base material with material not subject to frost action.

This soil has fair potential for wetland wildlife habitat and good potential for shallow water areas. Most areas have good potential for grain and seed crops. Capability subclass IIw.

13—Hegne silty clay, wet. This level, very poorly drained soil is on concave glacial lake plains. Areas generally range from 10 to more than 180 acres, and most are circular.

Typically, the surface layer is black silty clay about 10 inches thick. The underlying material to a depth of 60 inches is silty clay. It is dark olive gray in the upper part, olive gray in the middle part, and olive in the lower part. In some places the surface layer is thinner, and in others the depth to lime is more than 16 inches.

Permeability is slow, and available water capacity is high. Runoff is slow. The organic-matter content and fertility are high.

Most areas are used for pasture or hay. The potential is poor for cultivated crops, good for hay and pasture, and poor for most engineering uses.

This soil is poorly suited to small grain and flax. It has a seasonal high water table. Runoff from surrounding slopes causes ponding for long periods. Drainage is generally not feasible because of the lack of suitable outlets.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition. Restriction of grazing during wet periods prevents compaction of the surface layer and disruption of the plants.

This soil is poorly suited to windbreak and environmental plantings. The seasonal high water table and the ponding are severe limitations.

This soil is generally not suited to building site development and to most onsite waste disposal. The seasonal high water table, the ponding, the slow percolation rate, and the shrink-swell potential require costly design, installation, and maintenance. The Hegne soil in this survey area is not used for building sites or most related uses.

This soil has fair to good potential for wetland wildlife habitat and good potential for shallow water areas. Most areas are surrounded by soils having good potential for grain and seed crops. Capability subclass Vw.

14—Bearden silty clay loam. This level, somewhat poorly drained soil is in low-lying areas on glacial lake

plains. Areas generally range from 5 to more than 200 acres and are circular or oval.

Typically, the surface layer is very dark gray silty clay loam about 14 inches thick. The underlying material to a depth of 60 inches is silty clay loam. It is grayish brown in the upper part, light olive brown in the middle part, and gray in the lower part. In some places the soil is moderately saline.

Permeability is slow, and available water capacity is high. Runoff is slow. Tilth is fair. The organic-matter content and fertility are high.

Most areas are in crops. The potential is good for cultivated crops, hay, pasture, and trees and fair for most engineering uses.

This soil is well suited to small grain and flax. Wetness sometimes delays tillage and seeding in spring. Tilth can be maintained or improved by timely tillage. The hazard of soil blowing is moderate and can be controlled under crop residue management and with stripcropping, windbreaks, and buffer strips.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted grazing during wet periods keep the pasture in good condition.

This soil is well suited to windbreak and environmental plantings. All climatically adapted species grow well.

This soil is generally suited to building site development and most onsite waste disposal. The seasonal high water table can be lowered by drainage. The slow percolation rate, a problem for septic tank absorption fields, can be overcome by enlarging the field. Frost action breaks up roads and streets but can be overcome by replacing the base material with material not subject to frost action.

This soil has fair potential for wetland wildlife habitat. Most areas have good potential for grain and seed crops. Capability subclass IIe.

15—Bearden silty clay loam, saline. This level, somewhat poorly drained, moderately saline soil is in lowlying areas on glacial lake plains. Areas generally range from 10 to more than 100 acres and are circular or oval.

Typically, the surface layer is very dark gray silty clay loam about 14 inches thick. The underlying material to a depth of 60 inches is silty clay loam. It is grayish brown in the upper part, light olive brown in the middle part, and gray in the lower part. In some places the soil is only slightly saline.

Permeability is slow, and available water capacity is high. Runoff is slow. Tilth is fair. The organic-matter content and fertility are high.

Most areas are in crops. The potential is fair for cultivated crops, good for hay and pasture, poor for trees, and fair for most engineering uses.

This soil is suited to small grain and flax. The moderate salt content reduces yields; salt-tolerant crops such as barley are better suited to this soil. Tilth can be maintained or improved by timely tillage. Wetness sometimes delays tillage and seeding in spring. The hazard of soil blowing is moderate and can be controlled under crop residue management and with stripcropping and buffer strips.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted grazing during wet periods keep the pasture in good condition.

This soil is generally not suited to windbreak and environmental plantings because of the seasonal high water table and the salt content.

This soil is generally suited to building site development and onsite waste disposal. The seasonal high water table can be lowered by drainage. The slow percolation rate is a problem in septic tank absorption fields but can be overcome by enlarging the field. Frost action breaks up roads and streets but can be overcome by replacing the base material with material that is not subject to frost action.

This soil has fair potential for wetland wildlife habitat. Most areas have fair potential for grain and seed crops. Capability subclass IIIw.

16—Overly silty clay loam. This level, moderately well drained soil is on flat glacial lake plains. Areas generally range from 20 to more than 200 acres.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsoil is silty clay loam about 13 inches thick. It is black in the upper part and very dark gray in the lower part. The underlying material is silty clay loam. It is grayish brown in the upper part and light olive brown in the lower part. In some places the surface layer is silt loam.

Permeability is moderately slow, and available water capacity is high. Runoff is slow. Tilth is fair. The organic-matter content and fertility are high.

Most areas are farmed. The potential is good for cultivated crops, hay, pasture, and trees and for most engineering uses.

This soil is well suited to small grain and flax. Tilth can be maintained or improved by timely cultivation. Cultivation should be avoided if the soil is either too wet or too dry. The hazard of soil blowing is slight and is easily controlled under crop residue management and with stripcropping. Buffer strips are helpful in controlling soil blowing in years of low crop-residue production.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

This soil is well suited to windbreak and environmental plantings. All climatically adapted species of trees and shrubs grow well.

This soil is suited to building site development and onsite waste disposal. The slow percolation rate, a problem in septic tank absorption fields, can be overcome by enlarging the field. The frost action limitation can be overcome by placing building footings below frost depth. Frost action breaks up roads and streets but can be overcome by replacing the base material with material not subject to frost action.

This soil has poor potential for wetland wildlife habitat and good potential for openland wildlife habitat. Grain, seed crops, grasses, and legumes in support of wildlife are well suited to this soil. Capability subclass IIc.

17—Colvin silty clay loam. This level, poorly drained soil is in low-lying areas on glacial lake plains. Areas are smooth and generally range from 5 to more than 50 acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. The underlying material from 8 to 19 inches is grayish brown and light brownish gray silty clay loam, from 19 to 36 inches olive gray silty clay loam, from 36 to 52 inches gray loam, and from 52 to 60 inches olive gray silty clay loam. In places the surface layer is thicker, and in others the soil is slightly to moderately saline.

Permeability is moderately slow, and available water capacity is high. Runoff is very slow. Tilth is fair. The organic-matter content and fertility are high.

Most areas are in native grass, pasture, or hay. The potential is poor for cultivated crops, good for native hay and pasture, and poor for most engineering uses.

If drained, this soil is suited to small grain and flax. Most areas are not drained, however, because of a lack of suitable outlets. Good tilth can be maintained by timely cultivation. Cultivation should be avoided if the soil is either too wet or too dry. The hazard of soil blowing is slight and is easily controlled under crop residue management and with stripcropping and buffer strips. Some areas of this soil are farmed in dry years, because it is in low-lying areas and receives additional moisture from runoff of surrounding slopes.

Keeping the soil in pasture and hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition and maintain the desirable native grass species.

Unless this soil is drained, it is generally not suited to windbreak and environmental plantings.

This soil is poorly suited to building sites and to most onsite waste disposal. It is well suited to sewage lagoons. The depth to the seasonal high water table and the duration, the ponding, and the slow percolation rate are severe limitations. The limitation of the slow percolation rate can be overcome by enlarging the field. The Colvin soil in this survey area is generally not used for building sites or most related uses.

This soil has good potential for wetland wildlife habitat. It is well suited to shallow water areas and the growth of wetland plants. Capability subclass IVw.

18—Colvin silty clay loam, channeled. This level, poorly drained and very poorly drained soil is on bottom land adjacent to intermittent drainage channels. Areas have long and smooth slopes and generally range from 10 to more than 100 acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. In most of this county, however, it is 8 to 10 inches thick. The underlying material from 8 to 19 inches is grayish brown and light brownish gray silty clay loam, from 19 to 36 inches olive gray silty clay loam, from 36 to 52 inches gray loam, and from 52 to 60 inches olive gray silty clay loam. In some places the surface layer is silt loam, and in other places it contains less lime. In some places the soil is slightly to moderately saline.

Included with this soil in mapping are natural drainage channels, which make up less than 5 percent of the map unit. They are generally either too wet or too deep to cross with machinery.

Permeability is moderately slow, and available water capacity is high. Runoff is very slow to ponded. The organic-matter content and fertility are high.

Most areas are used for native grass pasture or hay. The potential is poor for cultivated crops and trees, good for native grass hay and pasture, and poor for most engineering uses.

This soil is not suited to small grain and flax. It is generally not drained because it lacks suitable outlets. It is subject to stream overflow and is sometimes covered with water for long periods.

Keeping this soil in native grass pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition and maintain the desirable native grass species.

This soil is generally not suited to windbreak and enviromental plantings. Ponding and the high water table are severe limitations.

This soil is poorly suited to building sites and most onsite waste disposal. It is well suited to sewage lagoons. The seasonal high water table, the ponding, and the slow percolation rate are severe limitations. The slow percolation rate can be overcome by enlarging the absorption field. The Colvin soil in this survey area is generally not used for building sites and related uses.

This soil has good potential for wetland wildlife habitat. It is well suited to development of shallow water areas and to wetland plants. Capability subclass Vw.

20—Pits, gravel, are miscellaneous areas from which the soil material has been removed in order to mine the underlying sand and gravel. They are irregularly shaped pits and fill areas that range from 3 to more than 30 acres. Most are barren of vegetation.

These pits have poor potential for cultivated crops, hay, pasture, and trees. They are generally not suited to most engineering uses. They are generally not suited as waste disposal areas because of the rapid percolation rate. The rapid percolation rate can allow waste material to contaminate the ground water supply. Capability subclass not assigned.

24—Hecla-Ulen loamy fine sands, 0 to 3 percent slopes. This map unit consists of level and nearly level, moderately well drained Hecla soils and somewhat poorly drained Ulen soils on sandy lacustrine and glacial outwash plains. It is about 60 percent Hecla soil and 35 percent Ulen soil. The Hecla soil is in the higher lying areas, and the Ulen soil in shallow depressions. Areas generally range from 10 to more than 250 acres.

Typically, the Hecla soil has a surface layer of black loamy fine sand about 18 inches thick. The underlying

material from 18 to 25 inches is very dark gray loamy fine sand, from 25 to 36 inches dark grayish brown loamy fine sand, and from 36 to 60 inches grayish brown fine sand.

Typically, the Ulen soil has a surface layer of loamy fine sand about 15 inches thick. It is black in the upper part and very dark gray in the lower part. The underlying material from 15 to 23 inches is grayish brown loamy fine sand, from 23 to 40 inches light yellowish brown fine sand, from 40 to 48 inches yellowish brown fine sand, and from 48 to 60 inches light olive brown fine sand.

About 5 percent of the map unit is included small areas of Fossum soils. These soils are in depressions. In places they are slightly to moderately saline.

Permeability is rapid, and available water capacity is low for both soils. Runoff is slow. Tilth is fair. The organic-matter content is moderate, and fertility is low.

Many areas are in cultivated crops. Some are used for hay or pasture. The soils have poor potential for cultivated crops, fair potential for hay and pasture, good potential for trees and shrubs, and fair potential for most engineering uses.

These soils are suited to small grain and flax. The Ulen soil has a seasonal high water table that in some years delays tillage and seeding in spring. The hazard of soil blowing is high. Intensive crop residue management, buffer strips, stripcropping, and windbreaks are needed. Both soils are droughty as a result of the low available water capacity. Rye is generally the best suited small grain because it can be seeded in fall to protect the soil from blowing and it makes the best use of available moisture.

Keeping these soils in pasture or hay is effective in controlling moisture. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition. If the pasture is overgrazed, soil blowing is a hazard.

These soils have poor potential for the development of wetland wildlife habitat. The potential is fair for openland wildlife habitat and for grain and seed crops.

The included Fossum soils are wetter than Hecla and Ulen soils. Because they are ponded, they are generally not suited to cultivated crops or to engineering uses. They have good potential for wetland wildlife habitat development. Capability subclass IVe.

25—Hecla loamy fine sand, 0 to 3 percent slopes. This level and nearly level, moderately well drained soil is on sandy lacustrine plains and glacial outwash plains. Areas range from 10 to more than 300 acres. Slopes are long.

Typically, the surface layer is black loamy fine sand about 18 inches thick. The underlying material from 18 to 25 inches is very dark gray loamy fine sand, from 25 to 36 inches dark grayish brown loamy fine sand, and from 36 to 60 inches grayish brown fine sand.

About 10 percent of the map unit is included small areas of the well drained Maddock soils. These soils are on mounds and slight rises and have a loamy fine sand or fine sand surface layer.

Permeability is rapid, and available water capacity is low. Runoff is slow. Tilth is fair. The organic-matter content is moderate, and fertility is low.

Many areas are in cultivated crops. Some are used for tame grass, pasture, or hay. The potential is poor for cultivated crops; fair for hay, pasture, and most engineering uses; and good for trees and shrubs.

This soil is poorly suited to small grain and flax. It is droughty. The hazard of soil blowing is high (fig. 7). Intensive crop residue management, buffer strips, stripcropping, and windbreaks are needed. Rye is generally the best suited small grain because it can be seeded in fall to protect the soil from blowing and it makes the best use of available moisture.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition. Soil blowing is a hazard if this soil is overgrazed.

This soil is well suited to windbreak and environmental plantings. All climatically adapted trees and shrubs grow well.

This soil is suited to building site development. The frost action limitation can be overcome by placing building footers below frost depth. The caving in of cutbanks, a problem in shallow excavations, can be overcome by shoring trench walls. Frost action breaks up roads and streets but can be overcome by draining the soil or by replacing the base material with material not subject to frost action. This soil is generally not suited to onsite waste disposal because of the rapid percolation rate. Contamination of ground water is a hazard.

This soil has poor potential for wetland wildlife habitat. The potential is fair for openland wildlife habitat and for grain and seed crops.

The included Maddock soil has good potential for building site development and for roads and streets. Capability subclass IVe.

26B—Maddock loamy fine sand, 3 to 6 percent slopes. This undulating, well drained soil is on sandy lacustrine and glacial outwash plains. Areas generally range from 20 to more than 300 acres. Slopes are short. Local relief is about 5 to 15 feet.

Typically, the surface layer is very dark gray loamy fine sand about 11 inches thick. The underlying material from 11 to 20 inches is dark grayish brown loamy fine sand, from 20 to 48 inches dark grayish brown fine sand, and from 48 to 60 inches loamy very fine sand. In some places the surface layer is fine sand, and in others it is thicker.

About 10 to 20 percent of the map unit is included small areas of the moderately drained Hecla soils. These areas are generally less than 3 acres. They occupy lower concave positions.

Permeability is rapid, and available water capacity is low. Runoff is slow. Tilth is fair. The organic-matter content is moderate, and fertility is low.

Many areas are in cultivated crops. Some areas are used for hay or pasture. The potential is poor for cultivated crops; fair for pasture, hay, and trees; and good to fair for most engineering uses.

This soil is poorly suited to small grain and flax. It is droughty. The hazard of soil blowing is high. Intensive crop residue management, buffer strips, stripcropping, and windbreaks are needed. Rye is generally the best suited small grain because it can be seeded in fall to protect the soil from blowing and it makes the best use of available moisture.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition. Soil blowing is a hazard if this soil is overgrazed.

This soil is fairly well suited to windbreak and environmental plantings. Some of the climatically adapted trees and shrubs grow fairly well.

This soil is well suited to building site development and fairly well suited to onsite waste disposal. The caving in of cutbanks, a problem in shallow excavations, can be overcome by shoring trench walls. If this soil is used for waste disposal, the seepage resulting from the rapid percolation rate may allow waste to contaminate the ground water.

This soil has very poor potential for wetland wildlife habitat. It has fair potential for openland wildlife habitat and for grain and seed crops.

The included Hecla soil has a seasonal high water table and a related wetness limitation. Capability subclass IVe.

27C—Maddock loamy fine sand, 6 to 15 percent slopes. This gently rolling and rolling, well drained soil is on sandy lacustrine and glacial outwash plains. Areas generally range from 10 to more than 50 acres. Slopes are short. Local relief is about 15 to 50 feet.

Typically, the surface layer is very dark gray loamy fine sand about 11 inches thick. The underlying material from 11 to 20 inches is dark grayish brown loamy fine sand, from 20 to 48 inches dark grayish brown fine sand, and from 48 to 60 inches loamy very fine sand. In some areas the surface layer is fine sand, and in others it is thicker.

About 5 to 15 percent of the map unit is included small areas of the moderately well drained Hecla soils. These areas are generally less than 3 acres in size. They occupy lower concave positions.

Permeability is rapid, and available water capacity is low. Runoff is slow. The organic-matter content is moderate, and fertility is low.

Most areas are used for native grass pasture or hay. Some previously cultivated areas are now in permanent tame grass hay or pasture. The potential is poor for cultivated crops and trees and fair for native grass hay or pasture and for most engineering uses.

This soil is generally not suited to small grain, flax, and grass-legume hay. The hazard of soil blowing is high, and the soil is droughty. Slopes are an added limitation. The soil is best suited to permanent grass pasture or hay.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition and help maintain the desirable native grass species. If this soil is overgrazed, erosion is a hazard.

This soil is generally not suited to windbreak and environmental plantings. Special or scalp plantings for wildlife habitat, recreation, or beautification can be made, but they require intensive management to survive and grow well.

This soil is fairly well suited to building site development and onsite waste disposal. The caving in of cutbanks, a problem in shallow excavations, can be overcome by shoring trench walls. Slope, a problem on building sites, can be overcome by cut and fill operations. If this soil is used for waste disposal, seepage resulting from the rapid percolation rate may allow waste to contaminate the ground water.

If cut and fill operations disturb the vegetative cover, soil blowing becomes a hazard. This can be controlled by timely reestablishment of the vegetative cover.

This soil has very poor potential for wetland wildlife habitat. It has fair potential for openland wildlife habitat and for grass and legumes.

The included Hecla soil has a seasonal high water table and a related wetness limitation. Capability subclass VIe.

29—Towner loamy fine sand, 0 to 3 percent slopes. This level and nearly level, moderately well drained and well drained soil is on glacial till plains mantled by wind- or water-sorted loamy fine sand. Individual areas of this unit generally range from 20 to more than 250 acres. Slopes are long. Local relief is less than 5 feet.

Typically, the surface layer is loamy fine sand about 20 inches thick. It is black in the upper part and very dark gray in the lower part. The underlying material from 20 to 29 inches is very dark grayish brown loamy fine sand, from 29 to 36 inches grayish brown loam, and from 36 to 60 inches olive brown loam. In some places, generally on the highest areas, the surface layer is thinner.

About 5 to 10 percent of the map unit is included small areas of the moderately well drained Hecla soils. They occupy the same position as the Towner soils but lack the contrasting loam underlying material.

Permeability is rapid over moderate or moderately slow. Available water capacity is moderate. Runoff is slow. Tilth is fair. The organic-matter content is moderate, and fertility is low.

Most areas are in cultivated crops or in tame grass pasture or hay. The potential is fair for cultivated crops, hay, pasture, and trees and good for some engineering uses.

This soil is fairly well suited to small grain and flax. It is somewhat droughty. The hazard of soil blowing is high. Intensive crop residue managment, buffer strips, stripcropping, and windbreaks are needed. Rye is generally the best suited small grain because it can be seeded in fall to protect the soil from blowing and because it makes the best use of available moisture.

Keeping the soil in pasture, in hay, or in both, is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

This soil is fairly well suited to windbreak and environmental plantings. Many of the climatically adapted species of trees and shrubs grow fairly well.

This soil is well suited to building site development and fairly well suited to onsite waste disposal. The wetness limitation, a problem for building sites, can be overcome by foundation drainage. Frost action breaks up roads and streets but can be overcome by draining the soil or by replacing the base material with material not subject to frost action. The slow percolation rate, a problem in septic tank absorption fields, can be overcome by enlarging the field.

This soil has poor potential for wetland wildlife habitat. It has good potential for openland wildlife habitat and for grasses and legumes.

The included Hecla soil has about the same limitations as this soil, but it does not have the slow percolation rate. Capability subclass IVe.

31B—Towner-Dickey loamy fine sands, 3 to 6 percent slopes. This map unit consists of undulating, moderately well drained and well drained Towner soils and well drained Dickey soils on glacial till plains mantled by wind- or water-sorted loamy fine sand. The unit is about 60 percent Towner soil and 30 percent Dickey soil. The Towner soil is on the lower lying concave slopes and in swales. The Dickey soil is on hillcrests and the upper parts of hillsides. Areas generally range from 10 to more than 200 acres.

Typically, the Towner soil has a surface layer of loamy fine sand about 20 inches thick. It is black in the upper part and very dark gray in the lower part. The underlying material from 20 to 29 inches is very dark grayish brown loamy fine sand, from 29 to 36 inches grayish brown loam, and from 36 to 60 inches olive brown loam.

Typically, the Dickey soil has a surface layer of very dark gray loamy fine sand about 12 inches thick. The subsoil, from 12 to 30 inches, is dark brown. It is loamy fine sand in the upper part and fine sand in the lower part. The underlying material, from 30 to 60 inches, is loam. It is light olive brown in the upper part and olive brown in the lower part.

About 5 to 10 percent of the unit is included small areas of Hecla and Maddock soils. The Hecla soil occupies positions on the landscape similar to those of the Towner soil. The Maddock soil occupies positions similar to those of the Dickey soil but lacks the contrasting loam underlying material.

Permeability is rapid in the upper part of the soils and moderately slow or slow in the lower part. Available water capacity is moderate. Runoff is slow. Tilth is poor. The organic-matter content is moderate, and fertility is low.

Many areas are farmed to cultivated crops. Some are in tame grass pasture or hay. The potential is poor for cultivated crops and fair for hay, pasture, and trees. The potential for most engineering construction is fair on the Towner soil and good on the Dickey soil.

These soils are poorly suited to small grain and flax. They are droughty. The hazard of soil blowing is high. Intensive crop residue management, buffer strips, stripcropping, and windbreaks are needed. Rye is generally the best suited small grain because it can be seeded in fall to protect the soil from blowing, and it makes the best use of available moisture.

Keeping these soils in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition. If the pasture is overgrazed, soil blowing is a hazard.

These soils are fairly well suited to windbreak and environmental plantings. Many of the climatically adapted trees and shrubs grow fairly well.

These soils are well suited to fairly well suited to building site development and onsite waste disposal. The wetness limitation of the Towner soil can be overcome by foundation drainage around buildings. The frost action limitation of the Towner soil for roads and streets can be overcome by draining the soil or by replacing the base material with material not subject to frost action. The caving in of cutbanks, a problem in shallow excavations, can be overcome by shoring trench walls. The slow percolation rate, a problem for septic tank absorption fields, can be overcome by enlarging the field.

These soils have very poor potential for wetland wildlife habitat. They have good potential for openland wildlife habitat and for grass and legumes.

The included Hecla soil has about the same kinds of limitations as the Towner soil. The included Maddock soil has about the same limitations as the Dickey soil. Neither of the included soils, however, has a slow percolation rate. Capability subclass IVe.

32C—Dickey loamy fine sand, 6 to 15 percent slopes. This gently rolling and rolling, well drained soil is on glacial till plains mantled by wind- or water-sorted loamy fine sand. Areas generally range from 20 to more than 200 acres. Slopes are short. Local relief is about 15 to 50 feet.

Typically, the surface layer is very dark gray loamy fine sand about 12 inches thick. The subsoil, from 12 to 30 inches, is dark brown. It is loamy fine sand in the upper part and fine sand in the lower part. The underlying material to a depth of 60 inches is loam. It is light olive brown in the upper part and olive brown in the lower part. In places, usually lower concave positions, the surface layer is thicker.

Included with this soil in mapping are small areas of Maddock and Hecla soils. The Maddock soil occupies positions similar to those of the Dickey soil and makes up 5 to 10 percent of the unit, but it lacks the contrasting loam underlying material. The Hecla soil is moderately well drained, occupies lower concave positions, and makes up 5 to 10 percent of the unit.

Permeability is rapid in the upper part of the soil, and moderately slow or slow in the lower part. Available water capacity is moderate. Runoff is slow. Tilth is poor. The organic-matter content is moderate, and fertility is low.

Most areas are used for native grass pasture or hay. Some previously cultivated areas are now in permanent tame grass hay or pasture. The potential is poor for cultivated crops and trees and fair for native grass hay or pasture and for most engineering uses.

This soil is generally not suited to small grain, flax, or grass-legume hay. The hazard of soil blowing is high. The soil is droughty. Slope is an added limitation. The soil is better suited to permanent grass pasture or hay.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition and maintain the desirable native grass species. If pastures are overgrazed, erosion is a hazard.

This soil is generally not suited to windbreak and environmental plantings. Special or scalp plantings for wildlife habitat, recreation, or beautification can be made but require intensive management to survive and grow well.

This soil is fairly well suited to building site development and onsite waste disposal. The caving in of cutbanks, a problem in shallow excavations, can be overcome by shoring trench walls. Slope, a problem in building sites, can be overcome by cut and fill operations. Seepage above the contrasting underlying material is a problem for sanitary landfills and may allow waste to contaminate water supplies. Soil blowing, a hazard where cut and fill operations disturb the vegetative cover, can be controlled by timely reestablishment of the vegetative cover.

This soil has very poor potential for wetland wildlife habitat. It has fair potential for openland wildlife habitat and grasses and legumes.

The included Maddock soil has about the same limitations as this soil, but it does not have the slow percolation rate. The included Hecla soil has a seasonal high water table and the related wetness hazard. Capability subclass VIe.

34—Tiffany fine sandy loam. This level, poorly drained soil is in shallow depressions on glacial outwash plains and lacustrine plains. Areas generally range from 3 to 50 acres.

Typically, the surface layer is very dark gray fine sandy loam about 21 inches thick. The underlying material from 21 to 28 inches is dark gray fine sandy loam, from 28 to 39 inches dark grayish brown fine sandy loam, from 39 to 45 inches dark gray silt loam, from 45 to 56 inches light olive brown fine sandy loam, and from 56 to 60 inches light brownish gray and light olive brown clay loam.

Permeability and available water capacity are moderate. Runoff is very slow. Tilth is good. The organic-matter content is high, and fertility is moderate.

Most areas are in hay, but some are cropped or idle. The potential is poor for cultivated crops and trees, good for hay or pasture, and poor for most engineering uses.

This soil is poorly suited to small grain and flax. Ponding in spring delays or prevents tillage and seeding. Most areas are not drained because of the lack of suitable outlets. The hazard of soil blowing is high in cultivated areas. Intensive crop residue management, buffer strips, stripcropping, and windbreaks are needed.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

If drained, this soil is well suited to windbreak and environmental plantings. All climatically adapted species of trees and shrubs grow well. Unless drained, this soil is generally not suited to trees.

This soil is poorly suited to building site development and to most onsite waste disposal. The seasonal high water table and the duration, the seepage, and the ponding are severe limitations and require costly design, installation, and maintenance. The Tiffany soils in this survey area are not used for building sites or most related uses.

This soil has fair potential for wetland wildlife habitat and shallow water areas. It is commonly adjacent to soils having fair potential for grain or seed crops in support of wildlife. Capability subclass IVw.

35—Embden fine sandy loam, 0 to 3 percent slopes. This level and nearly level, moderately well drained soil is on glacial outwash and lacustrine plains. Areas generally range from 20 to more than 300 acres. Slopes are long. Local relief is less than 5 feet.

Typically, the surface layer is black fine sandy loam about 14 inches thick. The subsoil, from 14 to 32 inches, is fine sandy loam. It is very dark brown in the upper part and very dark grayish brown in the lower part. The underlying material is light olive brown. It is fine sandy loam in the upper part and loamy fine sand in the lower part. In places, usually on the higher areas, the surface layer is thinner.

About 5 to 10 percent of the map unit is included small areas of Swenoda soils. These areas are generally less than 3 acres. They are well drained and moderately well drained, have contrasting loam underlying material, and occupy positions similar to the Embden soil.

Permeability is moderately rapid, and available water capacity is moderate. Runoff is slow. Tilth is good. The organic-matter content is high, and fertility is moderate.

Most areas are farmed. The potential is good for cultivated crops, trees, hay, and pasture and for some engineering uses.

This soil is well suited to small grain and flax. It is slightly droughty. The hazard of soil blowing is high. Intensive crop residue management, buffer strips, stripcropping, and windbreaks are needed. Rye is generally the best suited small grain because it can be seeded in fall to protect the soil from blowing, and because it makes the best use of available moisture.

Keeping the soil in hay or pasture is effective in controlling erosion. Proper stocking rates, pasture rotation,

and timely deferment of grazing keep the pasture in good condition.

This soil is well suited to windbreak and environmental plantings. All climatically adapted species of trees and shrubs grow well.

This soil is well suited to building site development. Frost action is a problem for buildings, roads, and streets, but it can be overcome by placing or building footers below frost depth, by draining the soil, or by replacing street or road base material with material not subject to frost action. This soil is poorly suited to sewage lagoons and sanitary landfills. Seepage is a problem for onsite disposal of waste and may allow waste to contaminate the ground water. The seepage problem for sewage lagoons can be overcome with plastic liners or clay blankets.

This soil has poor potential for wetland wildlife habitat. The potential is good for openland wildlife habitat and for grasses and legumes.

The included Swenoda soil has about the same limitations as this soil, but it has a slow percolation rate. Capability subclass IIIe.

36B—Embden-Egeland fine sandy loams, 3 to 6 percent slopes. This map unit consists of undulating, moderately well drained Embden soils and well drained Egeland soils on glacial outwash plains and lacustrine plains. It is about 60 percent Embden soil and about 30 percent Egeland soil. The Embden soil is on the low-lying concave slopes and in swales, and the Egeland soil is on upper side slopes and hillcrests. Areas generally range from 5 to more than 150 acres.

Typically, the Embden soil has a surface layer of black fine sandy loam about 14 inches thick. The subsoil, from 14 to 32 inches, is fine sandy loam. It is very dark brown in the upper part and very dark grayish brown in the lower part. The underlying material is fine sandy loam in the upper part and loamy fine sand in the lower part. It is light olive brown.

Typically, the Egeland soil has a surface layer of black fine sandy loam about 10 inches thick. The subsoil, from 10 to 24 inches, is dark brown fine sandy loam. The underlying material from 21 to 40 inches is dark grayish brown fine sandy loam, from 40 to 50 inches dark brown fine sandy loam, and from 50 to 65 inches grayish brown loamy fine sand.

About 5 to 10 percent of the map unit is included small areas of the well drained and moderately well drained Swenoda soils. These areas are generally less than 3 acres. They have underlying material of contrasting loam.

Permeability is moderately rapid, and available water capacity is moderate. Runoff is slow to medium. Tilth is good. The organic-matter content is high in the Embden soils and moderate in the Egeland soils. Fertility is moderate.

Most areas are farmed. The potential is fair for cultivated crops and trees, fair to good for engineering uses, and good for hay and pasture.

These soils are suited to small grain and flax. They are somewhat droughty. The hazard of soil blowing is high. Intensive crop residue management, buffer strips, stripcropping, and windbreaks are needed. Rye is generally the best suited small grain because it can be seeded in fall to protect the soil from blowing, and it makes the best use of available moisture.

Keeping the soils in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

The Embden soil is well suited for windbreak and environmental plantings. All climatically adapted trees and shrubs grow well. The Egeland soil is suited, and many of the climatically adapted trees and shrubs grow fairly well.

These soils are suited to building site development. The frost action limitation can be overcome by placing building footers below frost depth. The seasonal high water table of the Embden soil can be lowered by foundation drainage. The caving in of cutbanks, a problem in shallow excavations, can be overcome by shoring of trench walls. Frost action breaks up roads and streets but can be overcome by draining the soil or by replacing the base material with material not subject to frost action.

These soils are poorly suited to onsite disposal from sewage lagoons and sanitary landfills. Seepage is a problem for onsite disposal of waste, because waste can contaminate the ground water. The seepage problem from sewage lagoons can be overcome with plastic liners or clay blankets.

These soils have very poor potential for wetland wildlife habitat. They have good potential for openland wildlife habitat and for grasses and legumes.

The included Swenoda soil has about the same limitations as these soils, but it has a slow percolation rate. Capability subclass IIIe.

37C—Egeland fine sandy loam, 6 to 9 percent slopes. This gently rolling, well drained soil is on lacustrine plains and glacial outwash plains. Areas generally range from 5 to more than 50 acres. Slopes are short. Local relief is about 15 to 50 feet.

Typically, the surface layer is black fine sandy loam about 10 inches thick. The subsoil, from 10 to 21 inches, is dark brown fine sandy loam. The underlying material from 21 to 40 inches is dark grayish brown fine sandy loam, from 40 to 50 inches dark brown fine sandy loam, and from 50 to 65 inches grayish brown loamy fine sand. In places, usually the lower concave slopes, the surface layer is thicker.

About 5 to 15 percent of the map unit is included small areas of Swenoda soils. These areas are generally less than 3 acres. They are well drained and moderately well drained and have underlying material of contrasting loam.

Permeability is moderately rapid, and the available water capacity is moderate. Runoff is medium. Tilth is good. The organic-matter content and fertility are moderate.

Most areas are farmed. The potential is fair for cultivated crops, trees, hay, and pasture and good to fair for most engineering uses.

This soil is suited to small grain and flax. It is somewhat droughty. The hazard of soil blowing is high. Intensive crop residue management, buffer strips, stripcropping, and windbreaks are needed. Rye is generally the best suited small grain because it can be seeded in fall to protect the soil from blowing, and it makes the best use of available moisture.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

This soil is suited to windbreak and environmental plantings. Many of the climatically adapted tree and shrub species grow well.

This soil is suited to building site development. The problem of frost action can be overcome by placing building footers below frost depth and by replacing road and street base material with material not subject to frost action. The caving in of cutbanks, a problem in shallow excavations, can be overcome by shoring trench walls.

This soil is generally poorly suited to sewage lagoons and sanitary landfills. Seepage is a problem for onsite disposal of waste, because waste may contaminate the ground water. The seepage problem from sewage lagoons can be overcome with plastic liners or clay blankets.

This soil has very poor potential for wetland wildlife habitat. It has good potential for openland wildlife habitat and for grasses and legumes.

The included Swenoda soil has about the same limitations as this soil, but it has a slow percolation rate. Capability subclass IVe.

39—Swenoda fine sandy loam, 0 to 3 percent slopes. This level and nearly level, moderately well drained and well drained soil is on glacial till plains mantled by wind- or water-sorted fine sandy loam. Areas generally range from 10 to more than 200 acres. Slopes are long. Local relief is less than 5 feet.

Typically, the surface layer is very dark gray fine sandy loam about 8 inches thick. The subsoil, from 8 to 29 inches, is fine sandy loam. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The underlying material to a depth of 60 inches is loam. It is grayish brown in the upper part and olive brown in the lower part.

About 5 to 15 percent of the map unit is included small areas of Embden soils. These areas are generally less than 3 acres. They are moderately well drained and have fine sandy loam and loamy fine sand underlying material.

Permeability is moderately rapid over moderate or moderately slow. Available water capacity is moderate. Runoff is slow. Tilth is good. The organic-matter content is high, and fertility is moderate.

Most areas are farmed. The potential is good for cultivated crops, hay, and pasture and fair for trees and most engineering uses.

This soil is well suited to small grain and flax. It is somewhat droughty. The hazard of soil blowing is high. Intensive crop residue management, buffer strips, stripcropping, and windbreaks are needed. Rye is generally the best suited small grain because it can be seeded in fall to protect the soil from blowing, and it makes the best use of available moisture.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

This soil is fairly well sutied to windbreak and environmental plantings. Many of the climatically adapted trees and shrubs grow well.

This soil is suited to building site development. The problem of frost action can be overcome by placing building footers below frost depth and by replacing road and street base material with material not subject to frost action. The seasonal high water table can be lowered by foundation drainage around buildings. The slow percolation rate, a problem in septic tank absorption fields, can be overcome by enlarging the field. Seepage, a problem for sanitary landfills and sewage lagoons, can be overcome by removing the upper permeable part of the soil profile.

This soil has poor potential for wetland wildlife habitat. It has good potential for openland wildlife habitat and for grain and seed crops.

The included Embden soil has about the same limitations as this soil, but seepage is a greater problem. Capability subclass IIIe.

41B—Swenoda fine sandy loam, 3 to 6 percent slopes. This undulating, well drained and moderately well drained soil is on glacial till plains mantled with wind- or water-sorted fine sandy loam. Areas generally range from 10 to more than 300 acres. Slopes are short. Local relief is about 5 to 15 feet.

Typically, the surface layer is very dark gray fine sandy loam about 8 inches thick. The subsoil, from 8 to 29 inches, is fine sandy loam. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The underlying material to a depth of 60 inches is loam. It is grayish brown in the upper part and olive brown in the lower part.

About 5 to 15 percent of this map unit is included small areas of Embden soils. These areas are generally less than 3 acres. They are moderately well drained and have fine sandy loam and loamy fine sand underlying material.

Permeability is moderately rapid in the upper part of the soil and moderate or moderately slow in the lower part. Available water capacity is moderate. Runoff is medium. Tilth is good. The organic-matter content is high, and fertility is moderate.

Most areas are farmed. The potential is good for cultivated crops, hay, and pasture; fair for trees; and fair for most engineering uses.

This soil is well suited to small grain and flax. It is somewhat droughty. The hazard of soil blowing is high. Intensive crop residue management, buffer strips, stripcropping, and windbreaks are needed. Rye is generally the best suited small grain because it can be seeded in

fall to protect the soil from blowing and it makes the best use of available moisture.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

This soil is fairly well suited to windbreak and environmental plantings. Many of the climatically adapted trees and shrubs grow well.

This soil is suited to building site development. The problem of frost action can be overcome by placing building footers below frost depth and by replacing road and street base material with material not subject to frost action. The seasonal high water table can be lowered by foundation drainage around buildings. The slow percolation rate, a problem for septic tank absorption fields, can be overcome by enlarging the field. Seepage, a problem for sanitary landfill and sewage lagoons, can be overcome by removing the upper permeable part of the soil profile.

This soil has poor potential for wetland wildlife habitat. It has good potential for openland wildlife habitat and for grain and seed crops.

The included Embden soil has about the same limitations as this soil, but seepage is a greater problem. Capability subclass IIIe.

42C—Swenoda fine sandy loam, 6 to 9 percent slopes. This gently rolling, well drained and moderately well drained soil is on glacial till plains mantled with wind- or water-sorted fine sandy loam. Areas generally range from 5 to more than 100 acres. Slopes are short. Local relief is about 15 to 50 feet.

Typically, the surface layer is very dark gray fine sandy loam about 8 inches thick. The subsoil, from 8 to 29 inches, is fine sandy loam. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The underlying material to a depth of 60 inches is loam. It is grayish brown in the upper part and olive brown in the lower part.

About 5 to 20 percent of the map unit is included small areas of Embden and Egeland soils. These areas are generally less than 3 acres. The Egeland soils are well drained, and the Embden soils are moderately well drained. These soils have fine sandy loam and loamy fine sand underlying material.

Permeability is moderately rapid over moderate or moderately slow. Available water capacity is moderate. Runoff is medium. Tilth is good. The organic-matter content is high, and fertility is moderate.

Most areas are farmed. The potential is fair for cultivated crops, hay, pasture, and trees and for most engineering uses.

This soil is suited to small grain and flax. It is somewhat droughty. The hazard of soil blowing is high. Intensive crop residue management, buffer strips, stripcropping, and windbreaks are needed. Rye is generally the best suited small grain because it can be seeded in fall to protect the soil from blowing and it makes best use of available moisture.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

This soil is fairly well suited to windbreak and environmental plantings. Many of the climatically adapted trees and shrubs grow well.

This soil is suited to building site development. The problem of frost action can be overcome by placing building footers below frost depth and by replacing road and street base material with material not subject to frost action. The seasonal high water table can be lowered by foundation drainage. The slow percolation rate, a problem for septic tank absorption fields, can be overcome by removing the upper permeable part of the soil profile.

This soil has poor potential for wetland wildlife habitat. It has good potential for openland wildlife habitat and for grain and seed crops.

The included Egeland and Embden soils have about the same limitations as this soil, but seepage is a greater problem. Capability subclass IVe.

43—Wyndmere fine sandy loam. This level, somewhat poorly drained soil occupies flats and swales on lacustrine plains and glacial outwash plains. Areas generally range from 5 to more than 150 acres.

Typically, the surface layer is black fine sandy loam about 10 inches thick. The underlying material from 10 to 19 inches is dark grayish brown fine sandy loam, from 19 to 34 inches grayish brown fine sandy loam, and from 34 to 60 inches light olive brown fine sand. In some places the surface layer is thicker.

Permeability is moderately rapid, and available water capacity is moderate. Runoff is slow. Tilth is good. The organic-matter content is high, and fertility is moderate.

Most areas are farmed. The potential is good for cultivated crops, pasture, hay, and trees and poor for most engineering uses.

This soil is well suited to small grain and flax. The hazard of soil blowing is high. Intensive crop residue management, buffer strips, stripcropping, and windbreaks are needed. Wetness sometimes delays tillage and seeding in spring. Rye is generally the best suited small grain because it can be seeded in fall to protect the soil from blowing.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing maintain the pasture in good condition.

This soil is well suited to windbreak and environmental plantings. All climatically adapted trees and shrubs grow well.

This soil is poorly suited to building site development and to most onsite waste disposal. The depth to the seasonal water table and the duration, the frost action, and the seepage are severe limitations. The Wyndmere soil in this survey area is generally not used for building site development and related use.

This soil has poor potential for wetland wildlife habitat. The potential is good for openland wildlife habitat and for grasses and legumes. Capability subclass IIIe.

44—Fossum soils. These level, poorly drained soils are in shallow depressions on lacustrine plains and glacial outwash plains. Areas generally range from 5 to more than 100 acres.

Typically, the surface layer is about 22 inches thick. It is black fine sandy loam or loamy fine sand in the upper part, very dark gray loamy fine sand in the middle part, and very dark grayish brown loamy fine sand in the lower part. The underlying material to a depth of 60 inches is grayish brown fine sand. The soil is calcareous throughout the profile, but in some places it is noncalcareous.

Permeability is rapid, and available water capacity is low. Runoff is very slow. Tilth is good. The organic-matter content is moderate. Fertility is low.

Most areas are in pasture or hay. The potential is poor for cultivated crops; good for pasture, hay, and trees; and poor for most engineering uses.

This soil is poorly suited to small grain and flax. Wetness delays tillage and seeding in spring. Drainage is seldom feasible because of the lack of suitable outlets. The soils are droughty. The hazard of soil blowing is high. Intensive crop residue management, buffer strips, stripcropping, and windbreaks are needed.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

If drained, these soils are well suited to windbreak and environmental plantings. All climatically adapted trees and shrubs grow well. Unless drained, these soils are generally not suited to trees.

These soils are poorly suited to building site development and to onsite waste disposal. The depth to the seasonal high water table and the duration, the ponding, and the seepage are the severe limitations. The Fossum soils in this survey area are generally not used for building site development and related use.

These soils have good potential for wetland wildlife habitat and shallow water areas. Most areas are adjacent to soils having good or fair potential for grain and seed crops in support of wetland wildlife. Capability subclass IVw.

49—Hamerly loam, 0 to 3 percent slopes. This level and nearly level, somewhat poorly drained soil is on areas surrounding depressions, on low-lying flats, and in swales on glacial till plains. Areas generally range from 3 to more than 70 acres.

Typically, the surface layer is very dark gray loam about 7 inches thick. The underlying material from 7 to 16 inches is grayish brown loam, from 16 to 29 inches dark grayish brown and light brownish gray loam, from 29 to 38 inches light olive brown loam, and from 38 to 60 inches olive brown clay loam (fig. 8).

About 5 to 15 percent of the map unit is included small, intermingled areas of the poorly drained Vallers and Tonka soils. These areas are generally less than 3 acres. The Vallers soils are in slightly lower lying areas, and the Tonka soils are in shallow depressions.

Permeability is moderately slow, and available water capacity is high. Runoff is slow. Tilth is good. The organic-matter content and fertility are high.

Most areas are farmed. The potential is good for cultivated crops, hay, pasture, and trees and fair for most engineering uses.

This soil is well suited to small grain and flax. It has a seasonal high water table that delays tillage and seeding in spring. Good tilth is easily maintained. The hazard of soil blowing is moderate. Crop residue management, buffer strips, stripcropping, and windbreaks are needed.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

This soil is well suited to windbreak and environmental plantings. All climatically adapted species of trees and shrubs grow well.

This soil is suited to building site development and onsite waste disposal. The wetness, a limitation for buildings, can be overcome by foundation drainage. The frost action limitation can be overcome by placing building footers below frost depth and by replacing road and street base material not subject to frost action. The slow percolation rate, a problem for septic tank absorption fields, can be overcome by enlarging the field.

This soil has fair potential for wetland wildlife habitat. It has good potential for openland wildlife habitat and for grain and seed crops.

The included Tonka and Vallers soils are wetter than this soil and are generally not used for building site development and related use. They have good potential for wildlife habitat. Capability subclass IIe.

50—Svea loam, 0 to 3 percent slopes. This level and nearly level, moderately well drained soil is in swales on glacial till plains. Areas generally range from 3 to more than 100 acres.

Typically, the surface layer is black loam about 12 inches thick. The subsoil, from 12 to 27 inches, is very dark grayish brown loam. The underlying material to a depth of 60 inches is light olive brown clay loam.

About 10 to 20 percent of the map unit is included small areas of Barnes, Tonka, and Hamerly soils. These areas are generally less than 3 acres. The Barnes soil is well drained, is in slightly higher lying areas, and has a thinner surface layer than this Svea soil. The Tonka soil is poorly drained and is in depressions. The Hamerly soil is somewhat poorly drained and surrounds the depressions.

Permeability is moderately slow, and available water capacity is high. Runoff is slow. Tilth is good. The organic-matter content and fertility are high.

Most areas are farmed. The potential is good for cultivated crops, trees, hay, and pasture and fair to good for most engineering uses.

This soil is well suited to small grain and flax. The hazard of soil blowing is low and can be easily controlled under crop residue management and with stripcropping and windbreaks.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

This soil is well suited to windbreak and environmental plantings. All climatically adapted species grow well.

This soil is suited to building site development and onsite waste disposal. The wetness limitation, a problem for buildings, can be overcome by foundation drainage. The frost action limitation for roads and streets can be overcome by replacing base material with material not subject to frost action. The slow percolation rate, a problem for septic tank absorption fields, can be overcome by enlarging the field.

This soil has poor potential for wetland wildlife habitat. It has good potential for openland wildlife habitat and for grain and seed crops.

The included Tonka and Hamerly soils are wetter and have a higher seasonal water table than this soil. The included Barnes soil is better drained. Capability subclass IIc.

51—Barnes-Svea loams, 0 to 3 percent slopes. This map unit consists of the level and nearly level, well drained Barnes soils and the moderately well drained Svea soils on glaical till plains. Areas generally range from 20 to more than 400 acres and are about 45 percent Barnes soils and 40 percent Svea soils. The Barnes soils are on plane and slightly convex, higher lying side slopes, and the Svea soils are mostly on slightly concave, lower lying side slopes.

Typically, the Barnes soil has a surface layer of black loam about 7 inches thick. The subsoil, from 7 to 19 inches, is loam. It is dark brown in the upper part and olive brown in the lower part. The underlying material to a depth of 60 inches is loam. It is olive brown in the upper part and light olive brown in the lower part (fig. 9). In some places the surface layer is thinner.

Typically, the Svea soil has a surface layer of black loam about 12 inches thick. The subsoil, from 12 to 27 inches, is very dark grayish brown loam. The underlying material to a depth of 60 inches is light olive brown clay loam.

Included with these soils in mapping are small areas of Tonka and Hamerly soils. These areas are generally less than 3 acres in size. The Tonka soils are poorly drained and are in shallow depressions. The Hamerly soils are somewhat poorly drained and are in swales surrounding the depressions.

Permeability is moderately slow, and available water capacity is high. Runoff is medium on the Barnes soil and slow on the Svea soil. Tilth is good. The organic-matter content and fertility are high.

Most areas are farmed. The potential is good for cultivated crops, hay, pasture, and trees. The potential for most engineering uses is good for Barnes soils and fair for Svea soils.

These soils are well suited to small grain and flax. Good tilth is easy to maintain. The hazard of soil blowing is low and is easily controlled under crop residue management and with stripcropping. Buffer strips are helpful in controlling soil blowing in years of low crop-residue production.

Keeping the soils in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

These soils are well suited to windbreak and environmental plantings. All climatically adapted trees and shrubs grow well.

These soils are suited to building site development and onsite waste disposal. The frost action limitation in the Svea soil, a problem for roads and streets, can be overcome by replacing base material with material not subject to frost action. The wetness limitation, a problem for buildings, can be overcome by foundation drainage. The slow percolation rate, a problem for septic tank absorption fields, can be overcome by enlarging the field.

These soils have poor to very poor potential for wetland wildlife habitat. The potential is good for openland wildlife habitat and for grain and seed crops.

The included Tonka and Hamerly soils are wetter than these soils. Capability subclass IIc.

51B—Barnes-Svea loams, 3 to 6 percent slopes. This map unit consists of the undulating, well drained Barnes soils and the moderately well drained Svea soils on glacial till plains. Areas generally range from 10 to more than 200 acres and are about 50 percent Barnes soils and about 35 percent Svea soils. The Barnes soils are on plane and slightly convex side slopes, and Svea soils are generally on slightly concave side slopes.

Typically, the Barnes soil has a surface layer of black loam about 7 inches thick. The subsoil, from 7 to 19 inches, is loam. It is dark brown in the upper part and olive brown in the lower part. The underlying material to a depth of 60 inches is loam. It is olive brown in the upper part and light olive brown in the lower part.

Typically, the Svea soil has a surface layer of black loam about 12 inches thick. The subsoil, from 12 to 27 inches, is very dark grayish brown loam. The underlying material to a depth of 60 inches is light olive brown clay loam.

About 10 to 20 percent of the map unit is included small areas of Tonka and Hamerly soils. These areas are generally less than 3 acres. The Tonka soils are poorly drained and in depressions. The Hamerly soils are somewhat poorly drained and surround the depressions.

Permeability is moderately slow, and available water supply is high. Runoff is medium on the Barnes soil and slow on the Svea soil. Tilth is good. The organic-matter content and fertility are high.

Most areas are farmed. The potential is good for cultivated crops, pasture, hay, and trees. The potential for most engineering uses is good for Barnes soils and fair for Svea soils.

These soils are well suited to small grain and flax. Good tilth is easy to maintain. The hazard of soil blowing is low and is easily controlled under crop residue management and with stripcropping. Buffer strips are helpful in controlling soil blown in years of low crop-residue production.

Keeping the soils in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

These soils are well suited to windbreak and environmental plantings. All climatically adapted species of trees and shrubs grow well.

These soils are suited to building site development and onsite waste disposal. The frost action limitation in the Svea soil, a problem for roads and streets, can be overcome by replacing base material with material not subject to frost action. The wetness limitation, a problem for buildings, can be overcome by foundation drainage. The slow percolation rate, a problem for septic tank absorption fields, can be overcome by enlarging the field.

These soils have very poor potential for wetland wildlife habitat. The potential is good for openland wildlife habitat and for grain and seed crops.

The included Tonka and Hamerly soils are wetter than these soils. Capability subclass IIe.

53B—Barnes-Buse loams, 3 to 6 percent slopes. This map unit consists of the undulating, well drained Barnes and Buse soils on glacial till plains. Areas generally range from 3 to more than 100 acres and are about 60 percent Barnes soils and about 30 percent Buse soils. The Barnes soils are on the lower parts of side slopes. The Buse soils are on the upper part of side slopes and on the tops of knobs and knolls.

Typically, the Barnes soil has a surface layer of black loam about 7 inches thick. The subsoil, from 7 to 19 inches, is loam. It is dark brown in the upper part and olive brown in the lower part. The underlying material to a depth of 60 inches is loam. It is olive brown in the upper part and light olive brown in the lower part.

Typically, the Buse soil has a surface layer of very dark gray loam about 7 inches thick. The underlying material to a depth of 60 inches is loam. It is light olive brown in the upper part and olive brown in the lower part.

About 5 to 15 percent of the map unit is included small areas of Svea soils. These areas are generally less than 3 acres. They are in swales and at the base of slopes.

Permeability is moderately slow, and available water capacity is high. Runoff is medium. Tilth is good. The organic-matter content and fertility are high in the Barnes soil and moderate in the Buse soil.

Most areas are farmed. The potential is fair for cultivated crops; good for pasture, hay, and trees; and good for most engineering uses.

These soils are suited to small grain and flax. The hazards of soil blowing and erosion are moderate. Erosion can be controlled under crop residue management and with stripcropping, buffer strips, and windbreaks.

Keeping the soils in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

These soils are suited to windbreak and environmental plantings. Most climatically adapted trees and shrubs grow well.

These soils are well suited to building site development and onsite waste disposal. The frost action limitation, a problem for streets and roads, can be overcome by replacing the base material with material not subject to frost action. The slow percolation rate, a limitation for septic tank absorption fields, can be overcome by enlarging the field.

These soils have very poor potential for wetland wildlife habitat. The potential is good for openland wildlife habitat and for grain and seed crops.

The included Svea soils are wetter than these soils and have a seasonal high water table. Capability subclass IIIe.

53C—Barnes-Buse loams, 6 to 9 percent slopes. This map unit consists of the gently rolling, well drained Barnes and Buse soils on glacial till plains. Areas generally range from 3 to more than 100 acres and are about 55 percent Barnes soils and 35 percent Buse soils. The Barnes soils are on the lower parts of side slopes. The Buse soils are on the upper parts of side slopes and on the tops of knobs and knolls.

Typically, the Barnes soil has a surface layer of black loam about 7 inches thick. The subsoil, from 7 to 19 inches, is loam. It is dark brown in the upper part and olive brown in the lower part. The underlying material to a depth of 60 inches is loam. It is olive brown in the upper part and light olive brown in the lower part.

Typically, the Buse soil has a surface layer of very dark gray loam about 7 inches thick. The underlying material to a depth of 60 inches is loam. It is light olive brown in the upper part and olive brown in the lower part.

About 5 to 15 percent of the map unit is included small areas of Svea soils. These soils are generally less than 3 acres. They are in swales and at the base of slopes.

Permeability is moderately slow, and available water capacity is high. Runoff is medium. Tilth is good. The organic-matter content and fertility are high in the Barnes soil and moderate in the Buse soil.

Most areas are farmed. The potential is fair for cultivated crops; good for pasture, hay, and trees; and good for most engineering uses.

These soils are suited to small grain and flax. The hazards of soil blowing and water erosion are moderate and can be controlled under crop residue management and with stripcropping, buffer strips, and windbreaks.

Keeping the soils in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

These soils are suited to windbreak and environmental plantings. Most of the climatically adapted trees and shrubs grow well.

These soils are well suited to building site development and onsite waste disposal. The frost action limitation, a problem for roads and streets, can be overcome by replacing the base material with material not subject to frost action. The slow percolation rate, a limitation for septic tank absorption fields, can be overcome by enlarging the field.

These soils have very poor potential for wetland wildlife habitat. The potential is good for openland wildlife habitat and for grasses and legumes.

The included Svea soils are wetter than these soils and have a seasonal high water table. Capability subclass IVe.

55F—Esmond-Heimdal very stony loams, 9 to 25 percent slopes. This map unit consists of the rolling and hilly, well drained Esmond and Heimdal soils on glacial till plains. Areas generally range from 3 to more than 200 acres and are about 45 percent Esmond soils and 40 percent Heimdal soils. The Esmond soils are on the steeper upper parts of side slopes and ridgecrests. The Heimdal soils are on the lower parts of side slopes. The amount of stone cover ranges from about 3 to 15 percent. The Esmond soils generally have more stones on the surface than the Heimdal soils (fig. 10).

Typically, the Esmond soil has a surface layer of very dark grayish brown loam about 7 inches thick. The underlying material to a depth of 60 inches is loam. The upper part is grayish brown, and the lower part is dark grayish brown.

Typically, the Heimdal soil has a surface layer of black loam about 8 inches thick. The subsoil, from 8 to 26 inches, is loam. It is very dark brown in the upper part, dark grayish brown in the middle part, and light olive brown in the lower part. The underlying material to a depth of 60 inches is light olive brown loam.

About 10 to 20 percent of the map unit is included small areas of Emrick soils. These areas are generally less than 3 acres. They are in swales and on lower side slopes. In some places the stone cover is greater than 15 percent.

Permeability is moderate, and available water capacity is high. Runoff is rapid. The organic-matter content is moderate in Esmond soils and high in Heimdal soils. Fertility is low in the Esmond soils and high in the Heimdal soils.

Most areas are in pasture. The potential is poor for crops and hay, fair for pasture, and fair to poor for most engineering uses.

These soils are not suited to cultivated crops and hay because of the stoniness. Slope is an added limitation.

The soils are suited to native grass pasture. Keeping the soil in pasture is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition and maintain the desirable native grass species.

These soils are poorly suited to windbreak and environmental plantings. Specialized or scalp plantings for wildlife habitat, recreation, or beautification can be made but require intensive management. The best adapted species and the most favorable sites should be chosen to insure success.

These soils are poorly suited to building site development and onsite waste disposal. Slope is the main limitation. Stoniness is also a limitation. The slope limitation can be overcome in part by cut and fill operations. Erosion, a hazard if the vegetative cover has been removed by cut and fill operations, can be controlled by timely reestablishment of a vegetative cover. The stoniness limitation can be overcome by removing the stones.

These soils have very poor potential for wetland habitat. They have fair potential for rangeland wildlife habitat and for wild herbaceous plants.

The included Emrick soils have about the same limitations as these soils. Capability subclass VIs.

56—Cresbard-Svea loams, 0 to 3 percent slopes. This map unit consists of the level and nearly level, moderately well drained Cresbard and Svea soils on glacial till plains. Areas generally range from 5 to more than 300 acres and are about 50 percent Cresbard soils and about 35 percent Svea soils. The relief is uniform. The Cresbard soils have a dense subsoil that is affected by large amounts of sodium, but the Svea soils lack the large amounts of sodium in the subsoil.

Typically, the Cresbard soil has a surface layer of black loam about 7 inches thick. The subsurface layer, between 7 and 10 inches, is very dark gray silt loam. The subsoil, from 10 to 19 inches, is very dark gray clay loam. The underlying material to a depth of 60 inches is clay loam. It is light brownish gray in the upper part and olive brown in the lower part.

Typically, the Svea soil has a surface layer of black loam about 12 inches thick. The subsoil, from 12 to 27 inches, is very dark grayish brown loam. The underlying material to a depth of 60 inches is light olive brown clay loam.

About 10 to 20 percent of the map unit is included small areas of Hamerly and Barnes soils. These areas are generally less than 3 acres. The well drained Barnes soils are on slight rises. The somewhat poorly drained Hamerly soils are in low-lying swales.

Permeability is slow in the Cresbard soil and moderately slow in the Svea soil. The available water capacity is moderate in the Cresbard soil and high in the Svea soil. Runoff is slow. Tilth is fair in the Cresbard soil and good in the Svea soil. The organic-matter content is moderate in the Cresbard soil and high in the Svea soil. Fertility is high.

Most areas are farmed. The potential is fair for cultivated crops and trees, good for hay and pasture, and fair for most engineering uses.

These soils are suited to small grain and flax. The dense subsoil of the Cresbard soil limits rooting depth and plant use of stored moisture. The hazard of soil blow-

ing is moderate and can be controlled under crop residue management and with stripcropping, buffer strips, and windbreaks. Tilth can be improved or maintained by timely cultivation and maintaining the organic-matter content.

Keeping the soils in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

These soils are suited to windbreak and environmental plantings. All climatically adapted trees and shrubs grow well on the Svea soil, and many grow well on the Cresbard soil.

These soils are suited to building site development and onsite waste disposal. The shrink-swell limitation is a problem that can be overcome by design and construction to withstand stress. The wetness limitation, a problem for buildings, can be overcome by foundation drainage. The slow percolation rate, a problem for septic tank absorption fields, can be overcome by enlarging the field.

These soils have very poor potential for wetland wildlife habitat. They have good potential for openland wildlife habitat and for grasses and legumes.

The included Barnes soils are generally better suited to most engineering uses than these soils. The included Hamerly soils have a seasonal high water table and are wetter than these soils. Capability subclass IIIs.

57—Vallers loam. This level, poorly drained soil is on low-lying flats and in swales on glacial till plains. Areas generally range from 5 to more than 200 acres.

Typically, the surface layer is very dark gray loam about 8 inches thick. The underlying material, from 8 to 60 inches, is loam. It is dark grayish brown from 8 to 16 inches, light olive gray from 16 to 30 inches, olive gray from 30 to 42 inches, and dark grayish brown from 42 to 60 inches. In some places the soil is saline. If this Vallers soil is associated with Emrick, Heimdal, and Fram soils, it contains more silt and less clay than if it is associated with Barnes, Svea, and Hamerly soils.

Permeability is moderately slow, and available water capacity is high. Runoff is slow. Tilth is good. The organic-matter content and fertility are high.

Many areas are farmed, and some are in pasture or hay. The potential is poor for cultivated crops and trees, poor for most engineering uses, and good for hay and pasture.

This soil is poorly suited to small grain and flax. The seasonal high water table delays tillage and seeding in most years. Drainage that would lower the water table is seldom feasible because of the lack of adequate outlets. Good tilth is easily maintained by timely cultivation The hazard of soil blowing is moderate. In cultivated areas, soil blowing can be controlled under crop residue management and with buffer strips, stripcropping, and windbreaks.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

If drained, this soil is well suited to windbreak and environmental plantings. All climatically adapted species of trees and shrubs grow well. Unless drained, this soil is generally not suited to trees.

This soil is poorly suited to building site development and onsite waste disposal. The depth to the seasonal high water table and the duration are severe limitations. The Vallers soil in this survey ara is generally not used for building site development and related use.

This soil has good potential for wetland wildlife habitat and shallow water areas. Most areas are surrounded by soils having good potential for crops and vegetation in support of wetland wildlife. Capability subclass IVw.

58—Vallers loam, saline. This level, poorly drained, moderately saline soil is on low-lying flats and in swales on glacial till plains. Areas generally range from 5 to more than 100 acres and are usually long and narrow.

Typically, the surface layer is very dark gray loam about 8 inches thick. The underlying material to a depth of 60 inches is loam. It is dark grayish brown from 8 to 16 inches, light olive gray from 16 to 30 inches, olive gray from 30 to 42 inches, and dark grayish brown from 42 to 60 inches. In some places the soil is not saline. If this Vallers soil is associated with the Emrick, Heimdal, and Fram soils, it contains more silt and less clay than it does if associated with Barnes, Svea, and Hamerly soils.

Permeability is moderately slow, and available water capacity is moderate. Runoff is slow. Tilth is good. The organic-matter content and fertility are high.

Most areas are in pasture or hay. The potential is poor for cultivated crops, hay, and trees; poor for most engineering uses; and good for pasture.

This soil is generally not suited to flax and small grain. The seasonal high water table delays tillage and seeding in most years. The soil contains excess amounts of salts. Drainage is seldom feasible because of the lack of suitable outlets.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition and maintain the desirable native grasses.

This soil is generally not suited to windbreak and environmental plantings because of the seasonal high water table and salt content.

This soil is poorly suited to building site development and onsite waste disposal. The depth to the seasonal high water table and the duration are severe limitations. The Vallers soil in this survey area is generally not used for building site development and related use.

This soil has good potential for wetland wildlife habitat and shallow water areas. Most areas are near soils having good potential for crops and vegetation in support of wetland wildlife. Capability subclass Vw.

59—Hamerly-Tonka complex, 0 to 3 percent slopes. This map unit consists of the level and nearly level, somewhat poorly drained Hamerly soils and the level, poorly drained Tonka soils on glacial till plains. Areas generally range from 5 to more than 500 acres and are

about 50 percent Hamerly soil and about 25 percent Tonka soil. The Tonka soil is in shallow depressions. The Hamerly soil is in areas between these depressions.

Typically, the Hamerly soil has a surface layer of very dark gray loam about 7 inches thick. The underlying material from 7 to 16 inches is grayish brown loam, from 16 to 29 inches dark grayish brown and light brownish gray loam, from 29 to 38 inches light olive brown loam, and from 38 to 60 inches olive brown clay loam. In some places slopes are more than 3 percent.

Typically, the Tonka soil has a surface layer of very dark gray silt loam about 11 inches thick. The subsurface layer, from 11 to 24 inches, is dark gray silt loam. The subsoil, from 24 to 37 inches, is silty clay loam. It is very dark gray in the upper part and dark gray in the lower part. The underlying material to a depth of 60 inches is dark grayish brown clay loam.

About 20 to 30 percent of the map unit is included small areas of Vallers, Barnes, and Svea soils. The well drained Barnes soils are on the highest positions, the moderately well drained Svea soils are between the Barnes and Hamerly soils, and the poorly drained Vallers soils surround the Tonka soils.

Permeability is moderately slow in the Hamerly soil and slow in the Tonka soil. The available water capacity is high. Runoff is slow on the Hamerly soil and ponded on the Tonka soil. Tilth is good. The organic-matter content and fertility are high.

Most areas are farmed, but some are in pasture and hay. The potential is good for cultivated crops, hay, and pasture; good to fair for trees; and fair to poor for most engineering uses.

These soils are well suited to small grain and flax. The Tonka soil has a seasonal high water table, and ponding occurs in wet periods. Drainage increases the suitability of the Tonka soil if adequate outlets are available. Even if this soil is drained, however, spring tillage may be delayed by wetness. Good tilth can be maintained by timely cultivation. The hazard of soil blowing is moderate and can be controlled under crop residue management and with buffer srips, stripcropping, and windbreaks.

Keeping the soils in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

If drained, the Hamerly soil and the Tonka soil are well suited to windbreak and environmental plantings. All climatically adapted species of trees and shrubs grow well. Unless drained, the Tonka soil is generally not suited to trees.

The Hamerly soils are generally suited to building site development and onsite waste disposal. The wetness limitation, a problem for buildings, can be overcome by foundation drainage. The frost action limitation can be overcome by placing building footers below frost depth and by replacing road and street base material with material not subject to frost action. The slow percolation rate, a problem for septic tank absorption fields, can be overcome by enlarging the field.

The Tonka soil is poorly suited to building site development and onsite waste disposal but is well suited to sewage lagoons. The depth to the seasonal high water table and the duration and the ponding are severe limitations. The Tonka soil in this survey area is generally not used for building site development and related use.

Potential for wetland wildlife habitat and for shallow water areas is fair for the Hamerly soil and good for the Tonka soil. Most areas are surrounded by soils having good potential for crops and vegetation in support of wetland wildlife.

The included Barnes and Svea soils are generally better suited to most uses than these soils. The included Vallers soils have about the same limitations and potentials as the Tonka soils. Capability subclass IIe.

60—Emrick loam, 0 to 3 percent slopes. This level and nearly level, moderately well drained soil is on plane to concave areas on glacial till plains. Areas generally range from 5 to more than 100 acres and are usually irregular in shape.

Typically, the surface layer is black loam about 11 inches thick. The subsoil, from 11 to 22 inches, is loam. It is very dark grayish brown in the upper part and dark brown in the lower part. The underlying material to a depth of 60 inches is olive brown loam.

About 5 to 15 percent of the map unit is included small areas of Fram and Tonka soils. These areas are generally less than 3 acres. The poorly drained Tonka soils are in shallow depressions, and the somewhat poorly drained Fram soils surround the depressions.

Permeability is moderate, and available water capacity is high. Runoff is medium. Tilth is good. The organic-matter content and fertility are high.

Most areas are farmed. The potential is good for cultivated crops, trees, pasture, and hay and for most engineering uses.

This soil is well suited to small grain and flax. The hazard of soil blowing is moderate and can be controlled under crop residue management and with stripcropping, buffer strips, and windbreaks.

Keeping the soil in hay or pasture is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

This soil is well suited to windbreak and environmental plantings. All climatically adapted species of trees and shrubs grow well.

This soil is well suited to building site development and to onsite waste disposal. The frost action limitation for roads and streets can be overcome by replacing the base material with material not subject to frost action. The seepage problem for sewage lagoons can be overcome by using clay blankets or similar material to seal the lagoons.

This soil has poor potential for wetland wildlife habitat. It has good potential for openland wildlife habitat and for grain and seed crops.

The included Fram and Tonka soils are wetter than this soil. Capability subclass IIe.

60B—Emrick loam, 3 to 6 percent slopes. This undulating, moderately well drained soil is on plane to concave areas on glacial till plains. Areas generally range from 3 to more than 20 acres and are irregular in shape.

Typically, the surface layer is black loam about 11 inches thick. The subsoil, from 11 to 22 inches, is loam. It is very dark grayish brown in the upper part and dark brown in the lower part. The underlying material to a depth of 60 inches is olive brown loam. In some places the surface layer is thinner.

About 5 to 15 percent of the map unit is included small areas of Fram and Tonka soils. These areas are generally less than 3 acres. The poorly drained Tonka soils are in shallow depressions, and the somewhat poorly drained Fram soils surround the depressions.

Permeability is moderate, and available water capacity is high. Runoff is medium. Tilth is good. The organic-matter content and fertility are high.

Most areas are farmed. The potential is good for crops, trees, pasture, and hay and for most engineering uses.

This soil is well suited to small grain and flax. The hazard of soil blowing is moderate and can be controlled under crop residue management and with stripcropping, buffer strips, and windbreaks.

Keeping the soils in hay or pasture is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

This soil is well suited to windbreak and environmental plantings. All climatically adapted species of trees and shrubs grow well.

This soil is well suited to building site development and onsite waste disposal. The frost action limitation for roads and streets can be overcome by replacing the base material with material not subject to frost action. The seepage problem for sewage lagoons can be overcome by using clay blankets or similar material to seal the lagoons.

This soil has poor potential for wetland wildlife habitat. It has good potential for openland wildlife habitat and for grain and seed crops.

The included Fram and Tonka soils are wetter than this soil. Capability subclass IIe.

61B—Heimdal and Emrick very stony loams, 3 to 9 percent slopes. This map unit consists of the undulating and gently rolling, well drained Heimdal soils and the moderately well drained Emrick soils on glacial till plains. Areas generally range from 5 to more than 150 acres and can be either all Heimdal soil, all Emrick soil, or both. The Heimdal soils are on convex side slopes, and the Emrick soils are commonly on concave side slopes. The amount of stone cover is about 3 to 15 percent.

Typically, the Heimdal soil has a surface layer of black loam about 8 inches thick. The subsoil, from 8 to 26 inches, is loam. It is very dark brown in the upper part, dark grayish brown in the middle part, and light olive brown in the lower part. The underlying material to a depth of 60 inches is light olive brown loam. In some places the surface layer is thinner, and in others the stone cover is more than 15 percent.

Typically, the Emrick soil has a surface layer of black loam about 11 inches thick. The subsoil, from 11 to 22 inches, is loam. It is very dark grayish brown in the upper part and dark brown in the lower part. The underlying material to a depth of 60 inches is olive brown loam.

Permeability is moderate, and available water capacity is high. Runoff is slow on the Emrick soil and medium on the Heimdal soil. The organic-matter content and fertility are high.

Most areas are in pasture. The potential is poor for crops, hay, and windbreaks; good for pasture; and fair for most engineering uses.

These soils are not suited to cultivated crops and hay because of stoniness.

These soils are suited to native grass pasture. Keeping them in pasture is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition and maintain the desirable native grass species.

These soils are poorly suited to windbreak and environmental plantings. Specialized or scalp plantings for wildlife habitat, recreation, or beautification can be made but require intensive management. The best adapted species and the most favorable sites should be chosen to insure success.

These soils are well suited to building site development and onsite waste disposal. The frost action limitation for roads and streets can be overcome by replacing the base material not subject to frost action. The seepage problem for sewage lagoons can be overcome by using clay blankets or similar material to seal the lagoons. The stoniness limitation can be overcome by removing the large stones.

These soils have very poor potential for wetland wildlife habitat. The potential is fair for rangeland wildlife habitat. Capability subclass VIs.

62—Emrick-Heimdal loams, 0 to 3 percent slopes. This map unit consists of the level and nearly level, moerately well drained Emrick soils and well drained Heimdal soils on glacial till plains. Areas generally range from 5 to about 200 acres and are 60 percent Emrick soils and 25 percent Heimdal soils. The Heimdal soils are on the higher lying convex side slopes, and the Emrick soils are on lower lying side slopes and in swales.

Typically, the Emrick soil has a surface layer of black loam about 11 inches thick. The subsoil, from 11 to 22 inches, is loam. It is very dark grayish brown in the upper part and dark brown in the lower part. The underlying material to a depth of 60 inches is olive brown loam.

Typically, the Heimdal soil has a surface layer of black loam about 8 inches thick. The subsoil, from 8 to 26 inches, is loam. It is very dark brown in the upper part, dark grayish brown in the middle part, and light olive brown in the lower part. The underlying material to a depth of 60 inches is light olive brown loam. In some places the surface layer is thinner.

About 15 percent of the map unit is included small areas of Fram and Tonka soils that are generally less than 3 acres. The poorly drained Tonka soils are in depressions, and the Fram soils surround the depressions.

Permeability is moderate, and available water capacity is high. Runoff is slow on the Emrick soil and medium on the Heimdal soil. Tilth is good. The organic-matter content and fertility are high.

Most areas are farmed. The potential is good for cultivated crops, trees, pasture, and hay and for most engineering uses.

These soils are well suited to small grain and flax. The hazard of soil blowing is moderate and can be controlled under crop residue management and with stripcropping, buffer strips, and windbreaks.

Keeping the soils in hay or pasture is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

These soils are well suited to windbreak and environmental plantings. All climatically adapted species of trees and shrubs grow well on the Emrick soils, but those species with high moisture requirements should not be planted on the Heimdal soils.

These soils are well suited to building site development and onsite waste disposal. The frost action limitation for roads and streets can be overcome by replacing the base material with material not subject to frost action. The seepage problem for sewage lagoons can be overcome by using clay blankets or similar material to seal the lagoons.

These soils have poor to very poor potential for wetland wildlife habitat. They have good potential for openland wildlife and for grain and seed crops.

The included Fram and Tonka soils are wetter than these soils. Capability subclass IIe.

62B—Emrick-Heimdal loams, 3 to 6 percent slopes. This map unit consists of the undulating, moderately well drained Emrick soils and the well drained Heimdal soils on glacial till plains. Areas generally range from 5 to more than 500 acres and are about 55 percent Emrick soils and 30 percent Heimdal soils. The Heimdal soils are on the higher lying, convex side slopes. The Emrick soils are on lower lying side slopes and in swales.

Typically, the Emrick soil has a surface layer of black loam about 11 inches thick. The subsoil, from 11 to 22 inches, is loam. It is very dark grayish brown in the upper part and dark brown in the lower part. The underlying material to a depth of 60 inches is olive brown loam.

Typically, the Heimdal soil has a surface layer of black loam about 8 inches thick. The subsoil, from 8 to 26 inches, is loam. It is very dark brown in the upper part, dark grayish brown in the middle part, and light olive brown in the lower part. The underlying material to a depth of 60 inches is light olive brown loam. In some places the surface layer is thinner and lighter colored.

About 15 percent of the map unit is included small areas of Fram and Tonka soils. These areas are generally less than 3 acres. The poorly drained Tonka soils are in depressions, and the Fram soils surround the depressions.

Permeability is moderate, and available water capacity is high. Runoff is slow on the Emrick soil and medium on the Heimdal soil. Tilth is good. The organic-matter content and fertility are high.

Most areas are farmed. The potential is good for cultivated crops, trees, pasture, and hay and for most engineering uses.

These soils are well suited to small grain and flax. The hazard of soil blowing is moderate and can be controlled under crop residue management and with stripcropping, buffer strips, and windbreaks.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

These soils are well suited to windbreaks and environmental plantings. All climatically adapted trees and shrubs grow well on the Emrick soil, but those species with high moisture requirements should not be planted on the Heimdal soils.

These soils are well suited to building site development and onsite waste disposal. The frost action limitation for roads and streets can be overcome by replacing the base material with material not subject to frost action. The seepage problem for sewage lagoons can be overcome by using clay blankets or similar material to seal the lagoons.

These soils have very poor potential for wetland wildlife habitat. They have good potential for openland wildlife and for grain and seed crops.

The included Fram and Tonka soils are wetter than these soils. Capability subclass IIe.

62C—Heimdal-Emrick loams, 6 to 9 percent slopes. This map unit consists of the gently rolling, well drained Heimdal soils and the moderately well drained Emrick soils on glacial till plains. Areas generally range from 10 to about 150 acres and are about 50 percent Heimdal soils and about 10 percent Emrick soils. The Heimdal soils are on the upper parts of side slopes, ridges, and tops of knolls. Emrick soils are on the lower parts of side slopes and in swales.

Typically, the Heimdal soil has a surface layer of black loam about 8 inches thick. The subsoil, from 8 to 26 inches, is loam. It is very dark brown in the upper part, dark grayish brown in the middle part, and light olive brown in the lower part. The underlying material to a depth of 60 inches is light olive brown loam (fig. 11). In some places the surface layer is thinner and lighter colored.

Typically, the Emrick soil has a surface layer of black loam about 11 inches thick. The subsoil, from 11 to 22 inches, is loam. It is very dark grayish brown in the upper part and dark brown in the lower part. The underlying material to a depth of 60 inches is olive brown loam.

Permeability is moderate, and available water capacity is high. Runoff is slow on the Emrick soil and medium on the Heimdal soil. Tilth is good. The organic-matter content and fertility are high.

Most areas are farmed. The potential is fair for cultivated crops; good for pasture, hay, and trees; and good for most engineering uses.

These soils are suited to small grain and flax. The hazard of soil blowing is moderate and can be controlled

under crop residue management and with stripcropping, buffer strips, and windbreaks.

Keeping the soils in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

These soils are well suited to windbreak and environmental plantings. All climatically adapted species of trees and shrubs grow well on the Emrick soil, but those species with high moisture requirements should not be planted on the Heimdal soils.

These soils are well suited to building site development and onsite waste disposal. Slope severely limits the potential storage capacity for sewage lagoons. The frost action limitation for roads and streets can be overcome by replacing the base material with material not subject to frost action.

These soils have very poor potential for wetland wildlife habitat. They have fair potential for openland wildlife habitat and for grain and seed crops. Capability subclass IIIe.

63D—Esmond-Heimdal loams, 9 to 15 percent slopes. This map unit consists of the rolling, well drained Esmond soils and Heimdal soils on glacial till plains. Areas generally range from 10 to more than 300 acres and are about 45 percent Esmond and about 40 percent Heimdal soils. The Esmond soils are on the steeper, upper parts of side slopes and ridgecrests. The Heimdal soils are on the lower parts of side slopes.

Typically, the Esmond soil has a surface layer of very dark grayish brown loam about 7 inches thick. The underlying material to a depth of 60 inches is loam. The upper part is grayish brown and the lower part is dark grayish brown.

Typically, the Heimdal soil has a surface layer of black loam about 8 inches thick. The subsoil, from 8 to 26 inches, is loam. It is very dark brown in the upper part, dark grayish brown in the middle part, and light olive brown in the lower part. The underlying material to a depth of 60 inches is light olive brown loam.

About 10 to 20 percent of the map unit is included small areas of the moderately well drained Emrick soils. These areas are generally less than 3 acres. They are in swales.

Permeability is moderate, and available water capacity is high. Runoff is rapid. The organic-matter content is high in the Heimdal soil and moderate in the Esmond soil. Fertility is low in the Esmond soil and high in the Heimdal soil.

Most areas are in pasture or hay. The potential is poor for cultivated crops and trees, good for pasture and hay, and fair for most engineering uses.

These soils are generally not suited to small grain and flax because of slope. They tend to be droughty.

Keeping the soils in native grass, pasture, or hay is effective in controlling erosion. They are well suited to these uses. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition and maintain the desirable native grass species.

These soils are poorly suited to windbreak and environmental plantings. Special or scalp plantings for wildlife habitat, recreation, or beautification can be made but require intensive management. The best adapted species and the most favorable sites should be chosen to insure success.

These soils are suited to building site development and onsite waste disposal. Slope severely limits the potential storage capacity for sewage lagoons. The frost action limitation for roads and streets can be overcome by replacing the base material with material not subject to frost action. The slope limitation for building sites can be overcome by cut and fill operations. Erosion, a hazard where the vegetative cover has been removed by cut and fill operations, can be overcome by the timely reestablishment of the cover.

These soils have very poor potential for wetland wildlife habitat. The potential is fair for openland wildlife and for grasses and legumes.

The included Emrick soils are wetter than these soils. Capability subclass VIe.

63F—Esmond-Heimdal loams, 15 to 35 percent slopes. This map unit consists of the hilly and steep, well drained Esmond soils and Heimdal soils on glacial till plains. Areas generally range from 10 to about 250 acres and are about 55 percent Esmond soils and about 35 percent Heimdal soils. The Esmond soils are on the steeper, upper side slopes and ridgecrests. The Heimdal soils are on the lower, less steep side slopes.

Typically, the Esmond soil has a surface layer of very dark grayish brown about 7 inches thick. The underlying material to a depth of 60 inches is loam. The upper part is grayish brown and the lower part is dark grayish brown.

Typically, the Heimdal soil has a surface layer of black loam about 8 inches thick. The subsoil, from 8 to 26 inches, is loam. It is very dark brown in the upper part, dark grayish brown in the middle part, and light olive brown in the lower part. The underlying material, to a depth of 60 inches, is light olive brown loam.

About 5 to 15 percent of the map unit is included small areas of the moderately well drained Emrick soils. These areas are generally less than 3 acres. They are in swales.

Permeability is moderate, and available water capacity is high. Runoff is rapid. The organic-matter content is high in the Heimdal soil and moderate in the Esmond soil. Fertility is low in the Esmond soil and high in the Heimdal soil.

Most areas are in native grass pasture. The potential is poor for cultivated crops, trees, and hay; good for pasture; and poor for most engineering uses.

These soils are not suited to small grain and flax because of the excessive slope.

Keeping the soils in native grass pasture is effective in controlling erosion. They are suited to this use. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition and maintain the desirable native grass species.

These soils are poorly suited to windbreak and environmental plantings. Special or scalp plantings for wildlife habitat, recreation, or beautification can be made but require intensive management. The best adapted species and the most favorable sites should be chosen to insure success.

These soils are poorly suited to building site development and onsite waste disposal. The slope limitation is severe and difficult to overcome.

The included Emrick soils are wetter than these soils. Capability subclass VIe.

64C—Heimdal-Esmond loams, 3 to 9 percent slopes. This map unit consists of the undulating and gently rolling, well drained Heimdal and Esmond soils on glacial till plains. Areas generally range from 10 to more than 150 acres and are about 55 percent Heimdal soils and about 35 percent Esmond soils. The Heimdal soils are on side slopes, and the Esmond soils are on ridgecrests and on the tops of knolls (fig. 12).

Typically, the Heimdal soil has a surface layer of black loam about 8 inches thick. The subsoil, from 8 to 26 inches, is loam. It is very dark brown in the upper part, dark grayish brown in the middle part, and light olive brown in the lower part. The underlying material to a depth of 60 inches is light olive brown loam.

Typically, the Esmond soil has a surface layer of very dark grayish brown loam about 7 inches thick. The underlying material to a depth of 60 inches is loam. The upper part is grayish brown, and the lower part is dark grayish brown.

About 5 to 15 percent of the map unit is included small areas of the moderately well drained Emrick soils, generally less than 3 acres. They are in swales and on lower side slopes.

Permeability is moderate, and available water capacity is high. Runoff is rapid on the Esmond soil and medium on the Heimdal soil. Tilth is fair. The organic-matter content is high in the Heimdal soil and moderate in the Esmond soil. Fertility is low in the Esmond soil and high in the Heimdal soil.

Many areas are farmed. A few are in hay or pasture. The potential is fair for cultivated crops and trees, good for hay and pasture, and good for most engineering uses.

These soils are suited to small grain and flax. If cultivated, the Esmond soils are limy at the surface and need to be carefully fertilized. The hazard of soil blowing is moderate and can be controlled under crop residue management and with stripcropping and buffer strips.

Keeping the soils in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

These soils are suited to windbreak and environmental plantings, although the Heimdal soils are better suited to this use than the Esmond soils. All climatically adapted species of trees and shrubs but those that require much moisture grow on these soils.

These soils are suited to building site development and to onsite waste disposal. The frost action limitation for roads and streets can be overcome by replacing the base material with material not subject to frost action. The seepage problem for sewage lagoons can be overcome by using clay blankets or similar material to seal the lagoons.

These soils have very poor potential for wetland wildlife habitat. They have good potential for openland wildlife habitat and for grain and seed crops.

The included Emrick soils are wetter than these soils. Capability subclass IVe.

65—Fram loam, 0 to 3 percent slopes. This level and nearly level, somewhat poorly drained soil is in swales on glacial till plains adjacent to depressions. Areas generally range from 3 to more than 100 acres.

Typically, the surface layer is very dark gray loam about 8 inches thick. The underlying material to a depth of 60 inches is loam. It is grayish brown in the upper part and light olive brown in the middle and lower parts. In some places slopes are more than 3 percent.

About 20 percent or less of the map unit is included small areas of the poorly drained Vallers and Tonka soils and the moderately well drained Emrick soils. These areas are generally less than 3 acres. The Tonka soils are in shallow depressions. The Vallers soils surround the depressions. The Emrick soils are on slightly higher landscape positions above the Fram soils.

Permeability is moderate, and available water capacity is high. Runoff is slow. Tilth is good. The organic-matter content and fertility are high.

Most areas are farmed. The potential is good for cultivated crops, trees, pasture, and hay and fair for most engineering uses.

This soil is well suited to small grain and flax, but the seasonal high water table delays seeding and tillage in spring. Good tilth is easily maintained. The hazard of soil blowing is moderate and can be controlled under crop residue management and with buffer strips, stripcropping, and windbreaks.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

This soil is well suited to windbreak and environmental plantings. All climatically adapted species of trees and shrubs grow well.

This soil is suited to building site development and onsite waste disposal. The wetness limitation, a problem for buildings, can be overcome by foundation drainage. The frost action limitation for roads and streets can be overcome by replacing base material with material not subject to frost action.

This soil has fair potential for wetland wildlife habitat and for shallow water areas. Most areas are surrounded by soils having good potential for crops and vegetation in support of wetland wildlife.

The included Vallers and Tonka soils are wetter than this soil and have good potential for wetland wildlife

habitat. The included Emrick soils are better drained and are better suited to most uses than this soil. Capability subclass IIe.

66—Gardena silt loam, 0 to 3 percent slopes. This level and nearly level, moderately well drained soil is on glacial lake plains. Areas generally range from 30 to more than 250 acres.

Typically, the surface layer is black silt loam about 20 inches thick. The subsoil, from 20 to 34 inches, is very dark grayish brown silt loam. The underlying material from 34 to 42 inches is dark grayish brown silt loam and from 42 to 60 inches light olive brown very fine sandy loam. In some places the soil contains some coarse fragments.

About 10 percent of the map unit is included small areas of the well drained Eckman soils, the somewhat poorly drained Glyndon soils, and the poorly drained Tonka soils. These areas are generally less than 3 acres. The Eckman soils are on slight rises, the Tonka soils are in depressions, and the Glyndon soils surround the depression.

Permeability is moderate, and available water capacity is high. Runoff is slow. Tilth is good. The organic-matter content and fertility are high.

Most areas are farmed. The potential is good for cultivated crops, hay, pasture, and trees and for most engineering uses.

This soil is well suited to small grain (fig. 13) and flax. The hazard of soil blowing is moderate and is easily controlled under crop residue management and with buffer strips, stripcropping, or windbreaks. Good tilth is easy to maintain.

Keeping the soil in hay or pasture is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

This soil is well suited to windbreak and environmental plantings. All climatically adapted species of trees and shrubs grow well.

This soil is suited to building site development and onsite waste disposal. The wetness limitation for buildings can be overcome by foundation drainage. The frost action limitation for roads and streets can be overcome by replacing base material with material not subject to frost action. The seepage limitation for sewage lagoons can be overcome by using clay blankets or similar material to seal the lagoon.

This soil has poor potential for wetland wildlife habitat. The potential is good for openland wildlife habitat and for grain and seed crops.

The included Tonka and Glyndon soils are wetter than this soil. The Tonka soils have good potential for wetland wildlife habitat. The included Eckman soils are better drained. Capability subclass IIe.

67B—Gardena silt loam, 3 to 6 percent slopes. This undulating, moderately well drained soil is on glacial lake plains. Areas generally range from 5 to more than 50 acres.

Typically, the surface layer is black silt loam about 20 inches thick. The subsoil, from 20 to 34 inches, is very dark grayish brown silt loam. The underlying material from 34 to 42 inches is dark grayish brown silt loam and from 42 to 60 inches light olive brown very fine sandy loam.

About 25 percent of the map unit is included small areas of the well drained Eckman soils. These areas are generally less than 3 acres. They are on slight rises and upper slopes.

Permeability is moderate, and available water capacity is high. Runoff is slow. Tilth is good. The organic-matter content and fertility are high.

Most areas are farmed. The potential is good for cultivated crops, hay, pasture, and trees and for most engineering uses.

This soil is well suited to small grain and flax. Good tilth is easy to maintain. The hazard of soil blowing is moderate and is easily controlled under crop residue management and with buffer strips, stripcropping, or windbreaks.

Keeping the soil in hay or pasture is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

This soil is well suited to windbreak and environmental plantings. All climatically adapted species of trees and shrubs grow well.

This soil is suited to building site development and onsite waste disposal. The wetness limitation for buildings can be overcome by foundation drainage. The frost action limitation for roads and streets can be overcome by replacing base material with material not subject to frost action. The seepage limitation for sewage lagoons can be overcome by using clay blankets or similar material to seal the lagoons.

This soil has very poor potential for wetland wildlife habitat. The potential is good for openland wildlife habitat and for grain and seed crops.

The included Eckman soils are better drained. Capability subclass IIe.

68C—Eckman silt loam, 6 to 9 percent slopes. This gently rolling, well drained soil is on glacial lake plains. Areas generally range from 10 to more than 50 acres.

Typically, the surface layer is black silt loam about 9 inches thick. The subsoil, from 8 to 16 inches, is dark grayish brown silt loam. The underlying material from 16 to 29 inches is dark grayish brown very fine sandy loam and from 29 to 60 inches olive very fine sand (fig. 14).

About 30 percent or less of the map unit is included small areas of the moderately well drained Gardena soils. These areas are generally less than 3 acres. They are on lower slopes and in swales.

Permeability is moderate, and available water capacity is high. Runoff is medium. Tilth is good. The organic-matter content and fertility are high.

Most areas are farmed. The potential is fair for crops; good for hay, pasture, and trees; and good for most engineering uses.

This soil is suited to small grain and flax. Good tilth is easy to maintain. The hazard of soil blowing is moderate and can be controlled under crop residue management and with buffer strips, stripcropping, windbreaks, and contour tillage.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

This soil is well suited to windbreak and environmental plantings. All climatically adapted species of trees and shrubs grow well.

This soil is suited to building site development and to most types of onsite waste disposal. Slope severely reduces the potential storage capacity of sewage lagoons. The frost action limitation for streets and roads can be overcome by replacing base material with material not subject to frost action.

This soil has very poor potential for wetland wildlife habitat. The potential is good for openland wildlife and for grasses and legumes.

The included Gardena soils are wetter than this soil and have a wetness limitation. Capability subclass IIIe.

70—Glyndon silt loam, 0 to 3 percent slopes. This level and nearly level, somewhat poorly drained soil is on broad flats and the surrounding depressions on glacial lake plains. Areas generally range from 5 to more than 100 acres.

Typically, the surface layer is black silt loam about 7 inches thick. The underlying material from 7 to 21 inches is gray silt loam, from 21 to 27 inches dark gray silt loam, from 27 to 33 inches light gray and pale olive silt loam, from 33 to 45 inches light olive gray very fine sandy loam, and from 45 to 60 inches grayish brown sandy clay loam.

About 5 to 10 percent of the map unit is included small areas of the poorly drained Tonka soils in depressions. These areas are generally less than 3 acres.

Permeability is moderately rapid, and available water capacity is high. Runoff is slow. Tilth is good. The organic-matter content and fertility are high.

Most areas are farmed. The potential is good for cultivated crops, pasture, hay, and trees, and for most engineering uses.

This soil is well suited to small grain and flax. The seasonal high water table delays tillage and seeding in spring. Good tilth is easily maintained. The hazard of soil blowing is moderate and can be controlled under crop residue management and with buffer strips, stripcropping, and windbreaks. Keeping the soil in pasture and hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

This soil is well suited to windbreak and environmental plantings. All climatically adapted trees and shrubs grow well.

This soil is suited to building site development and onsite waste disposal. The caving of cutbanks, a problem in shallow excavations, can be overcome by shoring trench walls. The frost action limitation for buildings and for roads and streets can be overcome by placing footers below frost depth and by replacing road and street base material with material not subject to frost action. The seasonal high water table, a problem for buildings, can be overcome by foundation drainage. The seepage, a limitation for sewage lagoons, can be overcome by using clay blankets or similar material to seal the lagoon.

This soil has poor potential for wetland wildlife habitat. The potential is good for openland wildlife and for grain and seed crops.

The included Tonka soils are wetter than this soil. They are less suited to most uses than this soil but do have good potential for wetland wildlife habitat. Capability subclass IIe.

71—Gardena silt loam, clayey substratum, 0 to 3 percent slopes. This level and nearly level, moderately well drained soil is on glacial lake plains. Areas generally range from 50 to more than 400 acres.

Typically, the surface layer is black silt loam about 8 inches thick. The subsoil, from 8 to 17 inches, is very dark grayish brown silt loam. The underlying material, from 17 to 40 inches, is light olive brown very fine sandy loam, and from 40 to 60 inches dark grayish brown and olive brown silty clay. In some places the underlying material is silt loam.

About 10 to 15 percent of the map unit is included small areas of the well drained Eckman, the somewhat poorly drained Glyndon, and the poorly drained Tonka soils. These areas are generally less than 3 acres. The Eckman soils are on slight rises, the Tonka soils are in shallow depressions, and the Glyndon soils surround the depressions.

Permeability is moderate above 40 inches and moderately slow below 40 inches. Available water capacity is high. Runoff is slow. Tilth is good. The organic-matter content and fertility are high.

Most areas are farmed. The potential is good for cultivated crops, pasture, hay, and trees and for most engineering uses.

This soil is well suited to small grain and flax. The hazard of soil blowing is moderate and is easily controlled under crop residue management and with buffer strips, stripcropping, or windbreaks.

Keeping the soil in pasture and hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

This soil is well suited to windbreak and environmental plantings. All climatically adapted species of trees and shrubs grow well.

This soil is suited to building site development and onsite waste disposal. The frost action limitation for buildings and for roads and streets can be overcome by placing footers below frost depth and by replacing local road and street base material with material not subject to frost action. The slow percolation rate, a limitation for

septic tank absorption fields, can be overcome by enlarging the field.

The included Eckman soil is better drained than this soil. The Glyndon and Tonka soils are wetter.

This soil has poor potential for wetland wildlife habitat. The potential is good for openland wildlife habitat and for grain and seed crops. Capability subclass IIe.

72—Glyndon silt loam, saline, 0 to 3 percent slopes. This level and nearly level, somewhat poorly drained, moderately saline soil is on broad flats and surrounding depressions on glacial lake plains. Areas generally range from 10 to more than 200 acres.

Typically, the surface layer is black silt loam about 7 inches thick. The underlying material from 7 to 21 inches is gray silt loam, from 21 to 27 inches dark gray silt loam, from 27 to 33 inches light gray and pale olive silt loam, from 33 to 45 inches light olive gray very fine sandy loam, and from 45 to 60 inches grayish brown sandy clay loam. In some places the soil is not saline, and in others it is only slightly saline.

About 5 to 10 percent of the map unit is included small areas of the poorly drained Tonka soils in depressions. These areas are generally less than 3 acres.

Permeability is moderate, and available water capacity is high. Runoff is slow. Tilth is good. The organic-matter content and fertility are high.

Most areas are farmed. The potential is fair for cultivated crops, good for pasture and hay, poor for trees, and fair for most engineering uses.

This soil is suited to small grain and flax. Surface evaporation from summer fallow fields tends to increase the salinity in the surface layer. The hazard of soil blowing is moderate and can be controlled under crop residue management and with buffer strips and stripcropping.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

This soil is generally not suited to windbreak and environmental plantings because of the salt content.

This soil is suited to building site development and to onsite waste disposal. The caving of cutbanks, a problem in shallow excavation, can be overcome by shoring trench walls. The frost action limitation for buildings and for roads and streets can be overcome by placing footers below frost depth and by replacing road and street base material with material not subject to frost action. The seasonal high water table, a problem for buildings, can be overcome by foundation drainage. The seepage, a limitation for sewage lagoons, can be overcome by using clay blankets or similar material to seal the lagoon.

This soil has poor potential for wetland wildlife habitat. The potential is fair for openland wildlife habitat and for grain and seed crops.

The included Tonka soils are wetter than this soil. They are less suited to most uses than this soil but have good potential for wetland wildlife habitat. Capability subclass IIIw.

73—Borup and Fossum soils, wet. This map unit consists of the level, very poorly drained Borup and Fossum soils in depressions on glacial lake plains and outwash plains. Areas generally range from 5 to more than 150 acres and may be either all Borup soil, all Fossum soil, or both.

Typically, the Borup soil has a surface layer of silt loam about 11 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The underlying material from 11 to 16 inches is gray silt loam, from 16 to 29 inches grayish brown silt loam, from 29 to 36 inches gray silty clay loam, and from 36 to 60 inches gray silt loam.

Typically, the Fossum soil has a surface layer about 22 inches thick. It is black fine sandy loam in the upper part, very dark gray loamy fine sand in the middle part, and very dark grayish brown loamy fine sand in the lower part. It ranges from fine sandy loam to loamy fine sand in texture. The underlying material to a depth of 60 inches is grayish brown fine sand. In some places the soil is saline.

Permeability is moderately rapid in the Borup soil and rapid in the Fossum soil. The available water capacity is high in the Borup soil and low in the Fossum soil. Runoff is very slow. The organic-matter content is high in the Borup soil and moderate in the Fossum soil. Fertility is high in the Borup soil and low in the Fossum soil.

Most areas are in hay or pasture. The potential is poor for cultivated crops and trees, good for native grass pasture, fair for hay, and poor for most engineering uses.

These soils are not suited to cultivated crops because of long periods of wetness. Drainage is generally not feasible because of the lack of suitable outlets.

These soils are suited to native grass pasture. Keeping the soils in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition and maintain the desirable native grass species. In many years some areas are too wet to support machinery, and hay cannot be harvested.

These soils are generally not suited to windbreak and environmental plantings because of wetness and salt content.

These soils are generally not suited to building site development and to onsite waste disposal. The seasonal high water table, the ponding, the lack of suitable drainage outlets, and the seepage require costly design, installation, and maintenance. The Borup and Fossum soils in this survey area are not used for building sites and most related uses.

These soils have good potential for wetland wildlife habitat and for shallow water areas. They are generally located near soils having good potential for grain and seed crops in support of wetland wildlife. Capability subclass Vw.

74—Borup silt loam. This level, poorly drained soil is in low areas on glacial till plains. Areas generally range from 5 to more than 50 acres.

Typically, the surface layer is silt loam about 11 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The underlying material from 11 to 16 inches is gray silt loam, from 16 to 29 inches grayish brown silt loam, from 29 to 36 inches gray silty clay loam, and from 36 to 60 inches gray silt loam. In some places the soil is moderately saline, and in others it is very poorly drained.

Permeability is moderately rapid, and available water capacity is high. Runoff is very slow. Tilth is good. The organic-matter content and fertility are high.

Most areas are in grass pasture and hay. The potential is poor for cultivated crops and trees, good for native pasture and hay, and poor for most engineering uses.

This soil is suited to small grain and flax if drained, but drainage is seldom feasible because of the lack of suitable outlets. The hazard of soil blowing is moderate and can be controlled under crop residue management and with stripcropping, buffer strips, and windbreaks.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition and maintain the desirable native grass species.

If drained, this soil is well suited to windbreaks and environmental plantings. All climatically adapted trees and shrubs grow well. Unless drained, this soil is generally not suited to trees.

This soil is poorly suited to building site development and to onsite waste disposal. The wetness limitation, the lack of adequate drainage outlets, and the seepage require costly design, installation, and maintenance. The Borup soil in this survey area is not used for building site development and related use.

This soil has good potential for wetland wildlife habitat and for shallow water areas. It is generally located near soils having good potential for grain and seed crops in support of wetland wildlife. Capability subclass IVw.

75—Borup silt loam, saline. This level, poorly drained, moderately saline soil is in low areas on glacial lake plains. Areas generally range from 5 to more than 100 acres.

Typically, the surface layer is silt loam about 11 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The underlying material from 11 to 16 inches is gray silt loam, from 16 to 29 inches grayish brown silt loam, from 29 to 36 inches gray silty clay loam, and from 36 to 60 inches gray silt loam. In some places the soil is not saline, and in others it is very poorly drained.

Permeability is moderately rapid, and available water capacity is moderate. Runoff is very slow. The organic-matter content and fertility are high.

Most areas are in native grass pasture or hay. The potential is poor for cultivated crops and trees, good for native grass pasture, and poor for most engineering uses.

This soil is generally not suited to small grain and flax because of wetnesss. Drainage is seldom feasible because of the lack of suitable outlets.

Keeping the soil in pasture is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition and maintain the desirable native grass species.

This soil is generally not suited to windbreak and environmental plantings because of wetness and salinity.

This soil is poorly suited to building site development and onsite waste disposal. The wetness limitation, the lack of suitable drainage outlets, and the seepage require costly design, installation, and maintenance. The Borup soil in this survey area is generally not used for building site development and related use.

This soil has good potential for wetland wildlife habitat and shallow water areas. Capability subclass Vw.

78—Emrick-Cathay loams, 0 to 3 percent slopes. This map unit consists of the level and nearly level, moderately well drained Emrick and Cathay soils on glacial till plains. Areas generally range from 10 to more than 150 acres and are about 40 percent Emrick soils and about 35 percent Cathay soils. The relief of this unit is uniform. The Cathay soils have a dense subsoil that is affected by large amounts of sodium. The Emrick soils, however, do not have large amounts of sodium in the subsoil.

Typically, the Emrick soil has a surface layer of black loam about 11 inches thick. The subsoil, from 11 to 22 inches, is loam. It is very dark grayish brown in the upper part and dark brown in the lower part. The underlying material to a depth of 60 inches is olive brown loam.

Typically, the Cathay soil has a surface layer of black loam about 7 inches thick. The surface layer, from 7 to 10 inches, is very dark gray loam. The subsoil, from 10 to 24 inches, is clay loam. It is very dark brown in the upper part and very dark gray in the lower part. The underlying material to a depth of 60 inches is loam. It is light brownish gray in the upper part and light olive brown in the middle and lower parts.

About 25 percent of the map unit is included small areas of Heimdal soils, which are generally less than 3 acres. They are well drained and are on slight rises.

Permeability is moderate in the Emrick soil and slow in the Cathay soil. The available water capacity is high in the Emrick soil and moderate in the Cathay soil. Runoff is slow. Tilth is good in the Emrick soil and fair in the Cathay soil. The organic-matter content is high in the Emrick soil and moderate in the Cathay soil. Fertility is high.

Most areas are farmed. The potential is good for cultivated crops, trees, pasture, and hay, and for most engineering uses.

This unit is suited to small grain and flax. The dense subsoil of the Cathay soils limits root and moisture penetration. Tilth can be maintained or improved by timely cultivation, by maintaining the organic-matter content, and by stubble mulching to conserve moisture. The hazard of soil bowing is moderate and can be controlled under crop residue management and with stripcropping, buffer strips, and windbreaks.

Keeping the soils in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep pastures in good condition.

These soils are suited to windbreak and environmental plantings. Many of the climatically adapted species of trees and shrubs grow well on the Cathay soils. All grow well on the Emrick soils.

These soils are suited to building site development and onsite waste disposal. The frost action, a limitation for roads and streets, can be overcome by replacing base material with material not subject to frost action. The shrink-swell limitation can be overcome by special design to withstand stress. The slow percolation limitation, a problem for septic tank absorption fields, can be overcome by enlarging the field. The seepage, a problem for sewage lagoons, can be overcome by using clay blankets to seal the lagoons.

These soils have poor potential for wetland wildlife habitat. The potential is good to fair for openland wildlife habitat and for grain and seed crops.

The included Heimdal soils are better drained than these soils and are better suited to most uses. Capability subclass IIe.

80—Cathay loam, 0 to 3 percent slopes. This level and nearly level, moderately well drained soil is on glacial till plains. Areas generally range from 10 to more than 200 acres.

Typically, the surface layer is black loam about 7 inches thick. The subsurface layer, from 7 to 10 inches, is very dark gray loam. The subsoil, from 10 to 24 inches, is clay loam. It is very dark brown in the upper part and very dark gray in the lower part. The underlying material to a depth of 60 inches is loam. It is light brownish gray in the upper part and light olive brown in the middle and lower parts.

About 15 to 20 percent of the map unit is included small areas of Emrick soils. These areas are generally less than 3 acres. They occupy the same position as the Cathay soils.

Permeability is slow, and available water capacity is moderate. Runoff is slow. Tilth is fair. The organic-matter content is moderate, and fertility is high.

Most areas are farmed. The potential is fair for cultivated crops and trees, good for hay and pasture, and good for most engineering uses.

This soil is suited to small grain and flax. The dense subsoil restricts the downward movement of water and roots. Tilth can be maintained or improved by timely cultivation, by maintenance of organic matter, and by stubble mulching to conserve moisture. The hazard of soil blowing is moderate and is easily controlled under crop residue management and with stripcropping and buffer strips.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

This soil is suited to windbreak and environmental plantings. Many of the climatically adapted trees and shrubs grow well.

This soil is suited to building site development and onsite waste disposal. The frost action, a limitation for roads and streets, can be overcome by replacing base material with material not subject to frost action. The shrink-swell limitation can be overcome by special design to withstand stress. The slow percolation rate, a problem for septic tank absorption fields, can be overcome by enlarging the field.

This soil has poor potential for wetland wildlife habitat. The potential is fair for openland wildlife habitat and for grain and seed crops.

The included Emrick soils lack the dense subsoil of this soil. They are generally better suited to most uses than this soil. Capability subclass IIIs.

80B—Cathay loam, 3 to 6 percent slopes. This undulating, moderately well drained soil is on glacial till plains. Areas generally range from about 5 to more than 100 acres.

Typically, the surface layer is black loam about 7 inches thick. The subsurface layer, from 7 to 10 inches, is very dark gray loam. The subsoil, from 10 to 24 inches, is clay loam. It is very dark brown in the upper part and very dark gray in the lower part. The underlying material to a depth of 60 inches is loam. It is light brownish gray in the upper part and light olive brown in the middle and lower parts.

About 20 to 25 percent of the map unit is included small areas of Emrick and Heimdal soils. These areas are generally less than 3 acres. The moderately well drained Emrick soil occupies the same position as this soil, and the well drained Heimdal soil is on slightly higher positions.

Permeability is slow, and available water capacity is moderate. Runoff is slow. Tilth is fair. The organic-matter content is moderate, and fertility is high.

Most areas are farmed. The potential is fair for cultivated crops and trees, fair for most engineering uses, and good for pasture and hay.

This soil is suited to small grain and flax. The dense subsoil restricts downward movement of water and roots. Tilth can be maintained or improved by timely cultivation, by maintaining the organic-matter content, and by stubble mulching to conserve moisture. The hazard of soil blowing is moderate and is easily controlled under crop residue management and with stripcropping and buffer strips.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

This soil is suited to windbreak and environmental plantings. Many of the climatically adapted trees and shrubs grow well.

This soil is suited to building site development and onsite waste disposal. The frost action, a limitation for roads and streets, can be overcome by replacing base

material with material not subject to frost action. The shrink-swell limitation can be overcome by special design to withstand stress. The slow percolation rate, a problem for septic tank absorption fields, can be overcome by enlarging the field.

This soil has very poor potential for wetland wildlife habitat. The potential is fair for openland wildlife habitat and for grain and seed crops.

The included Emrick soils lack the dense subsoil of this soil. The Heimdal soils are better drained. The included soils are better suited to most uses than this soil. Capability subclass IIIe.

81—Cathay-Gardena silt loams, 0 to 3 percent slopes. This map unit consists of the level and nearly level, moderately well drained Cathay and Gardena soils on glacial lake plains. It is about 45 percent Cathay soils and about 40 percent Gardena soils. Areas generally range from 10 to more than 200 acres. The relief of this unit is uniform. The Cathay soils have a dense subsoil affected by large amounts of sodium.

Typically, the Cathay soil has a surface layer of black silt loam about 7 inches thick. The subsurface layer, from 7 to 10 inches, is very dark gray silt loam. The subsoil, from 10 to 24 inches, is very dark gray silty clay loam. The underlying material, to a depth of 60 inches, is silt loam. It is light brownish gray in the upper part and light olive brown in the lower part.

Typically, the Gardena soil has a surface layer of black silt loam about 20 inches thick. The subsoil, from 20 to 34 inches, is very dark brown silt loam. The underlying material from 34 to 42 inches is dark grayish brown silt loam and from 42 to 60 inches is light olive brown very fine sandy loam.

About 10 to 15 percent of the map unit is included small areas of the somewhat poorly drained Glyndon soils and the poorly drained Tonka soils. These areas are generally less than 3 acres. The Tonka soils are in shallow depressions, and the Glyndon soils are in swales and in areas surrounding the depressions.

Permeability is slow in the Cathay soil and moderate in the Gardena soil. Available water capacity is moderate in the Cathay soil and high in the Gardena soil. Runoff is slow. Tilth is fair in the Cathay soil and good in the Gardena soil. The organic-matter content is moderate in the Cathay soil and high in the Gardena soil. Fertility is high.

Most areas are farmed. The potential is fair for cultivated crops and trees, good for pasture and hay, and good for most engineering uses.

These soils are suited to small grain and flax. Tilth can be maintained or improved by timely cultivation, by maintenance of organic matter, and by stubble mulching to conserve moisture. The hazard of soil blowing is moderate and is easily controlled under crop residue management and with stripcropping, buffer strips, and windbreaks.

Keeping the soils in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

These soils are suited to windbreak and environmental plantings. Many of the climatically adapted trees and shrubs grow well on the Cathay soils. All grow well on the Gardena soils.

These soils are well suited to building site development and onsite waste disposal. The wetness limitation for buildings can be overcome by using foundation drainage. The shrink-swell limitation for buildings can be overcome by design to withstand stress. The frost action limitation for roads and streets can be overcome by replacing base material with material not subject to frost action. The seepage, a limitation for sewage lagoons, can be overcome by using clay blankets to seal the lagoon. The slow percolation rate, a problem for septic tank absorption fields, can be overcome by enlarging the field.

These soils have poor potential for wetland wildlife habitat. The potential is fair to good for openland wildlife habitat and for grain and seed crops in support of wildlife.

The included Tonka and Glyndon soils are wetter than these soils. They are less suited to most uses, but the Tonka soils have good potential for wetland wildlife habitat. Capability subclass IIIs.

82—Letcher fine sandy loam, 0 to 3 percent slopes. This level and nearly level, moderately well drained soil is on glacial lake plains and outwash plains. Areas generally range from 3 to about 200 acres.

Typically, the surface layer is very dark gray fine sandy loam about 13 inches thick. The subsoil, from 13 to 25 inches, is fine sandy loam. It is dark grayish brown in the upper part and very dark grayish brown in the lower part. The underlying material from 25 to 38 inches is dark gray silty clay loam and from 38 to 60 inches light olive brown loamy very fine sand. In some places the surface layer is thinner.

Permeability is slow, and available water capacity is moderate. Runoff is slow. Tilth is poor. The organic-matter content is moderate, and fertility is low.

Most areas are farmed. The potential is fair for cultivated crops, pasture, and hay; poor for trees; and fair for most engineering uses.

This soil is suited to small grain (fig. 15) and flax. The dense subsoil limits root and water penetration. The subsoil and underlying material contain soluble salts that adversely affect water use by plants. Tilth can be improved or maintained by timely cultivation, by maintenance of organic matter, and by stubble mulching to conserve moisture. The hazard of soil blowing is high and can be controlled under crop residue management and with stripcropping and buffer strips.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition. If pastures are overgrazed, soil blowing is a hazard.

This soil is generally not suited to windbreak and environmental plantings. No species of trees and shrubs grow well.

This soil is suited to building sites and to onsite waste disposal. The wetness limitation for buildings can be overcome by using foundation drainage. The frost action limitation for buildings and for roads and streets can be overcome by placing footers below frost depth and by replacing road and street base material. The slow percolation rate, a problem for septic tank absorption fields, can be overcome by enlarging the field. The seepage limitation for sewage lagoons can be overcome by using clay blankets or plastic liners to seal the lagoon.

This soil has poor potential for wetland wildlife habitat. The potential is fair for openland wildlife habitat and for grain and seed crops. Capability subclass IVe.

88B—Arvilla soils, 0 to 6 percent slopes. These level, nearly level, and undulating, somewhat excessively drained soils are on glacial outwash plains. Areas generally range from 5 to more than 100 acres and are usually irregular in shape.

Typically, the surface layer is very dark gray sandy loam or loam. The subsoil, from 7 to 18 inches, is very dark grayish brown sandy loam. The underlying material to a depth of 60 inches is dark brown gravelly sand.

About 10 percent or less of the map unit is included small areas of Sioux soils. These areas are generally less than 3 acres. They contain large amounts of gravel in the underlying material.

Permeability is moderately rapid in the upper part of the soil and rapid in the lower part. Available water capacity is low. Runoff is slow. Tilth is good. The organic-matter content and fertility are low.

Most areas are farmed. The potential is poor for cultivated crops, trees, pasture, and hay, and good for some engineering uses.

These droughty soils are poorly suited to small grain and flax. The hazard of soil blowing is moderate to high and can be controlled under intensive crop residue management and with stripcropping and buffer strips. Rye is the best suited small grain because it can be seeded in fall to make the best use of early season rainfall.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

These soils are poorly suited to windbreak and environmental plantings. No species of trees or shrubs grow well.

These soils are well suited to building sites. The caving in of cutbanks, a problem in shallow excavations, can be overcome by shoring trench walls. Seepage, the result of the rapid percolation rates, can allow waste to contaminate ground water if these soils are used for waste disposal. These soils are among the best soils in the county for sources of sand and gravel.

These soils have very poor potential for wetland wildlife habitat. The potential is fair for openland wildlife habitat.

The included Sioux soils have about the same limitations as these soils but are more droughty and less suited to cultivated crops. Capability subclass IIIe.

89C—Sioux soils, 1 to 15 percent slopes. These nearly level to rolling, excessively drained soils are on low ridges or hills on glacial outwash plains. Areas generally range from 3 to more than 50 acres.

Typically, the surface layer is very dark gray loam or sandy loam about 6 inches thick. The underlying material to a depth of 60 inches is dark brown. It is gravelly loamy sand in the upper part and gravelly sand in the lower part (fig. 16).

About 15 percent of the map unit is included small areas of Arvilla soils. These areas are generally less than 3 acres. Less gravel occurs to a greater depth than in Sioux soils.

Permeability is rapid, and available water capacity is low. Runoff is slow. The organic-matter content and fertility are low.

Most areas are in native grass pasture. The potential is poor for cultivated crops and trees, fair for native grass pasture and hay, and good for some engineering uses.

These soils are generally not suited to small grain and flax. They are droughty.

Keeping the soils in native grass pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition and maintain the desired native grass species.

These soils are generally not suited to windbreak and environmental plantings.

These soils are suited to building site development. The caving in of cutbanks, a problem in shallow excavations, can be overcome by shoring trench walls. The slope limitation can be overcome by cut and fill operations. Seepage is a problem for onsite waste disposal. Waste materials can contaminate ground water if these soils are used for waste disposal. These soils are among the best in Pierce County for sources of sand and gravel.

These soils have very poor potential for wetland wildlife habitat. The potential is fair for rangeland wildlife habitat.

The included Arvilla soils have about the same limitations as these soils but are better suited to cultivated crops. Capability subclass VIs.

90C—Serden soils, 0 to 15 percent slopes. These level to rolling, excessively drained soils are on wind-disturbed glacial outwash plains. Areas generally range from 10 to more than 300 acres. Slopes are short and choppy.

Typically, the surface layer is very dark brown loamy fine sand or sand about 2 inches thick. The underlying material to a depth of 60 inches is dark grayish brown fine sand.

About 15 percent of the map unit is included small areas of the moderately well drained Aylmer soils and duneland. The Aylmer soils are in swales, and the duneland is on windblown ridges that are barren of vegetation.

Permeability is rapid, and available water capacity is low. Runoff is very slow. The organic-mater content and fertility are low.

Most areas are in native grass pasture. The potential is poor for cultivated crops and trees, fair for native grass pasture, and good for some engineering uses.

These soils are generally not suited to small grain and flax. The hazard of soil blowing is very high. These soils are droughty.

Keeping these soils in native grass pasture and hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition and maintain the desired native grass species. In overgrazed areas, the soils are subject to soil blowing (fig. 17).

These soils are generally not suited to windbreak plantings. Specialized or scalp plantings can be made for wildlife habitat, recreation, or beautification, but require intensive management to survive and grow well.

These soils are suited to building and site development. The caving in of cutbanks, a problem in shallow excavations, can be overcome by shoring trench walls. The slope limitation can be overcome by cut and fill operations. Soil blowing is a hazard where cut and fill operations disturb the vegetative cover, but it can be controlled by reestablishment of the cover. Seepage is a problem for onsite waste disposal, and effluent can contaminate ground water if these soils are used for waste disposal.

These soils have very poor potential for wetland wildlife habitat. The potential is fair for rangeland wildlife habitat.

The included Aylmer soils are wetter than these soils and have a wetness limitation. Capability subclass VIe.

95—Divide loam, 0 to 3 percent slopes. This level and nearly level, somewhat poorly drained soil is on glacial outwash plains. Areas generally range from 5 to more than 100 acres. Slopes are long and smooth.

Typically, the surface layer is black loam about 8 inches thick. The underlying material from 8 to 12 inches is very dark gray loam, from 12 to 20 inches grayish brown loam, from 20 to 31 inches dark yellowish brown gravelly sand, from 31 to 48 inches dark yellowish brown sand, and from 48 to 60 inches grayish brown sand.

Included with this soil in mapping are areas of poorly drained soils on lower landscape positions. These areas make up about 35 percent of the map unit.

Permeability is moderate in the upper part of the soil, and rapid in the lower part, and available water capacity is moderate. Runoff is slow. Tilth is good. The organic-matter content is high, and fertility is medium.

Most areas are farmed. The potential is fair for cultivated crops, good for pasture, hay and trees, and fair for most engineering uses.

This soil is suited to small grain and flax. Spring seeding and tillage are often delayed by the seasonal high water table and resultant wetness. The hazard of soil blowing is moderate and can be controlled under crop residue management and with stripcropping, buffer strips, and windbreaks.

Keeping the soil in pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition.

This soil is well suited to windbreak and environmental plantings. All climatically adapted species of trees and shrubs grow well. If drained, the included poorly drained soil is well suited to trees and shrubs.

This soil is suited to building site development. The caving in of cutbanks, a problem in shallow excavations, can be overcome by shoring trench walls. The wetness limitation for buildings can be overcome by foundation drainage. The frost action limitation for roads and streets can be overcome by replacing base material with material free of frost action. Seepage is a severe problem for onsite waste disposal in septic tanks, sewage lagoons, and sanitary landfills. Better suited alternate sites are generally near this soil.

The suitability for wetland wildlife habitat and shallow water areas is poor. The potential is fair for openland wildlife habitat and for grain and seed crops.

The included poorly drained soil is wetter than this soil. Capability subclass IIIs.

96—Aquents. These level to gently sloping, poorly drained and somewhat poorly drained soils are on narrow beaches surrounding lakes and large depressions. Areas generally range from less than 10 acres to more than 200 acres.

The surface layer is dark sand to silty clay loam generally less than 6 inches thick. The underlying material to a depth of 60 inches is light colored, calcareous, thin alternate layers of sand, silt, and clay.

Included with these soils in mapping are escarpments adjacent to the uplands. They make up 30 percent or less of individual areas. In some places stones cover as much as 15 percent of the surface area.

Permeability ranges from slow to rapid. The available water capacity is generally low. The organic-matter content and fertility are low. In nearly all areas these soils are moderately affected by salts. In many areas on the southeast shores of lakes, they are strongly affected. The salts and soil material are deposited by wind when the lakes are dry. The soils strongly affected by salts support little or no vegetation. Some are subject to flooding in spring.

These soils have poor potential for cultivated crops, hay, and trees. They are best suited to native pasture or wildlife habitat.

Keeping these soils in pasture is effective in controlling erosion. Proper stocking rates and timely deferment of grazing maintain the desirable native grass species.

The suitability of these soils for engineering use is poor. Wetness and flooding are severe limitations. Aquents are not used for building sites or related use.

These soils have fair potential for wetland wildlife habitat and shallow water areas. They have very poor potential for grasses, legumes, grain, and seed crops in support of wildlife.

The included escarpments are severely limited by slope for most uses. Capability subclass VIIs.

100—Stirum soils, 0 to 3 percent slopes. These level and nearly level, poorly drained soils are on glacial outwash plains. Areas generally range from about 5 acres to more than 200 acres. In most areas slopes are long and smooth, but in some areas small mounds and swales a few feet in diameter are common on the landscape.

Typically, the surface layer is black fine sandy loam or loam about 5 inches thick. The subsoil, from 5 to 14 inches, is very dark grayish brown fine sandy loam and from 14 to 23 inches light gray sandy clay loam. The underlying material, from 23 to 31 inches, is light gray loamy sand. In some places the soil is affected by salts and is slightly or moderately saline.

Included with these soils in mapping are some soils with clay loam or loam underlying material that formed in glacial till. The included soils make up about 15 to 25 percent of the map unit.

Permeability is moderately slow, and available water capacity is low. Runoff is very slow. Tilth is poor. The organic-matter content is moderate, and fertility is low.

Most areas are in native grass pasture and hay. The potential is poor for cultivated crops and trees, fair for native grass hay and pasture, and poor for most engineering uses.

These soils are generally not suited to cultivated crops because of the wetness, the poor tilth, the high hazard of soil blowing, and the low productivity.

Keeping the soils in native grass pasture or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture in good condition and maintain the desirable native grass species.

These soils are generally not suited to windbreak and environmental plantings because of wetness, low available water capacity, flooding, and salt content.

These soils are poorly suited to building site development and to onsite waste disposal. Flooding, wetness, and seepage in the underlying material are severe problems. The Stirum soils in this survey area are generally not used for building sites and waste disposal sites.

The potential is fair for wetland wildlife habitat and for shallow water areas. The potential is very poor for grass, legume, grain, and seed crops grown in support of wetland wildlife.

The included soils have about the same limitations as these soils. Capability subclass VIw.

104—Aquolls. These level, poorly drained soils are in depressions, shallow lakes, and ponds. They are covered by water much of the year and support a vegetative cover of reeds, sedges, and rushes. The water is saline in some areas and nonsaline in others. Areas range from about 5 to more than 500 acres. Most areas remain undrained because of the lack of drainage outlets.

Most areas are used for production of wetland wildlife. They are best suited to wildlife use. The potential is poor for all other uses because of wetness, ponding, and lack of drainage outlets. Capability subclass VIIIw.

105—Aylmer-Fossum complex, 0 to 6 percent slopes. This map unit consists of level to undulating, moderately well drained Aylmer soils and poorly drained Fossum soils on sandy outwash plains. It is about 70 percent Aylmer soil and 20 percent Fossum soil. The Aylmer soil occupies the higher positions and the Fossum soil the depressions. Areas generally range from 10 to more than 150 acres.

Typically, the Aylmer soil has a surface layer of dark gray sand about 7 inches thick. The underlying material, from 7 to 60 inches, is sand. It is dark grayish brown in the upper part and grayish brown in the middle and lower parts.

Typically, the Fossum soil has a surface layer 22 inches thick. It is black fine sandy loam to loamy fine sand in the upper part, very dark gray loamy fine sand in the middle part, and very dark grayish brown loamy fine sand in the lower part. The underlying material from 22 to 60 inches is grayish brown fine sand. In some places the soil is slightly saline.

About 10 percent of the unit is included small areas of excessively drained Serden soils, which are above the Aylmer soil.

Permeability is rapid, and available water capacity is low. Runoff is slow on the Aylmer soil and very slow on the Fossum soil. The organic-matter content is low in the Aylmer soil and moderate in the Fossum soil. Fertility is low in both soils.

Most areas are in native grass pasture. The potential is poor for cultivated crops, trees, and tame grass pasture. The potential is fair for most engineering uses.

These soils are generally not suited to small grain and flax because of the hazard of soil blowing and the low available water capacity and resulting droughtiness.

Keeping these soils in native grass pasture or hay is effective in controlling erosion. Proper stocking rates, rotation grazing, and timely deferment of grazing keep the pasture in good condition and maintain the desirable native grass species.

The Aylmer soil is generally not suited to windbreaks and environmental plantings. Special or scalp plantings can be made, but they require intensive management to survive and grow well. The Fossum soil is well suited to all climatically adapted trees and shrubs.

The Fossum soil is generally not suited to building site development and onsite waste disposal. It is severely limited by wetness, seepage, and flooding. The Aylmer soil is better suited. The caving in of cutbanks in shallow excavations is a problem but can be overcome by shoring trench walls. The wetness limitation for buildings can be overcome by foundation drainage and for roads and streets by building up roadbeds and providing drainage. Seepage is a severe problem for sewage lagoons and landfills.

The Fossum soil has good potential for wetland wildlife habitat. The Aylmer soil has very poor potential. Both soils have fair potential for openland wildlife habitat and for grasses and legumes.

The included Serden soils are better drained than the Aylmer and Fossum soils. Capability subclass VIe.

Use and management of the soils

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

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

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

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

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

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

Crops and pasture

EDWARD R. WEIMER, agronomist, Soil Conservation Service, helped prepare this section.

The major management concerns in using the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited to the soil, including some not commonly grown in the survey area, are identified. The system of capability classification used by the Soil Conservation Service is explained. Also, yields of the main crops, hay, and pasture are predicted for each soil.

This section provides information on the overall agricultural potential and needed practices in the survey area for those in the agribusinss sector, for example, equipment dealers, drainage contractors, fertilizer companies, processing companies, planners, and conservationists. For each kind of soil, information about management is presented in the section "Soil Maps for Detailed Planning." In planning management for individual fields or farms, refer to the specified soil description.

According to the North Dakota Conservation Needs Inventory dated July 1970, more than 515,000 acres in Pierce County was used for crops and pasture in 1967. Of this total, 27,970 acres was used for pasture, 13,340 acres for row crops, mainly corn; 287,680 acres for close-grown crops, mainly wheat, barley, oats, and flax; and 92,000 acres for summer fallow. Since 1967, however, the acreage in close-grown crops has increased and the acreage in pasture, row crops, and summer fallow has decreased, mainly as the result of higher grain prices and changes in agricultural programs.

The soil potential in Pierce County is good for increased production of food and fiber. Production could be increased by extending the latest crop production technology to all cropland in the county. This soil survey facilitates the application of this technology.

The main management needs for use of the soils in Pierce County are controlling soil blowing and water erosion, conserving moisture, and maintaining fertility.

Soil blowing is a hazard on nearly all soils of the county, but is most severe on the sandy Egeland, Embden, Hecla, Maddock, Swenoda, and Towner soils. It can damage these soils in a very short time if winds are strong and the soils are dry and bare of vegetation or surface mulch. Water erosion is a hazard mainly on the gently rolling and steeper soils, for example, Barnes, Buse, Esmond, and Heimdal soils. Among the measures that help to control soil blowing and water erosion are cover crops, stripcrops, buffer strips, windbreaks, contour tillage, diversions and waterways, minimum tillage, timely and emergency tillage, grasses and legumes in the cropping system, and crop residue. A combination of several measures generally is used.

Moisture generally is conserved by reducing evaporation, limiting runoff, increasing infiltration, and controlling weeds. Some of the effective management practices are stubble mulching, contour tillage, stripcropping, establishing field windbreaks and buffer strips, keeping tillage timely and minimal, growing grasses and legumes in the cropping system, maintaining crop residue on the surface, and applying fertilizer. Periods of fallow help to control weeds and store available moisture in the soil.

Among the measures that help to maintain fertility are the application of fertilizer; the plowing down of green manure and barnyard manure; the inclusion of cover crops, grasses, and legumes in the cropping system; and the use of summer fallow. Most measures used to control soil blowing and water erosion also help to maintain fertility.

To offset the effects of unfavorable soil characteristics, artificial drainage, stone removal, and the reduction of salinity are needed on some soils. Draining soils that are somewhat poorly drained to very poorly drained would increase yields and the choice of crops. Many areas, however, lack suitable outlets. Some stone removal is usually necessary on soils formed in glacial till, such as Heimdal and Barnes soils. Practices that benefit saline soils include eliminating summer fallow, growing the most salt-tolerant grain crops, green manure crops, and tame and native grasses.

The most commonly used conservation practices, for example, growing green manure crops and including grasses and legumes in the cropping system, help in maintaining good soil tilth. Heavy textured soils, such as Hegne silty clay, often are plowed in fall at the right moisture content to maintain tilth and prepare a good seedbed.

Some crops suited to the soils and climate of the county and commonly grown are wheat, barley, oats, flax, rye, legumes, and tame grasses. Crops not commonly grown, but suitable, are potatoes, sunflowers, dry edible beans, such as pinto beans, and buckwheat.

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

Yields per acre

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

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

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

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

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

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

Capability classes and subclasses

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

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

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

Class I soils have few limitations that restrict their use.

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

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

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

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

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

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

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

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

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

The capability class and subclass are identified in the description of each soil map unit in the section "Soil maps for detailed planning."

Windbreaks and environmental plantings

DAVID L. HINTZ, forester, Soil Conservation Service, helped prepare this section.

Approximately 1,600 acres in Pierce County is native woodland. Trembling aspen, diamond willow, sandbar willow, and redosier dogwood are common on sandy outwash areas of Aylmer, Hecla, Maddock, and Serden soils. Diamond willow, plains cottonwood, and sandbar willow are common on the margins of some potholes and lakes. Bur oak, boxelder, American elm, green ash, common chokecherry, Saskatoon serviceberry, silverberry, western snowberry, round-leaved hawthorn, Missouri gooseberry, red raspberry, and several species of rose grow on rolling to steep north-facing slopes on the Dickey, Emrick, Esmond, Heimdal, Swenoda, and Towner soils.

The early settlers used the trees for building materials, fence posts, and fuel. Today the native tree and shrub species are valued primarily for livestock protection, wildlife habitat, recreation, esthetic value, and watershed protection.

Windbreaks are established to protect livestock, buildings, and yards from wind and snow. Windbreaks also help protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broad-leaf and coniferous species provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field, the interval depending on erodibility of the soil. They protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

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

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

Engineering

ORVAL C. HOVEY, agricultural engineer, Soil Conservation Service, helped prepare this section.

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

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

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

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

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal

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

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

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

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

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

Building site development

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

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

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

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

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

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

Sanitary facilities

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

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

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

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

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

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

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

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

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

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

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

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

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

Construction materials

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

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

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

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

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

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

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

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

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

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

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

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

Water management

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

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

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

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

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil

blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

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

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

Recreation

ERLING B. PODOLL, biologist, Soil Conservation Service, helped prepare this section.

Most of the recreational developments in the survey area are in municipal or town parks. Picnic sites are available at Rugby Park, Baltic Dam, and Buffalo Lake. Developed play areas are limited to Rugby. There are two privately developed camping areas in the county, but no developed public trails or paths.

Four state-owned tracts totaling 1,430 acres and 7,850 acres managed by the Department of Interior are the only public lands available for public use in the county. They provide for such activities as hiking, nature study, birding, and hunting. Public access to fishing waters is available.

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

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

The information in table 11 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 8, and interpretations for dwellings without basements and for local roads and streets, given in table 7.

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

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over bedrock or hardpan should be enough to allow necessary grading.

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

Wildlife habitat

ERLING B. PODOLL, biologist, Soil Conservation Service, helped prepare this section.

Hunting and fishing provide an opportunity for outdoor activity in Pierce County. Both are important to the economy of the county.

The numbers of wildlife have been reduced substantially since presettlement of the county, but the kinds of wildlife are still somewhat similar. Habitat is available for a wide variety of species. The development and mangement of fisheries have increased fishing opportunities.

Wild geese and sandhill cranes have been replaced to some degree by farm game species, such as the gray partridge. Extirpated mammals, such as moose, antelope, elk, and bear, have not been replaced.

The most important game species in Pierce County are ducks; geese, as hunting populations, not as breeders; gray partridge; sharp-tailed grouse; and white-tailed deer. Pheasant numbers are extremely low. Mourning dove, cottontail, and fox squirrel are under utilized as game species. Red fox and jackrabbit, important furbearers, provide a source of winter outdoor recreation. Muskrat and mink are other important furbearers.

The county has about 68,000 acres of Type 3, 4, and 5 wetlands and about 22,500 acres of Type 1 wetlands (*6*). Included in Types 4 and 5 are inland saline marshes and inland open saline waters. All types are important to the production of waterfowl and other water-related wildlife.

Public fishing is provided by the Balta Reservoir, Buffalo Lake, and Sand Lake. There is fair potential for the construction of fish reservoirs. The most commonly sought fish are perch, bullhead, and northern pike.

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

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

In table 12, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

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

Grain and seed crops are seed-producing annuals used by wildlife. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, barley, millet, sunflower, and rye.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are bromegrass, clover, alfalfa, wheatgrass, and switchgrass.

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

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture. Examples of shrubs are snowberry, silverberry, chokecherry, and juneberry.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, saltgrass, cordgrass, rushes, sedges, reeds, and cattail.

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

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

Openland habitat consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous

plants. The kinds of wildlife attracted to these areas include killdeer, gray partridge, pheasant, meadowlark, field sparrow, cottontail, red fox, and badgers.

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

Rangeland habitat consists of areas of wild herbaceous plants and shrubs. Wildlife attracted to rangeland include white-tailed deer, sharp tailed grouse, horned lark, meadowlark, and lark bunting.

Soil properties

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

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

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

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

Engineering properties

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

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

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

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*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, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

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

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are

based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

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

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

Physical and chemical properties

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

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

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

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

Salinity 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 the nonirrigated soils. The salinity of individual irrigated fields is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of individual fields can differ greatly from the value given in table 14. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its potential to corrode metal and concrete.

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

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

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

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

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

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.

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

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

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Table 15 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

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

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

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

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

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 15 are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action results from the movement of soil moisture into the freezing temperature zone in the soil, which causes ice lenses to form. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Classification of the soils

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to "Soil taxonomy" (*5*).

The system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 16, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol*. An example is Mollisol.

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

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Calciaquolls (*Calci*, meaning simple horizons, plus *aquoll*, the suborder of Mollisols that have an aquic moisture regime).

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceeding the name of the great group. The adjective *Typic* identifies the subgroup that is thought to typify the great group. An example is Typic Calciaquolls.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine-loamy, frigid, Typic Calciaquolls.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Soil series and morphology

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

Characteristics of the soil and the material in which it formed are discussed for each series. The soil is then compared to similar soils and to nearby soils of other series. Then a pedon, a small three-dimensional area of soil that is typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (*4*). Unless otherwise noted, colors described are for moist soil.

Following the pedon description is the range of important characteristics of the soil series in this survey area. Phases, or map units, of each soil series are described in the section "Soil maps for detailed planning."

Arvilla series

The Arvilla series consists of deep, somewhat excessively drained, moderately rapidly permeable soils on glacial outwash plains. These soils are shallow over sand and gravel. They formed in a thin mantle of material weathered from loamy alluvium underlain by thick beds of loose sand and gravel. Slopes are 0 to 6 percent.

Arvilla soils are associated on the landscape with Divide and Sioux soils. Divide soils, in lower lying and slightly concave depressions, have a calcic horizon within 16 inches of the surface. Sioux soils, generally on the steeper adjacent hills and ridges, have a thinner solum than Arvilla soils.

Typical pedon of Arvilla sandy loam in area of Arvilla soils, 0 to 6 percent slopes, 265 feet north and 80 feet west of southeast corner sec. 22, T. 151 N., R. 73 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak medium granular structure; soft, very friable, slightly sticky, nonplastic; neutral; abrupt smooth boundary.

B2—7 to 18 inches; very dark grayish brown (10YR 3/2) sandy loam, dark brown (10YR 4/3) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, nonsticky, nonplastic; neutral; clear wavy boundary.

IIC1—18 to 36 inches; dark brown (10YR 4/3) gravelly sand, brown (10YR 5/3) dry; single grained; loose, nonsticky, nonplastic; lime coatings on underside of pebbles; 20 to 30 percent coarse fragments;

strong effervescence; moderately alkaline; gradual irregular boundary.

IIC2—36 to 60 inches; dark brown (10YR 4/3) gravelly sand, pale brown (10YR 6/3) dry; single grained; loose, nonsticky, nonplastic; 20 to 30 percent coarse fragments; slight effervescence; moderately alkaline.

Thickness of the solum and the depth to sand and gravel range from 14 to 24 inches. The solum is sandy loam, fine sandy loam, or loam that is less than 18 percent clay.

The A horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. The B2 horizon has 10YR or 2.5Y hue, value of 3 or 4, 3 through 5 dry, and chroma of 1 through 3. Some pedons have a B3ca or Cca horizon. The IIC horizon ranges from coarse sand to gravelly sand.

Aylmer series

The Aylmer series consists of deep, moderately well drained, rapidly permeable soils on sand plains. These soils formed in material weathered from wind-worked medium and fine sands. Slopes are 0 to 6 percent.

Aylmer soils are similar to Serden soils and are commonly associated on the landscape with Fossum, Hecla, Maddock, Serden, and Ulen soils. Fossum, Hecla, Maddock, and Ulen soils have a mollic epipedon. Fossum and Ulen soils are wetter than Aylmer soils. Serden soils are better drained and do not have mottles.

Typical pedon of Aylmer sand in area of Aylmer-Fossum complex, 0 to 6 percent slopes, in native grass, 750 feet south and 100 feet east of northwest corner sec. 27, T. 154 N., R. 74 W.

A1—0 to 7 inches; very dark gray (10YR 3/1) sand, dark grayish brown (10YR 4/2) dry; weak fine granular structure; loose, nonsticky, nonplastic; common roots; neutral; abrupt smooth boundary.

C1—7 to 24 inches; dark grayish brown (10YR 4/2) sand, grayish brown (10YR 5/2) dry; single grained; loose, nonsticky, nonplastic; few roots; mildly alkaline; gradual wavy boundary.

C2—24 to 40 inches; grayish brown (10YR 5/2) sand, light brownish gray (10YR 6/2) dry; many large prominent yellowish brown (10YR 5/6) mottles; single grained; loose, nonsticky, nonplastic; few roots; neutral; gradual wavy boundary.

C3—40 to 60 inches; grayish brown (2.5Y 5/2) sand, light gray (2.5Y 7/2) dry; common medium distinct yellowish brown (10YR 5/6) mottles; single grained; loose, nonsticky, nonplastic; neutral.

The A horizon has hue of 10YR, value of 2 through 4, 3 through 5 dry, and chroma of 1 or 2. It commonly is sand but in some pedons is fine sand, loamy fine sand, or loamy sand. The C horizon has hue of 10YR or 2.5Y, value of 4 through 6, 5 through 7 dry, and chroma of 2 or less. It is sand or fine sand.

The profile is neutral or mildly alkaline. Mottles are at a depth of 20 to 40 inches.

Barnes series

The Barnes series consists of deep, well drained, moderately slowly permeable soils on glacial till plains. These soils formed in material weathered from calcareous fine loamy glacial till. Slopes are 0 to 9 percent.

Barnes soils are associated on the landscape with Buse, Hamerly, and Svea soils. Buse soils have a thinner solum than Barnes soils and are calcareous throughout. The somewhat poorly drained Hamerly soils have a calcic horizon within 16 inches of the surface. Svea soils have a thicker mollic epipedon.

Typical pedon of Barnes loam in area of Barnes-Buse loams, 3 to 6 percent slopes, 1,450 feet north and 2,100 feet west of southeast corner sec. 27, T. 158 N., R. 69 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak coarse subangular blocky structure parting to moderate medium granular; slightly hard, friable, slightly sticky, slightly plastic; many fine pores; mildly alkaline; abrupt smooth boundary.

B21—7 to 11 inches; dark brown (10YR 3/3) loam, brown (10YR 4/3) dry; moderate medium prismatic structure parting to moderate medium angular blocky; slightly hard, firm, slightly sticky, slightly plastic; common medium pores; patches of clay on vertical faces of peds; mildly alkaline; clear wavy boundary.

B22—11 to 19 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky, slightly plastic; common medium pores; mildly alkaline; clear wavy boundary.

C1ca—19 to 37 inches; olive brown (2.5Y 4/4) loam, pale yellow (2.5Y 7/4) dry; moderate coarse prismatic structure parting to moderate medium subangular blocky; friable, slightly sticky, slightly plastic; few medium pores; few lime segregations; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—37 to 60 inches; light olive (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; few medium distinct yellowish brown (10YR 5/6) mottles; massive; hard, firm, slightly sticky, slightly plastic; strong effervescence; moderately alkaline.

Thickness of the solum and depth to carbonates ranges from 10 to 21 inches. The mollic epipedon is 7 to 16 inches thick. The control section is loam or light clay loam that averages between 18 and 28 percent clay.

The A horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. The B horizon has hue of 10YR or 2.5Y, value of 3 through 5, 4 through 6 dry, and chroma of 2 through 4. The Cca horizon has hue of 2.5Y, value of 4 or 5, 5 through 7 dry, and chroma of 2 through 4.

Bearden series

The Bearden series consists of deep, somewhat poorly drained, slowly permeable soils on glacial lake plains. These soils formed in material weathered from calcareous, silty lacustrine sediment. Slopes are 0 to 1 percent.

Bearden soils are associated on the landscape with Colvin, Hegne, and Overly soils. Colvin and Hegne soils are very poorly and poorly drained. Overly soils, at higher elevations, are better drained than Bearden soils and do not have calcic horizons within a depth of 16 inches.

Typical pedon in area of Bearden silty clay loam, 2,000 feet north and 75 feet west of southeast corner sec. 6, T. 151 N., R. 72 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium granular structure; slightly hard, friable, sticky, plastic; few salt specks visible when dry; strong effervescence; mildly alkaline; abrupt smooth boundary.

ACca—8 to 14 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; slightly hard, friable, sticky, plastic; common fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear irregular boundary.

C1ca—14 to 18 inches; grayish brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; hard, friable, sticky, plastic; violent effervescence; moderately alkaline; gradual irregular boundary.

C2ca—18 to 32 inches; light olive brown (2.5Y 5/4) silty clay loam, light gray (2.5Y 7/2) dry; massive; hard, firm, sticky, plastic; moderately alkaline; violent effervescence; gradual irregular boundary.

C3—32 to 44 inches; light olive brown (2.5Y 5/4) and light brownish gray (2.5Y 6/2) silty clay loam, light yellowish brown (2.5Y 6/4) dry; massive; hard, firm, sticky, plastic; strong effervescence; moderately alkaline; gradual irregular boundary.

C4—44 to 60 inches; gray (5Y 5/1) silty clay loam, light gray (5Y 6/1) dry; many large prominent light olive brown (2.5Y 5/4) mottles; massive; hard, firm, sticky, plastic; slight effervescence; moderately alkaline.

The A horizon has hue of 10YR, value of 2 or 3, 3 through 5 dry, and chroma of 1. The control section is silty clay loam or silt loam that is less than 15 percent fine and coarser sand and 18 to 35 percent clay. Some pedons are saline.

Borup series

The Borup series consists of deep, poorly drained and very poorly drained, moderately rapidly permeable soils in slight depressions in lake plains. These soils formed in material weathered from calcareous coarse silty lake sediment. Slopes are 0 to 1 percent.

Borup soils are associated on the landscape with Embden, Gardena, Glyndon, and Wyndmere soils. Embden and Gardena soils are at higher elevations than Borup soils and do not have calcic horizons within a depth of 16 inches. Glyndon and Wyndmere soils are better drained.

Typical pedon in area of Borup silt loam, 1,300 feet east and 860 feet north of southwest corner sec. 7, T. 158 N., R. 73 W.

A11—0 to 8 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to moderate medium granular; hard, very friable, slightly sticky, slightly plastic; strong effervescence; moderately alkaline; clear wavy boundary.

A12—8 to 11 inches; very dark grayish brown (2.5Y 3/2) silt loam, gray (10YR 5/1) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; common fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; clear irregular boundary.

C1ca—11 to 16 inches; gray (N 5/0) silt loam, light gray (N 7/0) dry; few fine distinct yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; violent effervescence; moderately alkaline; clear wavy boundary.

C2ca—16 to 29 inches; grayish brown (2.5Y 5/2) silt loam, light gray (2.5Y 7/2) dry; many coarse prominent yellowish brown (10YR 5/6) mottles; weak medium fine subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; violent effervescence; moderately alkaline; gradual wavy boundary.

C3ca—29 to 36 inches; gray (5Y 5/1) and grayish brown (2.5Y 5/2) silty clay loam, light gray (5Y 6/1) and gray (5Y 5/1) and pale olive (5Y 6/3) dry; few fine prominent brown (7.5YR 4/4) mottles; massive; hard, firm, sticky, plastic; white (5Y 8/2) lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C4—36 to 60 inches; gray (5Y 6/1) silt loam, pale yellow (5Y 7/3) and olive (5Y 5/3) dry; many coarse prominent yellowish brown (10YR 5/6) and few medium distinct brown (7.5YR 5/4) mottles; massive; hard, firm, slightly sticky, plastic; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick. The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, 4 or 5 dry, and chroma of 1. Some pedons have an Aca horizon. The C horizon has hue of 2.5Y or 5Y, value of 3 through 6, 4 through 7 dry, and chroma of 1 through 3. The control section is less than 15 percent fine and coarser sand and less than 18 percent clay. Some pedons are saline.

Buse series

The Buse series consists of deep, well drained, moderately slowly permeable soils on glacial moraines. These soils formed in material weathered from fine loamy calcareous glacial till. Slopes are 3 to 9 percent.

Buse soils are associated on the landscape with Barnes, Hamerly, and Svea soils. Barnes soils have a thicker solum than Buse soils, have a B horizon, and are free of lime in the upper part of the solum. Hamerly soils are calcareous throughout the profile and are somewhat poorly drained. Svea soils have a thicker mollic epipedon.

Typical pedon of Buse loam in area of Barnes-Buse loams, 6 to 9 percent slopes, 1,400 feet south and 550 feet west of northeast corner sec. 5, T. 157 N., R. 69 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate medium granular structure; slightly hard, very friable, slightly sticky, slightly plastic; common fine roots; slight effervescence; moderately alkaline; abrupt smooth boundary.

C1ca—7 to 21 inches; light olive brown (2.5Y 5/4) loam, light brownish gray (2.5Y 6/2) weak medium subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; common fine roots; violent effervescence; moderately alkaline; clear wavy boundary.

C2—21 to 60 inches; olive brown (2.5Y 4/4) loam, grayish brown (2.5Y 5/2) dry; massive; hard, friable, sticky, plastic; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 10 inches thick. The control section is loam or light clay loam that averages 18 to 30 percent clay.

The A horizon has hue of 10YR, value of 2 or 3, 3 through 5 dry, and chroma of 1. The Cca horizon has hue of 10YR or 2.5Y, value of 4 or 5, 5 through 7 dry, and chroma of 2 through 4.

Cathay series

The Cathay series consists of deep, moderately well drained, slowly permeable soils on glacial till plains. These soils formed in material weathered from coarse loamy glacial till. They have natric horizons. Slopes are 0 to 6 percent.

Cathay soils are associated on the landscape with Emrick, Fram, Gardena, and Heimdal soils. Those soils do not have natric horizons. In addition Fram soils are calcareous throughout the profile and are wetter than Cathay soils.

Typical pedon of Cathay loam in area of Emrick-Cathay loams, 0 to 3 percent slopes, 80 feet east and 445 feet south of northwest corner sec. 11, T. 158 N., R. 73 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium granular structure; slightly hard, very friable, slightly sticky, slightly plastic; neutral; abrupt smooth boundary.

A2—7 to 10 inches; very dark gray (10YR 3/1) loam, light gray (10YR 6/1) and gray (10YR 5/1) dry; moderate medium platy structure parting to moderate fine platy; hard, friable, nonsticky, nonplastic; common medium pores; mildly alkaline; abrupt smooth boundary.

B21t—10 to 15 inches; very dark brown (10YR 2/2) crushed to very dark gray (10YR 3/1) clay loam, very dark gray (10YR 3/1) dry; strong medium prismatic structure parting to strong medium angular blocky; very hard, firm, sticky, plastic; many small pores; continuous distinct clay on all ped faces; cleaned sand and silt grains 1 millimeter thick coating faces of prisms; mildly alkaline; gradual wavy boundary.

B22t—15 to 24 inches; very dark gray (10YR 3/1) clay loam, very dark grayish brown (10YR 3/2) dry; moderate coarse prismatic structure parting to moderate medium angular blocky; hard, firm, sticky, plastic; many medium roots; continuous distinct clay on vertical faces and patches on horizontal faces; strong effervescence; moderately alkaline; gradual wavy boundary.

C1ca—24 to 36 inches; light brownish gray (2.5Y 6/2) loam, light gray (2.5Y 7/2) dry; massive; hard, very friable, slightly sticky, slightly plastic; common medium pores; violent effervescence; strongly alkaline; gradual wavy boundary.

C2—36 to 45 inches; light olive brown (2.5Y 5/4) loam, light brownish gray (2.5Y 6/2) dry; common medium distinct gray (5Y 5/1) and common fine prominent yellowish brown (10YR 5/6) mottles; massive, hard, friable, slightly sticky, slightly plastic; strong effervescence; strongly alkaline; gradual wavy boundary.

C3—45 to 60 inches; light olive brown (2.5Y 5/4) loam, light brownish gray (2.5Y 6/2) dry; common medium distinct gray (5Y 5/1) mottles; massive; hard, firm, sticky, plastic; strong effervescence; strongly alkaline.

The solum is 16 to 30 inches thick. The Ap horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. It is loam or silt loam. The A2 horizon has hue of 10YR or 2.5Y, value of 3 or 4, 4 through 6 dry, and chroma of 1 or 2. It also is loam or silt loam. The B2t horizon has hue of 10YR or 2.5Y, value of 3 or 4, 3 through 5 dry, and chroma of 1 through 3. It is loam or clay loam. A concentration of soluble salts is in the upper part of the C horizon in some pedons.

The Cathay soil in map unit 81, Cathay-Gardena silt loams, 0 to 3 percent slopes, is a silty taxadjunct of the Cathay series. It contains more silt and less sand than is defined as the range for the series, and it formed in material weathered from coarse silty lacustrine sediment. These differences do not alter the use or management of the soil.

Colvin series

The Colvin series consists of deep, poorly drained and very poorly drained, moderately slowly permeable soils in shallow depressions in glacial lake plains. These soils formed in material weathered from calcareous silty lake sediment. Slopes are 0 to 1 percent.

Colvin soils are associated on the landscape with Bearden, Hegne, and Overly soils. Bearden soils are better drained than Colvin soils. Hegne soils contain more clay, and Overly soils do not have calcic horizons within a depth of 16 inches.

Typical pedon in area of Colvin silty clay loam, 650 feet north and 2,300 feet west of southeast corner sec. 26, T. 158 N., R. 70 W.

A1—0 to 8 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium granular structure; hard, friable, sticky, plastic; strong effervescence; mildly alkaline; abrupt wavy boundary.

C1ca—8 to 19 inches; grayish brown and light brownish gray (2.5Y 5/2 and 6/2) silty clay loam, light gray and white (2.5Y 7/2 and N 8/0) dry; common medium distinct light olive brown (2.5Y 5/6) mottles; weak medium subangular blocky structure; hard, friable, sticky, plastic; tongues of the black A1 horizon extend into this horizon; common irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C2ca—19 to 36 inches; olive gray (5Y 5/2) silty clay loam, light gray (5Y 7/2) dry; many medium prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; hard, friable, sticky, plastic; violent effervescence; moderately alkaline; gradual wavy boundary.

C3—36 to 52 inches; gray (5Y 6/1) loam, light gray (5Y 7/1) dry; many large prominent yellowish brown (10YR 5/6) mottles; massive; slightly hard, very friable, slightly sticky, slightly plastic; slight effervescence; moderately alkaline; gradual wavy boundary.

C4—52 to 60 inches; olive gray (5Y 5/2) silty clay loam, light gray (5Y 7/2) dry; few medium distinct gray (5Y 6/1) and many medium prominent dark yellowish brown (10YR 4/4) mottles; massive; very hard, very firm, very sticky, very plastic; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick. The control section ranges from 18 to 35 percent clay. The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, 3 or 4 dry, and chroma of 1. The Cca horizon has hue of 2.5Y or 5Y, value of 4 through 6, 5 through 8 dry, and chroma of 0 through 2. Crystals of gypsum and soluble salts are in some pedons.

Cresbard series

The Cresbard series consists of deep, moderately well drained, slowly permeable soils on glacial till plains. These soils formed in material weathered from fine loamy calcareous glacial till. They have natric horizons. Slopes are 0 to 3 percent.

Cresbard soils are associated on the landscape with Barnes, Hamerly, and Svea soils. None of the associated soils have natric horizons. Hamerly soils have calcic horizons and are calcareous throughout the profile.

Typical pedon of Cresbard loam in area of Cresbard-Svea loams, 0 to 3 percent slopes, 2,150 feet east and 1,400 feet south of northwest corner sec. 3, T. 158 N., R. 69 W.

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

A2—7 to 10 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; moderate medium platy structure; hard, friable, slightly sticky, slightly plastic; neutral; abrupt smooth boundary.

B21t—10 to 14 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to strong fine angular blocky; very hard, very firm, very sticky, very plastic; many medium pores; continuous clay films on all faces, thick skins; many bleached sand grains coat top 2 inches of prisms; mildly alkaline; clear wavy boundary.

B22t—14 to 19 inches; very dark gray (10YR 3/1) crushing to very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate medium fine angular blocky structure; hard, firm, sticky, plastic; many medium pores; continuous distinct clay on all faces; a few salt threads; moderately alkaline; gradual wavy boundary.

C1ca—19 to 32 inches; light brownish gray (2.5Y 6/2) clay loam, light gray (2.5Y 7/2) dry; massive; hard, friable, slightly sticky, plastic; violent effervescence; strongly alkaline; gradual wavy boundary.

C2—32 to 60 inches; olive brown (2.5Y 4/4) clay loam, pale yellow (2.5Y 7/3) dry; few medium distinct light gray (5Y 7/1) and reddish yellow (7.5YR 6/8) mottles; massive; very hard, friable, sticky, plastic; strong effervescence; strongly alkaline.

The solum is 16 to 30 inches thick. The A1 horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. The A2 horizon has hue of 10YR, value of 3 or 4, 5 or 6 dry, and chroma of 1 or 2. Some pedons have a B&A or an A&B horizon. The B2t horizon has hue of 10YR or 2.5Y, value of 2 through 4, 3 or 4 dry, and chroma of 1 through 3. This soil formed in fine loamy glacial till that averages between 18 and 30 percent clay. The B horizon commonly is a clay loam that is more than 35 percent clay. Many pedons contain gypsum and other salts.

Dickey series

The Dickey series consists of deep, well drained, moderately slowly permeable soils on sand-mantled glacial till plains. These soils formed in material weathered from

wind- and water-deposited sand and loam glacial till. Slopes are 3 to 15 percent.

Dickey soils are associated with Hecla, Maddock, and Towner soils. Hecla and Maddock soils have a sandy substratum. Towner soils have a thicker mollic epipedon than Dickey soils.

Typical pedon of Dickey loamy fine sand in area of Towner-Dickey loamy fine sands, 3 to 6 percent slopes, 100 feet west and 650 feet south of northeast corner sec. 5, T. 153 N., R. 74 W.

A1—0 to 12 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky, nonplastic; many fine roots; mildly alkaline; clear wavy boundary.

B2—12 to 20 inches; dark brown (10YR 4/3) loamy fine sand, brown (10YR 5/3) dry; weak very coarse prismatic structure parting to weak medium and fine subangular blocky; very friable, nonsticky, nonplastic; common fine roots; neutral; clear wavy boundary.

B3—20 to 30 inches; dark brown (10YR 4/3) fine sand, brown (10YR 4/3) fine sand, brown (10YR 5/3) dry; single grained; loose; nonsticky, nonplastic; few fine roots; neutral; abrupt wavy boundary.

IIC1ca—30 to 42 inches; light olive brown (2.5Y 5/4) loam, light brownish gray (2.5Y 6/2) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; white (2.5Y 8/2) lime; violent effervescence; moderately alkaline; gradual wavy boundary.

IIC2—42 to 60 inches; olive brown (2.5Y 4/4) loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; hard, friable, slightly sticky, slightly plastic; strong effervescence; moderately alkaline.

Depth to the IIC horizon commonly is 24 to 36 inches but ranges from 20 to 40 inches. The mollic epipedon is 10 to 16 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. The B2 horizon has hue of 10YR or 2.5Y, value of 2 through 4, 3 through 6 dry, and chroma of 1 through 3. It is loamy fine sand or loamy sand. The B3 horizon is loamy fine sand, loamy sand, or fine sand. It has color similar to that of the B2 horizon. Some pedons lack a B horizon and have an AC or C horizon above the IIC material. The IIC horizon has hue of 2.5Y or 5Y, value of 4 through 6, 5 through 8 dry, and chroma of 2 through 4. It typically is loam, but in some places it is silt loam or silty clay loam lacustrine sediment.

Divide series

The Divide series consists of deep, somewhat poorly drained, moderately permeable soils on glacial outwash plains and lake plains. These soils are moderately deep over sand and gravel. They formed in material weathered from loamy sediment over sand and gravel. Slopes are 0 to 3 percent.

Divide soils are associated on the landscape with Arvilla and Sioux soils. Arvilla soils are better drained than Divide soils and do not have calcic horizons within a depth of 16 inches. Sioux soils, at higher elevations, are excessively drained.

Typical pedon in area of Divide loam, 0 to 3 percent slopes, 200 feet south and 1,850 feet west of northeast corner sec. 36, T. 151 N., R. 72 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; common fine roots; 0 to 5 percent coarse fragments; strong effervescence; moderately alkaline; abrupt smooth boundary.

ACca—8 to 12 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak medium subangular blocky structure; hard, very friable, slightly sticky, slightly plastic; common fine roots; 5 to 10 percent coarse fragments; violent effervescence; moderately alkaline; clear wavy boundary.

C1ca—12 to 20 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; common medium distinct pale yellow (2.5Y 7/4) mottles; weak medium subangular blocky structure; hard, very friable, slightly sticky, plastic; common fine roots; 5 to 10 percent coarse fragments; violent effervescence; moderately alkaline; gradual irregular boundary.

IIC2—20 to 31 inches; dark yellowish brown (10YR 4/4) gravelly sand, yellowish brown (10YR 5/6) dry; single grained; loose, nonsticky, nonplastic; few roots; 15 to 20 percent coarse fragments; slight effervescence; moderately alkaline; gradual wavy boundary.

IIC3—31 to 48 inches; dark yellowish brown (10YR 4/4) sand, brownish yellow (10YR 6/6) dry; single grained; loose, nonsticky, nonplastic; few roots; slight effervescence; moderately alkaline; gradual wavy boundary.

IIC4—48 to 60 inches; grayish brown (2.5Y 5/2) sand, light brownish gray (2.5Y 6/2) dry; single grained; loose, nonsticky, nonplastic; slight effervescence; moderately alkaline.

The depth to sand and gravel ranges from 20 to 36 inches. The mollic epipedon is 7 to 16 inches thick. The A1 horizon has hue of 10YR, value of 2 or 3, 3 through 5 dry, and chroma of 1. The ACca and Cca horizons have hue of 10YR or 2.5Y, value of 3 through 6, 5 through 8 dry, and chroma of 1 or 2. The material above the IIC horizon is loam that averages 18 to 27 percent clay. The IIC horizon has hue of 10YR or 2.5Y, value of 4 or 5, 5 or 6 dry, and chroma of 2 through 6. It is gravelly sand, sand, or coarse sand.

Eckman series

The Eckman series consists of deep, well drained, moderately permeable soils on glacial lake plains. These soils formed in material weathered from calcareous glaciolacustrine silt and very fine sand. Slopes are 6 to 9 percent.

Eckman soils are associated on the landscape with Gardena and Glyndon soils. Gardena soils are lower on the landscape and have a thicker mollic epipedon than Eckman soils. Glyndon soils have calcic horizons, are calcareous throughout, and are somewhat poorly drained.

Typical pedon in area of Eckman silt loam, 6 to 9 percent slopes, 1,125 feet west and 110 feet south of northeast corner sec. 3, T. 156 N., R. 73 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure parting to moderate fine granular; soft, very friable, nonsticky, nonplastic; neutral; clear smooth boundary.

B2—8 to 16 inches; dark grayish brown (10YR 4/2) silt loam, grayish brown (10YR 5/2) dry; weak medium prismatic structure parting to moderate medium and fine subangular blocky; soft, very friable, nonsticky, nonplastic; mildly alkaline; clear wavy boundary.

C1ca—16 to 29 inches; dark grayish brown (2.5Y 4/2) very fine sandy loam, light gray (2.5Y 7/2) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky, nonplastic; strong effervescence; mildly alkaline; gradual wavy boundary.

C2—29 to 60 inches; olive (5Y 5/3) very fine sand, pale yellow (5Y 7/3) dry; single grained; loose, nonsticky, nonplastic; slight effervescence; moderately alkaline.

The A horizon has hue of 10YR, value of 2 or 3, 3 through 5 dry, and chroma of 1. The B horizon has hue of 10YR, value of 3 or 4, 4 or 5 dry, and chroma of 2 through 4. The Cca horizon has hue of 2.5Y, value of 4 or 5, 5 through 7 dry, and chroma of 2 through 4. The mollic epipedon is 7 to 16 inches thick.

Egeland series

The Egeland series consists of deep, well drained, moderately rapidly permeable soils on glacial outwash plains. These soils formed in material weathered from loamy and sandy outwash sediment. Slopes are 3 to 9 percent.

Egeland soils are associated on the landscape with Embden, Maddock, and Wyndmere soils. Embden soils, in lower landscape positions, have a thicker mollic epipedon than Egeland soils. Maddock soils are coarser textured. Wyndmere soils have calcic horizons and are calcareous throughout.

Typical pedon in area of Egeland fine sandy loam, 6 to 9 percent slopes, 1,600 feet east and 75 feet south of northwest corner sec. 17, T. 158 N., R. 74 W.

Ap—0 to 10 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium and fine granular structure; soft, very friable, nonsticky, nonplastic; neutral; clear smooth boundary.

B2—10 to 21 inches dark brown (10YR 4/3) fine sandy loam, brown (10YR 5/3) dry; weak coarse prismatic structure parting to weak medium subangular blocky; soft, very friable, nonsticky, nonplastic; mildly alkaline; gradual wavy boundary.

C1ca—21 to 40 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky, nonplastic; strong effervescence; mildly alkaline; gradual wavy boundary.

C2—40 to 50 inches; dark brown (10YR 4/3) fine sandy loam, grayish brown (2.5Y 5/2) dry; single grained; soft, very friable, nonsticky, nonplastic; slight effervescence; mildly alkaline; gradual wavy boundary.

C3—50 to 65 inches; grayish brown (10YR 5/2) loamy fine sand, pale brown (10YR 6/3) dry; single grained; loose, nonsticky, nonplastic; slight effervescence; moderately alkaline.

The mollic epipedon is 8 to 16 inches thick. The solum is 18 to 30 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. The B2 horizon has hue of 10YR or 2.5Y, value of 3 or 4, 4 or 5 dry, and chroma of 2 through 4. It is sandy loam or fine sandy loam. The C horizon has hue of 2.5Y or 10YR, value of 4 or 5, 5 or 6 dry, and chroma of 2 through 4. It is fine sandy loam, 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 material weathered from loamy and sandy outwash sediment. Slopes are 0 to 6 percent.

Embden soils are associated on the landscape with Egeland, Hecla, and Wyndmere soils. Egeland soils are at higher elevations and have a thinner mollic epipedon than Embden soils. Hecla soils are coarser textured. Wyndmere soils have calcic horizons and are calcareous throughout.

Typical pedon in area of Embden fine sandy loam, 0 to 3 percent slopes, 520 feet south and 75 feet east of northwest corner sec. 20, T. 157 N., R. 83 W.

Ap—0 to 8 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; soft, very friable, nonsticky, nonplastic; neutral; abrupt smooth boundary.

A12—8 to 14 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; soft, very friable, nonsticky, nonplastic; neutral; clear wavy boundary.

B2—14 to 21 inches; very dark brown (10YR 2/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; soft, very friable, nonsticky, nonplastic; neutral; gradual wavy boundary.

B3—21 to 32 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; soft, very friable, nonsticky, nonplastic; neutral; gradual wavy boundary.

C1ca—32 to 48 inches; light olive brown (2.5Y 5/4) fine sandy loam, light gray (2.5Y 7/2) dry; massive; loose, nonsticky, nonplastic; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—48 to 60 inches; light olive brown (2.5Y 5/4) loamy fine sand, pale yellow (2.5Y 7/4) dry; few medium distinct dark yellowish brown (10YR 4/4) mottles; massive; loose, nonsticky, nonplastic; slight effervescence; moderately alkaline.

The mollic epipedon is 16 to more than 30 inches thick. The thickness of the solum ranges from 20 to more than 40 inches.

The A horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. The B horizon has hue of 10YR or 2.5Y, value of 2 through 4, 3 through 5 dry, and chroma of 1 through 3. It is fine sandy loam or sandy loam. The C horizon has hue of 2.5Y, value of 4 through 6, 5 through 7 dry, and chroma of 2 through 4. It is fine sandy loam, sandy loam, loamy fine sand, or loamy sand.

Emrick series

The Emrick series consists of deep, moderately well drained, moderately permeable soils on glacial till plains. These soils formed in material weathered from coarse loamy glacial till. Slopes are 0 to 9 percent.

Emrick soils are associated on the landscape with Esmond, Fram, Heimdal, Tonka, and Parnell soils. Esmond and Heimdal soils are at higher elevations than Emrick soils and have a thinner mollic epipedon. Fram soils have calcic horizons and are calcareous throughout. Tonka and Parnell soils, in depressions, have argillic horizons.

Typical pedon in area of Emrick loam, 0 to 3 percent slopes, 1,750 feet north and 100 feet east of southwest corner sec. 26, T. 155 N., R. 72 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; soft, very friable, slightly sticky, slightly plastic; neutral; clear smooth boundary.

A12—8 to 11 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium prismatic structure; soft, very friable, slightly sticky, slightly plastic; neutral; clear wavy boundary.

B21—11 to 19 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to weak medium angular blocky; slightly hard, friable, slightly sticky, slightly plastic; neutral; clear wavy boundary.

B22—19 to 22 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; weak medium prismatic structure parting to moderate medium and fine angular blocky; slightly hard, friable, slightly sticky, slightly plastic; neutral; clear wavy boundary.

C1ca—22 to 32 inches; olive brown (2.5Y 5/4) loam, light gray (2.5Y 7/2) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—32 to 60 inches; olive brown (2.5Y 4/4) loam, pale yellow (2.5Y 7/4) dry; massive; slightly hard, friable, slightly sticky, slightly plastic; strong effervescence; mildly alkaline.

The mollic epipedon is 16 to more than 24 inches thick. The solum is 16 to more than 30 inches thick. The control section is loam that averages between 10 and 18 percent clay.

The A horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. The B horizon has hue of 10YR or 2.5Y, value of 3 or 4, 4 or 5 dry, and chroma of 2 or 3. The C horizon has hue of 2.5Y, value of 4 through 6, 5 through 7 dry, and chroma of 2 through 4.

Esmond series

The Esmond series consists of deep, well drained, moderately permeable soils on glacial moraines. These soils formed in material weathered from calcareous, coarse loamy glacial till. Slopes are 3 to 35 percent.

Esmond soils are similar to Buse soils and are associated on the landscape with Emrick, Fram, and Heimdal soils. Buse soils formed in fine loamy glacial till. Emrick soils have a thicker mollic epipedon than Esmond soils. Fram soils are somewhat poorly drained and are calcareous throughout. Heimdal soils have a B horizon and a thicker mollic epipedon.

Typical pedon of Esmond loam in area of Esmond-Heimdal loams, 9 to 15 percent slopes, 720 feet south and 440 feet west of northeast corner sec. 2, T. 158 N., R. 73 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate medium granular structure; soft, very friable, slightly sticky, slightly plastic; strong effervescence; moderately alkaline; abrupt smooth boundary.

C1ca—7 to 23 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; violent effervescence; moderately alkaline; gradual wavy boundary.

C2ca—23 to 32 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard, friable, slightly sticky, slightly plastic; many large soft irregular masses of lime; violent effervescence; moderately alkaline; gradual irregular boundary.

C3—32 to 60 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; massive; hard, friable, slightly sticky, slightly plastic; strong effervescence; moderately alkaline.

The control section averages between 10 and 18 percent clay. The mollic epipedon is 7 to 12 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, 3 through 5 dry, and chroma of 1. Some pedons have an AC horizon. The Cca horizon has hue of 2.5Y or 10YR, value of 4 through 6, 5 through 7 dry, and chroma of 2 through 4.

Fossum series

The Fossum series consists of deep, poorly drained and very poorly drained, rapidly permeable soils in slight depressions in lake plains and deltas. These soils formed in material weathered from sandy calcareous glaciolacustrine sediment. Slopes are 0 to 1 percent.

Fossum soils are associated on the landscape with Aylmer, Hecla, and Serden soils. Aylmer soils are moderately well drained and noncalcareous in the upper part. Hecla and Serden soils, at higher elevations than Fossum soils, are better drained and are noncalcareous in the upper part.

Typical pedon of Fossum fine sandy loam in area of Fossum soils, 1,925 feet north and 65 feet west of southeast corner sec. 21, T. 154 N., R. 74 W.

A11—0 to 12 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to weak medium granular; soft, very friable, nonsticky, nonplastic; strong effervescence; moderately alkaline.

A12—12 to 18 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak medium and coarse subangular blocky structure; soft, very friable, nonsticky, nonplastic; strong effervescence; moderately alkaline; gradual wavy boundary.

A13—18 to 22 inches; very dark grayish brown (2.5Y 3/2) loamy fine sand, dark grayish brown (2.5Y 4/2) dry; many fine faint light yellowish brown (10YR 6/4) mottles; weak medium and coarse subangular blocky structure; soft, very friable, nonsticky, nonplastic; strong effervescence; moderately alkaline; clear wavy boundary.

C—22 to 60 inches; grayish brown (2.5Y 5/2) fine sand, light gray (2.5Y 7/2) dry; many large prominent yellowish brown (10YR 5/6) mottles; single grained; loose, nonsticky, nonplastic; strong effervescence; moderately alkaline; gradual wavy boundary.

The mollic epipedon is 15 to 24 inches thick.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, 3 or 4 dry, and chroma of 1 in the upper part and 1 or 2 in the lower part. The A11 and A12 horizons are fine sandy loam, sandy loam, loamy fine sand, or loamy sand. The A13 horizon is loamy fine sand, loamy sand, fine sand, or sand. The C horizon has hue of 2.5Y or 5Y, value of 4 through 6, 5 through 7 dry, and chroma of 2 through 4. Texture is fine sand or sand.

Fram series

The Fram series consists of deep, somewhat poorly drained, moderately permeable soils in slight depressions in glacial till plains. These soils formed in material derived from calcareous coarse loamy glacial till. Slopes are 0 to 3 percent.

Fram soils are associated on the landscape with Emrick, Heimdal, Vallers, and Tonka soils. Emrick and Heimdal soils have a B horizon, are better drained than Fram soils, and are noncalcareous in the upper part. Vallers soils are wetter. Tonka soils are in depressions, have argillic horizons, and are poorly drained.

Typical pedon in area of Fram loam, 0 to 3 percent slopes, 150 feet west and 105 feet south of northeast corner sec. 25, T. 151 N., R. 72 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate medium granular structure; slightly hard, very friable, slightly sticky, slightly plastic; strong effervescence; moderately alkaline; abrupt smooth boundary.

C1ca—8 to 13 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; weak medium subangular blocky structure; slightly hard, friable, sticky, plastic; violent effervescence; moderately alkaline; clear irregular boundary.

C2ca—13 to 28 inches; light olive brown (2.5Y 5/4) loam, light gray (2.5Y 7/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; few lime nodules; violent effervescence; moderately alkaline; gradual irregular boundary.

C3—28 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; few fine faint light olive brown (2.5Y 5/6) mottles; massive; hard, friable, slightly sticky, slightly plastic; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick. The loam control section averages between 10 and 18 percent clay.

The A horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. The Cca horizon has hue of 2.5Y or 10YR, value of 4 through 6, 5 through 7 dry, and chroma of 2 through 4.

Gardena series

The Gardena soils consists of deep, moderately well drained, moderately slowly permeable soils on glacial lake

plains. These soils formed in material weathered from coarse silty glaciolacustrine sediment. Slopes are 0 to 6 percent.

Gardena soils are associated on the landscape with Cathay, Eckman, Embden, and Glyndon soils. Eckman soils, at higher elevations, have a thinner mollic epipedon than Gardena soils. Embden soils contain more sand. Glyndon soils have a calcic horizon within a depth of 16 inches, and Cathay soils have natric horizons.

Typical pedon in area of Gardena silt loam, 0 to 3 percent slopes, 1,320 feet west and 100 feet north of southeast corner sec. 26, T. 157 N., R. 73 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate fine granular structure; soft, very friable, nonsticky, nonplastic; neutral; clear smooth boundary.

A12—8 to 20 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak coarse prismatic structure parting to weak medium subangular blocky; soft, very friable, nonsticky, nonplastic; neutral; clear wavy boundary.

B2—20 to 34 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to moderate medium fine subangular blocky; soft, very friable, nonsticky, nonplastic; mildly alkaline; gradual wavy boundary.

C1—34 to 42 inches; dark grayish brown (10YR 4/2) silt loam, grayish brown (10YR 5/2) dry; weak coarse and medium subangular blocky structure; soft, very friable, nonsticky, nonplastic; slight effervescence; mildly alkaline; gradual wavy boundary.

C2—42 to 60 inches; light olive brown (2.5Y 5/4) very fine sandy loam, pale yellow (2.5Y 7/4) dry; single grained; soft, very friable, nonsticky, nonplastic; slight effervescence; mildly alkaline.

The mollic epipedon is 16 to more than 30 inches thick. The control section averages less than 18 percent clay, less than 15 percent fine and coarser sand, and 20 to 45 percent or more very fine sand.

The A horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. The B2 horizon has hue of 10YR or 2.5Y, value of 2 through 4, 3 through 5 dry, and chroma of 1 through 3. Some pedons have a B2 horizon. The C horizon has hue of 10YR or 2.5Y, value of 4 through 6, 5 through 7 dry, and chroma of 2 through 4. Map unit 71, Gardena silt loam, clayey substratum, 0 to 3 percent slopes, has texture of silty clay or silty clay loam below depths of 40 and 60 inches.

Glyndon series

The Glyndon series consists of deep, somewhat poorly drained, moderately rapidly permeable soils on glacial lake plains. These soils formed in material weathered from calcareous coarse silty lake sediment. Slopes are 0 to 3 percent.

Glyndon soils are associated on the landscape with Borup, Eckman, and Gardena soils. Borup soils are wetter than Glyndon soils. Eckman and Gardena soils are at higher elevations, do not have calcic horizons, and are better drained.

Typical pedon in area of Glyndon silt loam, 0 to 3 percent slopes, 2,000 feet south and 1,100 feet west of northeast corner sec. 8, T. 158 N., R. 73 W.

Ap—0 to 7 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate medium granular structure; soft, very friable, slightly sticky, slightly plastic; strong effervescence; mildly alkaline; clear smooth boundary.

C1ca—7 to 21 inches; gray (10YR 5/1) silt loam, gray (10YR 6/1) and light gray (10YR 7/1) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; violent effervescence; strongly alkaline; gradual smooth boundary.

C2ca—21 to 27 inches; dark gray (10YR 4/1) silt loam, gray (10YR 5/1) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; violent effervescence; strongly alkaline; clear wavy boundary.

C3ca—27 to 33 inches; light gray (2.5Y 7/2) and pale olive (5Y 6/3) silt loam, light gray (2.5Y 7/2) and light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; violent effervescence; strongly alkaline; clear wavy boundary.

C4—33 to 45 inches; light olive brown (2.5Y 5/4) very fine sandy loam, light yellowish brown (2.5Y 6/4) dry; common medium distinct gray (5Y 6/1) mottles; massive; hard, friable, slightly sticky, slightly plastic; strong effervescence; moderately alkaline; gradual wavy boundary.

C5—45 to 60 inches; grayish brown (2.5Y 5/2) sandy clay loam, light brownish gray (2.5Y 6/2) dry; common medium distinct yellowish brown (10YR 5/6) mottles; massive; hard, firm, sticky, plastic; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick. The control section averages less than 18 percent clay, less than 15 percent fine and coarser sand, and 20 to over 45 percent very fine sand.

The A horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. The Cca horizon has hue of 10YR or 2.5Y, value of 4 through 6, 5 through 7 dry, and chroma of 1 through 4.

Hamerly series

The Hamerly series consists of deep, somewhat poorly drained, moderately slowly permeable soils on glacial till plains. These soils formed in material weathered from calcareous fine loamy glacial till. Slopes are 0 to 3 percent.

Hamerly soils are associated on the landscape with Barnes, Parnell, Tonka, and Vallers soils. Barnes soils have a B horizon, do not have calcic horizons, and are better drained than Hamerly soils. Parnell and Tonka soils are wetter, do not have calcic horizons, but have argillic horizons. Vallers soils are wetter.

Typical pedon of Hamerly loam in area of Hamerly-Tonka complex, 0 to 3 percent slopes, 1,300 feet north and 600 feet west of southeast corner sec. 28, T. 158 N., R. 69 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to moderate medium granular; slightly hard, friable, slightly sticky, slightly plastic; many fine pores; slight effervescence; moderately alkaline; abrupt smooth boundary.

C1ca—7 to 16 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; common medium pores; violent effervescence; moderately alkaline; gradual wavy boundary.

C2ca—16 to 29 inches; dark grayish brown (2.5Y 4/2) and light brownish gray (2.5Y 6/2) loam, light gray (2.5Y 7/2) and white (2.5Y 8/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; common medium pores; violent effervescence; moderately alkaline; gradual wavy boundary.

C3—29 to 38 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; common medium distinct olive gray (5Y 5/2) and yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; slightly hard, firm, slightly sticky, slightly plastic; few medium pores; strong effervescence; moderately alkaline; gradual wavy boundary.

C4—38 to 60 inches; olive brown (2.5Y 4/4) clay loam, light yellowish brown (2.5Y 6/4) dry; many medium distinct olive gray (5Y 5/2) and yellowish brown (10YR 5/6) mottles; massive; hard, firm, sticky, plastic; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick. The control section is loam or light clay loam that averages between 18 and 30 percent clay.

The A horizon has hue of 10YR, value of 2 or 3, 4 or 5 dry, and chroma of 1. The Cca horizon has hue of 2.5Y or 10YR, value of 4 or 5, 4 through 7 dry, and chroma of 1 through 4. The C horizon has hue of 2.5Y or 5Y, value of 4 through 6, 5 through 7 dry, and chroma of 2 through 4.

Hecla series

The Hecla series consists of deep, moderately well drained, rapidly permeable soils on sandy lacustrine and glacial outwash plains. These soils formed in material weathered from sandy eolian material. Slopes are 0 to 3 percent.

Hecla soils are associated on the landscape with Maddock and Ulen soils. Maddock soils are beter drained and have a thinner mollic epipedon than Hecla soils. Ulen soils have calcic horizons and are wetter.

Typical pedon in area of Hecla loamy fine sand, 0 to 3 percent slopes, 1,500 feet west and 100 feet north of southeast corner sec. 4, T. 158 N., R. 74 W.

A11—0 to 11 inches; black (10YR 2/1) loamy fine sand, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky, nonplastic; slightly acid; abrupt smooth boundary.

A12—11 to 18 inches; black (10YR 2/1) loamy fine sand, very dark gray (10YR 3/1) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky, nonplastic; neutral; clear smooth boundary.

C1—18 to 25 inches; very dark gray (10YR 3/1) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; soft, very friable, nonsticky, nonplastic; neutral; gradual wavy boundary.

C2—25 to 36 inches; dark grayish brown (10YR 4/2) loamy fine sand, grayish brown (10YR 5/2) dry; single grained; loose, sticky, nonplastic; neutral; gradual irregular boundary.

C3—36 to 60 inches; grayish brown (2.5Y 5/2) fine sand, light gray (2.5Y 7/2) dry; common fine distinct light yellowish brown (2.5Y 6/4) mottles; single grained; loose, nonplastic; strong effervescence; mildly alkaline.

The mollic epipedon is more than 16 inches thick. The solum is 24 to 40 inches thick. The control section is loamy fine sand, loamy sand, or fine sand.

The A horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. Some pedons have an AC horizon. The C horizon has hue of 10YR or 2.5Y, value of 3 through 5, 4 through 7 dry, and chroma of 2 through 4.

Hegne series

The Hegne series consists of deep, poorly drained and very poorly drained, very slowly permeable soils on glacial lake plains. These soils formed in material weathered from clayey calcareous lake sediment. Slopes are 0 to 1 percent.

Hegne soils are associated on the landscape with Bearden, Colvin, and Overly soils. Bearden, Colvin, and Overly soils contain less clay than Hegne soils. Overly soils are better drained and do not have calcic horizons within a depth of 16 inches.

Typical pedon in area of Hegne silty clay, 205 feet west and 25 feet south of northeast corner sec. 7, T. 157 N., R. 70 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure parting to strong medium granular; very hard, very firm, very sticky, very plastic; slight effervescence; moderately alkaline; abrupt smooth boundary.

C1ca—8 to 18 inches; dark olive gray (5Y 3/2) silty clay, gray (5Y 5/1) dry; moderate fine angular blocky structure; extremely hard, very firm, very sticky, very plastic; violent effervescence; moderately alkaline; gradual wavy boundary.

C2ca—18 to 32 inches; olive gray (5Y 4/2) silty clay, olive gray (5Y 5/2) dry; moderate fine angular blocky structure; extremely hard, very firm, very sticky, very plastic; violent effervescence; moderately alkaline; gradual wavy boundary.

C3—32 to 42 inches; olive gray (5Y 5/2) silty clay, light olive gray (5Y 6/2) dry; massive; extremely hard, very firm, very sticky, very plastic; common lime masses; 2 to 5 percent pebbles; thin gravelly contact layer at 42 inches; strong effervescence; moderately alkaline; gradual wavy boundary.

C4—42 to 60 inches; olive (5Y 4/3) silty clay, pale olive (5Y 6/3) dry; many fine prominent dark yellowish brown (10YR 4/4) mottles; massive; very hard, very firm, very sticky, very plastic; many large gypsum nests; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick. The control section is silty clay, but in some pedons it is clay.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, 3 or 4 dry, and chroma of 1. The C horizon to 40 inches has hue of 2.5Y or 5Y, value of 3 through 5, 4 through 7 dry, and chroma of 1 or 2. Below a depth of 40 inches the chroma is 1 through 3.

Heimdal series

The Heimdal series consists of deep, well drained, moderately permeable soils on glacial till plains. These soils formed in material weathered from calcareous coarse loamy glacial till. Slopes are 0 to 35 percent.

Heimdal soils are associated on the landscape with Emrick, Fram, Esmond, Tonka, and Parnell soils. Emrick soils have a thicker mollic epipedon than Heimdal soils. Fram soils have a calcic horizon within a depth of 16 inches and are calcareous throughout. Esmond soils are at higher elevations than Heimdal soils and do not have a B horizon. Tonka and Parnell soils are poorly drained or very poorly drained and have argillic horizons.

Typical pedon of Heimdal loam in area of Emrick-Heimdal loams, 3 to 6 percent slopes, 2,400 feet south and 100 feet east of northwest corner sec. 26, T. 155 N., R. 72 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; soft, very friable, slightly sticky, slightly plastic; neutral; abrupt smooth boundary.

B21—8 to 14 inches; very dark brown (10YR 2/2) loam, brown (10YR 4/3) dry; moderate medium prismatic structure parting to weak medium angular blocky; soft, friable, slightly sticky, slightly plastic; neutral; clear wavy boundary.

B22—14 to 20 inches; dark grayish brown (10YR 4/2) loam, pale brown (10YR 6/3) dry; weak medium prismatic structure parting to moderate medium angular blocky; soft, friable, slightly sticky, slightly plastic; mildly alkaline; clear wavy boundary.

B3ca—20 to 26 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; weak medium subangular blocky structure; soft, friable, slightly sticky, slightly plastic; strong effervescence; mildly alkaline; gradual wavy boundary.

C1ca—26 to 36 inches; light olive brown (2.5Y 5/4) loam, light gray (2.5Y 7/2) dry; weak medium subangular blocky structure; soft, friable, slightly sticky, slightly plastic; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—36 to 60 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; massive; soft, friable, slightly sticky, slightly plastic; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick. The control section is loam that averages between 10 and 18 percent clay.

The A horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. The B2 horizon has hue of 10YR, value of 2 through 5, 4 through 6 dry, and chroma of 2 through 4. Many pedons have a B2 horizon. The C horizon has hue of 2.5Y, value of 4 or 5, 5 through 7 dry, and chroma of 2 through 4.

Letcher series

The Letcher series consists of deep, moderately well drained, slowly permeable soils on glacial outwash plains. These soils have natric horizons. They formed in material weathered from glacial outwash sediment. Slopes are 0 to 3 percent.

Letcher soils are associated on the landscape with Embden and Swenoda soils. These soils do not have natric horizons.

Typical pedon in area of Letcher fine sandy loam, 0 to 3 percent slopes, 575 feet south and 130 feet east of northwest corner sec. 4, T. 158 N., R. 74 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium granular structure; soft, very friable, nonsticky, nonplastic; mildly alkaline; abrupt smooth boundary.

A12—7 to 13 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; soft, very friable, nonsticky, nonplastic; moderately alkaline; abrupt smooth boundary.

B21t—13 to 19 inches; dark grayish brown (10YR 4/2) fine sandy loam, grayish brown (2.5Y 5/2) dry; strong very coarse columnar structure parting to moderate medium angular blocky; very hard, friable, slightly sticky, slightly plastic; columns coated with bleached sand; salt threads visible; very strongly alkaline; gradual irregular boundary.

B22t—19 to 25 inches; very dark grayish brown (2.5Y 3/2) crushing to dark grayish brown (2.5Y 4/2) fine sandy loam, dark grayish brown (2.5Y 4/2) crushing to grayish brown (2.5Y 5/2) dry; moderate very coarse prismatic structure; hard, very friable, nonsticky, nonplastic; slight effervescence; very strongly alkaline; gradual irregular boundary.

C1ca—25 to 38 inches; dark gray (10YR 4/1) and grayish brown (2.5Y 5/2) silty clay loam, light gray (10YR 6/1) dry; massive; hard, friable, sticky, plastic; many soft masses of lime; violent effervescence; gradual irregular boundary.

C2—38 to 60 inches; light olive brown (2.5Y 5/4) loamy very fine sand, light yellowish brown (2.5Y 6/4) dry; common medium distinct olive yellow (2.5Y 6/6) mottles; massive; soft, very friable, nonsticky, nonplastic; strong effervescence; very strongly alkaline.

The A horizon has hue of 10YR, value of 2 or 3, 4 or 5 dry, and chroma of 1. Many pedons have an A2 horizon. The B2t horizon has hue of 10YR or 2.5Y, value of 3 or 4, 4 or 5 dry, and chroma of 2 or 3. It is sandy loam or fine sandy loam that averages less than 18 percent clay.

Maddock series

The Maddock series consists of deep, well drained, rapidly permeable soils on sandy lacustrine plains and glacial outwash plains. These soils formed in material weathered from sandy eolian material. Slopes are 3 to 15 percent.

Maddock soils are associated on the landscape with Dickey, Hecla, and Towner soils. Dickey and Towner soils have a IIC horizon of loam, silt loam, or silty clay loam. Hecla soils have a thicker mollic epipedon than Maddock soils.

Typical pedon in area of Maddock loamy fine sand, 3 to 6 percent slopes, 300 feet south and 2,050 feet east of the northwest corner sec. 30, T. 156 N., R. 74 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak medium granular structure; soft, very friable, nonsticky, nonplastic; mildly alkaline; abrupt smooth boundary.

A12—7 to 11 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 3/1) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky, nonplastic; mildly alkaline; abrupt wavy boundary.

C1—11 to 20 inches; dark grayish brown (10YR 4/2) loamy fine sand, light brownish gray (10YR 6/2) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky, nonplastic; neutral; gradual wavy boundary.

C2—20 to 48 inches; dark grayish brown (10YR 4/2) fine sand, pale brown (10YR 6/3) dry; single grained; loose, nonsticky, nonplastic; slight effervescence; moderately alkaline; gradual wavy boundary.

C3—48 to 60 inches; dark grayish brown (10YR 4/2) loamy very fine sand, very pale brown (10YR 7/3) dry; single grained; loose, nonsticky, nonplastic; strong effervescence; moderately alkaline.

The mollic epipedon is 10 to 16 inches thick. The control section is loamy fine sand, loamy sand, or fine sand.

The A horizon has hue of 10YR, value of 2 or 3, 3 through 5 dry, and chroma of 1. It is loamy fine sand or loamy sand. The C horizon has hue of 10YR or 2.5Y, value of 3 or 4, 5 through 7 dry, and chroma of 2 through 4.

Overly series

The Overly series consists of deep, moderately well drained, moderately slowly permeable soils on glacial lake plains. These soils formed in material weathered from calcareous fine silty lake sediment. Slopes are 0 to 1 percent.

Overly soils are associated on the landscape with Bearden and Colvin soils. They are similar to Gardena soils. Bearden and Colvin soils have calcic horizons within a depth of 16 inches. Gardena soils contain less clay than Overly soils.

Typical pedon in area of Overly silty clay loam, 1,325 feet east and 700 feet south of northwest corner sec. 25, T. 158 N., R. 70 W.

Ap—0 to 6 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium granular structure; slightly hard, friable, sticky, plastic; mildly alkaline; abrupt smooth boundary.

A12—6 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine angular blocky structure; slightly hard, friable, sticky, plastic; mildly alkaline; clear wavy boundary.

B2—9 to 17 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium angular blocky structure; hard, friable, sticky, plastic; mildly alkaline; gradual wavy boundary.

B3ca—17 to 22 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak coarse subangular blocky structure; hard, friable, sticky, plastic; many soft masses of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

C1ca—22 to 32 inches; grayish brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; weak fine subangular blocky structure; hard, friable, sticky, plastic; violent effervescence; mildly alkaline; gradual wavy boundary.

C2—32 to 60 inches; light olive brown (2.5Y 5/4) silty clay loam, pale yellow (2.5Y 7/4) dry; common medium distinct light brownish gray (2.5Y 6/2) mottles; massive; hard, firm, sticky, plastic; strong effervescence; moderately alkaline.

The mollic epipedon is 16 to 24 inches thick. The control section averages between 25 and 35 percent clay and is less than 15 percent fine or coarser sand.

The A horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. The B2 horizon has hue of 10YR or 2.5Y, value of 2 through 4, 3 through 5 dry, and chroma of 1 through 3. The B3 horizon has hue of 10YR or 2.5Y, value of 3 through 5, 4 through 7 dry, and chroma of 1 through 3. The Cca horizon has hue of 2.5Y, value of 4 through 6, 6 or 7 dry, and chroma of 2 through 4.

Parnell series

The Parnell series consists of deep, very poorly drained, slowly permeable soils in depressions in glacial till plains. These soils formed in material weathered from local clayey glacial alluvium. Slopes are 0 to 1 percent.

Parnell soils are associated on the landscape with Fram, Emrick, Hamerly, Svea, Tonka, and Vallers soils. Fram, Hamerly, and Vallers soils have calcic horizons within a depth of 16 inches. Emrick, Tonka, and Svea soils are better drained than Parnell soils. Emrick and Svea soils contain less clay. All the associated soils except Tonka soils lack argillic horizons.

Typical pedon in area of Parnell silty clay loam, 600 feet north and 70 feet west of southeast corner sec. 20, T. 158 N., R. 69 W.

A1—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; slightly hard, friable, sticky, plastic; slightly acid; clear wavy boundary.

B21tg—8 to 24 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; strong medium angular blocky structure; very hard, firm, very sticky, very plastic; thin continuous clay films on faces of blocks; neutral; clear wavy boundary.

B22tg—24 to 46 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; strong fine angular blocky structure; very hard, firm, very sticky, very plastic; few thin patchy clay films, neutral, slight effervescence; gradual wavy boundary.

Cg—46 to 60 inches; olive gray (5Y 5/2) clay loam, gray (5Y 6/1) dry; few fine faint yellow (2.5Y 7/6) mottles; massive; very hard, firm, very sticky, very plastic; slight effervescence; neutral.

The solum is more than 36 inches thick. The mollic epipedon is more than 24 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. The B horizon has hue of 10YR or 2.5Y, value of 2 through 4, 3 through 5 dry, and chroma of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 4 through 6, 5 through 7 dry, and chroma of 1 or 2. In many pedons it contains free carbonates.

Serden series

The Serden series consists of deep, excessively drained, rapidly permeable soils on sand-mantled uplands and outwash plains. These soils formed in material weathered from wind-sorted sands. Slopes are 0 to 15 percent.

Serden soils are associated on the landscape with Aylmer and Fossum soils. Aylmer soils have mottles within a depth of 40 inches and are not so well drained as Serden soils. Fossum soils are poorly drained.

Typical pedon of Serden loamy fine sand in area of Serden soils, 0 to 15 percent slopes, 1,405 feet west and 340 feet south of northeast corner sec. 16, T. 154 N., R. 74 W.

A1—0 to 2 inches; very dark brown (10YR 2/2) loamy fine sand, dark gray (10YR 4/1) dry; single grained; loose, nonsticky, nonplastic; neutral; clear wavy boundary.

C—2 to 60 inches; dark grayish brown (10YR 4/2) fine sand, grayish brown (10YR 5/2) dry; single grained; loose, nonsticky, nonplastic; neutral.

The control section is fine sand that is less than 65 percent medium sand and less than 25 percent coarse and very coarse sand. The mollic epipedon is less than 10 inches thick.

The A horizon has hue of 10YR, value of 2 through 4, 3 through 6 dry, and chroma of 1 or 2. It is loamy fine sand, loamy sand, or fine sand. The C horizon has hue of 10YR or 2.5Y, value of 4 through 6, 5 through 7 dry, and chroma of 2 through 4.

Sioux series

The Sioux series consists of deep, excessively drained, rapidly permeable soils on outwash plains and glacial moraines. These soils are very shallow over sand and gravel. They formed in material weathered from loamy sediment. Slopes are 1 to 15 percent.

Sioux soils are associated with Arvilla and Divide soils. Arvilla soils have a thicker solum and contain fewer rock fragments than Sioux soils. Divide soils have a calcic horizon within a depth of 16 inches.

Typical pedon of Sioux loam in area of Sioux soils, 1 to 15 percent slopes, 2,300 feet east and 1,400 feet south of northwest corner sec. 31, T. 152 N., R. 74 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure parting to moderate medium granular; slightly hard, very friable, slightly sticky, slightly plastic; mildly alkaline; abrupt smooth boundary.

IIC1—6 to 16 inches; dark brown (10YR 4/3) gravelly loamy sand, light gray (10YR 7/2) dry; single grained; loose, nonsticky, nonplastic; 40 percent coarse fragments; strong effervescence; moderately alkaline; gradual irregular boundary.

IIC2—16 to 60 inches; dark brown (10YR 4/3) gravelly sand, brown (10YR 5/3) dry; single grained; loose, nonsticky, nonplastic; lime coats underside of gravel; 40 percent coarse fragments; slight effervescence; moderately alkaline.

Thickness of the solum and the depth to sand and gravel range from 6 to 14 inches.

The A horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. It is loam or sandy loam and in a few pedons is gravelly. The IIC horizon has hue of 10YR or 2.5Y, value of 4 through 6, 5 through 7 dry, and chroma of 2 through 4. It is gravelly sand, sand, or coarse sand. In many pedons the upper part of the IIC horizon is gravelly loamy sand.

Stirum series

The Stirum series consists of deep, poorly drained, moderately slowly permeable soils on sandy outwash plains and lake plains. These soils have natric horizons. They formed in material weathered from loamy and sandy saline-alkali sediment. Slopes are 0 to 3 percent.

Stirum soils are associated on the landscape with Embden, Fossum, and Hecla soils. Embden and Hecla soils are better drained than Stirum soils, and Fossum soils contain more sand. All the associated soils lack natric horizons.

Typical pedon of Stirum fine sandy loam in area of Stirum soils, 0 to 3 percent slopes, 2,620 feet west and 1,320 feet south of northeast corner of sec. 8, T. 157 N., R. 74 W.

A1—0 to 5 inches; black (10YR 2/1) fine sandy loam, gray (10YR 5/1) dry; weak medium granular structure; soft, very friable, nonsticky, nonplastic; moderately alkaline; abrupt smooth boundary.

B2t—5 to 14 inches; very dark grayish brown (2.5Y 3/2) fine sandy loam, grayish brown (2.5Y 5/2) dry; strong coarse columnar structure;

hard, firm, sticky, plastic; black (10YR 2/1) clay films on prisms; bleach sand on upper prisms and column tops; slight effervescence; strongly alkaline; clear wavy boundary.

B3gsa—14 to 23 inches; light gray (5Y 7/1) sandy clay loam, white (5Y 8/1) dry; weak very coarse prismatic structure; hard, friable, slightly sticky, slightly plastic; gray (5Y 5/1) clay films on prisms; visible salts; strong effervescence (inside prisms); strongly alkaline; gradual irregular boundary.

C1g—23 to 31 inches; light olive gray (5Y 6/2) sandy loam, light gray (5Y 7/1) dry; common medium distinct greenish gray (5G 6/1) mottles; massive; slightly hard, very friable, nonsticky, nonplastic; slight effervescence; strongly alkaline; gradual irregular boundary.

C2g—31 to 60 inches; light gray (5Y 7/2) loamy sand, light gray (5Y 7/1) dry; many coarse prominent brownish yellow (10YR 6/8) mottles; single grained; hard, very friable, nonsticky, nonplastic; slight effervescence; strongly alkaline.

The solum is 16 to 30 inches thick. The B horizon, and in many pedons the A horizon, contains free lime.

The A horizon has hue of 10YR, value of 2 or 3, 3 through 5 dry, and chroma of 1. It is fine sandy loam or loam. The B2t horizon has hue of 10YR through 5Y, value of 3 through 5, 4 through 7 dry, and chroma of 1 or 2. It is loam or fine sandy loam. Some pedons do not have a B2 horizon. The C horizon has hue of 2.5Y or 5Y, value of 4 through 7, 5 through 8 dry, and chroma of 1 through 4. It is very fine sandy loam or loam.

Svea series

The Svea series consists of deep, moderately well drained, moderately slowly permeable soils on glacial till plains. These soils formed in material weathered from calcareous, fine loamy glacial till. Slopes are 0 to 6 percent.

Svea soils are associated on the landscape with Barnes, Buse, Hamerly, Parnell, Tonka, and Vallers soils. Barnes and Buse soils are well drained and have a thinner solum than Svea soils. Hamerly and Vallers soils have calcic horizons within a depth of 16 inches. Tonka and Parnell soils are wetter than Svea soils and have argillic horizons.

Typical pedon of Svea loam in area of Barnes-Svea loams, 3 to 6 percent slopes, 1,400 feet west and 800 feet north of southeast corner sec. 34, T. 158 N., R. 69 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak coarse subangular blocky structure parting to moderate medium granular; slightly hard, friable, slightly sticky, slightly plastic; many fine pores; neutral; abrupt smooth boundary.

A12—8 to 12 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak coarse prismatic structure parting to moderate medium granular; slightly hard, friable, slightly sticky, slightly plastic; many fine pores; neutral; clear wavy boundary.

B2—12 to 27 inches; very dark grayish brown (2.5Y 3/2) loam, grayish brown (2.5Y 5/2) dry; moderate medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky, slightly plastic; common medium pores; patches of clay on vertical faces; mildly alkaline; clear wavy boundary.

C1ca—27 to 37 inches; light olive brown (2.5Y 5/4) clay loam, pale yellow (2.5Y 7/4) dry; weak medium subangular blocky structure; hard, firm, sticky, plastic; common medium pores; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—37 to 60 inches; light olive brown (2.5Y 5/4) clay loam, pale yellow (2.5Y 7/4) dry; common fine distinct yellowish red (5YR 5/6) and few fine faint olive gray (5Y 5/2) mottles; massive; hard, firm, sticky, plastic; few gypsum nests; strong effervescence; moderately alkaline.

The mollic epipedon is 16 to more than 30 inches thick. The control section is loam or light clay loam that averages between 18 and 28 percent clay.

The A horizon has hue of 10YR, value of 2 or 3, 3 through 5 dry, and chroma of 1. The B2 horizon has hue of 10YR or 2.5Y, value of 2 or 3, 3 through 5 dry, and chroma of 1 through 3. The Cca horizon has hue of 2.5Y, value of 4 through 6, 5 through 7 dry, and chroma of 2 through 4.

Swenoda series

The Swenoda series consists of deep, moderately well drained and well drained, moderately slowly permeable soils on sand-mantled glacial till plains. These soils formed in material derived from eolian sands and loamy glacial till. Slopes are 0 to 9 percent.

Swenoda soils are associated on the landscape with Egeland, Embden, Towner, and Wyndmere soils. Egeland and Embden soils have a sandy substratum. Towner soils are sandy in the upper part. Wyndmere soils have a calcic horizon within a depth of 16 inches.

Typical pedon in area of Swenoda fine sandy loam, 3 to 6 percent slopes, 234 feet north and 2,415 feet west of southeast corner sec. 15, T. 153 N., R. 73 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; soft, very friable, nonsticky, nonplastic; common fine roots; neutral; abrupt wavy boundary.

B21—8 to 20 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak coarse prismatic structure parting to weak medium subangular blocky; soft, very friable, nonsticky, nonplastic; common fine roots; mildly alkaline; gradual wavy boundary.

B22—20 to 29 inches; dark grayish brown (10YR 4/2) fine sandy loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky, nonplastic; common fine roots; mildly alkaline; clear wavy boundary.

IIC1ca—29 to 42 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; weak coarse subangular blocky structure; hard, friable, slightly sticky, slightly plastic; white (2.5Y 8/2) lime; violent effervescence; moderately alkaline; gradual wavy boundary.

IIC2—42 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; hard, friable, slightly sticky, slightly plastic; strong effervescence; moderately alkaline.

Depth to the IIC horizon ranges from 22 to 40 inches. The IIC horizon is generally loam, but in some pedons it is clay loam, silt loam, or silty clay loam. The mollic epipedon is more than 16 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. The B horizon has hue of 10YR or 2.5Y, value of 2 through 4, 3 through 6 dry, and chroma of 1 through 3. The A and B horizons are fine sandy loam or sandy loam. The IIC horizon has hue of 2.5Y, value of 4 through 6, 6 through 8 dry, and chroma of 2 through 4.

Tiffany series

The Tiffany series consists of deep, poorly drained, moderately permeable soils on lake plains and outwash plains. These soils formed in material weathered from loamy and sandy sediment. Slopes are 0 to 1 percent.

Tiffany soils are associated on the landscape with Embden, Swenoda, and Wyndmere soils. Embden and Swenoda soils are better drained than Tiffany soils. Wyndmere soils have a calcic horizon within a depth of 16 inches.

Typical pedon in area of Tiffany fine sandy loam, 1,400 feet west and 160 feet north of southeast corner sec. 12, T. 158 N., R. 74 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium granular structure; soft, very friable, nonsticky, nonplastic; slightly acid; abrupt smooth boundary.

A12—7 to 21 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; common medium distinct dark brown (7.5YR 4/4) mottles; weak very coarse prismatic structure parting to weak medium and coarse subangular blocky; soft, very friable, nonsticky, nonplastic; common medium pores; mildly alkaline; clear wavy boundary.

C1—21 to 28 inches; dark gray (10YR 4/1) fine sandy loam, grayish brown (10YR 5/2) dry; common medium faint dark brown (7.5YR 4/4) mottles; weak very coarse prismatic structure parting to weak medium and coarse subangular blocky; soft, very friable, nonsticky, nonplastic; common fine pores; mildly alkaline; gradual wavy boundary.

C2—28 to 39 inches; dark grayish brown (10YR 4/2) fine sandy loam, light brownish gray (10YR 6/2) dry; common fine faint brown (7.5YR 5/4) mottles; weak coarse subangular blocky structure; soft, very friable, nonsticky, nonplastic; common medium pores; mildly alkaline; gradual irregular boundary.

IIC3—39 to 45 inches; dark gray (10YR 4/1) silt loam, gray (10YR 5/1) dry; massive; slightly hard, friable, slightly sticky, slightly plastic; strong effervescence; mildly alkaline; gradual irregular boundary.

IIC4—45 to 56 inches; light olive brown (2.5Y 5/4) fine sandy loam, light yellowish brown (2.5Y 6/4) dry; massive; soft, very friable, nonsticky, nonplastic; weak effervescence; mildly alkaline; gradual irregular boundary.

IIC5—56 to 60 inches; light brownish gray (2.5Y 6/2) and light olive brown (2.5Y 5/4) clay loam, light brownish gray (2.5Y 6/2) and light yellowish brown (2.5Y 6/4) dry; massive; hard, firm, sticky, plastic; weak effervescence; mildly alkaline.

The control section is fine sandy loam to light silt loam. Texture below a depth of 40 inches ranges from fine sand to clay loam.

The A horizon has hue of 10YR, value of 2 or 3, 3 through 5 dry, and chroma of 1. The C horizon has hue of 10YR through 5Y, value of 4 through 6, 5 through 7 dry, and chroma of 1 through 4. Some pedons have an AC horizon.

Tonka series

The Tonka series consists of deep, poorly drained, slowly permeable soils in shallow depressions in glacial till plains and lake plains. These soils formed in material derived from moderately fine or fine textured alluvium. Slopes are 0 to 1 percent.

Tonka soils are associated on the landscape with Barnes, Emrick, Fram, Gardena, Hamerly, Heimdal, Svea, and Vallers soils. Barnes, Emrick, Gardena, Heimdal, and Svea soils are at higher elevations and are better drained than Tonka soils. Fram, Hamerly, and Vallers soils have calcic horizons within a depth of 16 inches. None of these associated soils have argillic horizons.

Typical pedon in area of Tonka silt loam, 2,490 feet north and 225 feet west of southwest corner sec. 16, T. 155 N., R. 73 W.

A1—0 to 11 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; moderate medium granular structure; soft, very friable, slightly sticky, slightly plastic; slightly acid; abrupt wavy boundary.

A21—11 to 18 inches; dark gray (10YR 4/1) silt loam, light gray (10YR 7/1) dry; many large distinct dark yellowish brown (10YR 4/4) mottles; moderate fine platy structure; slightly hard, very friable, nonsticky, slightly plastic; slightly acid; clear wavy boundary.

A22—18 to 24 inches; dark gray (10YR 4/1) silt loam, gray (10YR 5/1) dry; moderate fine platy structure; very hard, firm, sticky, plastic; many bleached light gray (10YR 7/2) sand grains; medium acid; clear wavy boundary.

B21t—24 to 30 inches; very dark gray (10YR 3/1) heavy silty clay loam, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to strong fine angular blocky; very hard, very firm, sticky, very plastic; clay films on ped faces; medium acid; gradual wavy boundary.

B22—30 to 37 inches; dark gray (10YR 4/1) silty clay loam, grayish brown (10YR 5/2) dry; common medium distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate fine angular blocky; very hard, very firm, sticky, plastic; slightly acid; gradual irregular boundary.

C—37 to 60 inches; dark grayish brown (2.5Y 4/2) clay loam, light olive brown (2.5Y 5/4) dry; many large prominent brown (7.5YR 4/4) mottles; massive; very hard, very firm, sticky, plastic; neutral.

Depth to carbonates ranges from 20 to more than 60 inches.

The A1 horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. The A2 horizon has hue of 10YR or 2.5Y, value of 3 through 5, 5 through 7 dry, and chroma of 1 or 2. The B horizon has hue of 10YR or 2.5Y, value of 2 through 4, 3 through 6 dry, and chroma of 1 or 2. It ranges from heavy silty clay loam to silty clay. Some pedons have a B3 horizon.

Towner series

The Towner series consists of deep, moderately well drained and well drained, moderately slowly permeable soils on sand-mantled glacial till plains. These soils formed in material derived from wind- and water-deposited sand and loamy glacial till. Slopes are 0 to 6 percent.

Towner soils are associated on the landscape with Dickey, Hecla, Maddock, and Swenoda soils. Dickey soils have a thinner mollic epipedon than Towner soils. Hecla and Maddock soils have a sandy substratum. Swenoda soils contain less sand in the upper part.

Typical pedon in area of Towner loamy fine sand, 0 to 3 percent slopes, 552 feet west and 530 feet south of northeast corner sec. 5, T. 153 N., R. 74 W.

A11—0 to 6 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine granular structure; soft, very friable, nonsticky, nonplastic; many fine roots; neutral; clear wavy boundary.

A12—6 to 20 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak very coarse prismatic structure parting to weak medium and coarse subangular blocky; soft, very friable, nonsticky, nonplastic; common fine roots; mildly alkaline; clear wavy boundary.

C1—20 to 29 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak medium and coarse subangular blocky structure; soft, very friable, nonsticky, nonplastic; common fine roots; mildly alkaline; abrupt wavy boundary.

IIC2ca—29 to 36 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; violent effervescence; moderately alkaline; gradual wavy boundary.

IIC3—36 to 60 inches; olive brown (2.5Y 4/4) loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; strong effervescence; moderately alkaline.

Depth to the IIC horizon ranges from 20 to 40 inches. The mollic epipedon is 16 to 24 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. It is loamy fine sand or loamy sand. The C horizon has hue of 10YR or 2.5Y, value of 3 or 4, 4 through 6 dry, and chroma of 2 through 4. The IIC horizon has hue of 2.5Y or 5Y, value of 4 through 6, 5 through 8 dry, and chroma of 2 through 4. It typically is loam, but in some pedons it is silt loam or silty clay loam.

Ulen series

The Ulen series consists of deep, somewhat poorly drained, rapidly permeable soils on lacustrine and glacial outwash plains. These soils formed in material derived from sandy calcareous glaciolacustrine sediment. Slopes are 0 to 3 percent.

Ulen soils are associated on the landscape with Fossum and Hecla soils. Hecla soils are better drained than Ulen soils. Fossum soils are wetter. Neither Fossum nor Hecla soils have calcic horizons within a depth of 16 inches.

Typical pedon of Ulen loamy fine sand in area of Hecla-Ulen loamy fine sands, 0 to 3 percent slopes, 850 feet east and 110 feet north of southwest corner sec. 26, T. 154 N., R. 74 W.

A11—0 to 8 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; weak medium granular structure; soft, very friable, nonsticky, nonplastic; strong effervescence; moderately alkaline; clear wavy boundary.

A12ca—8 to 15 inches; very dark gray (10YR 3/1) loamy fine sand, gray (10YR 5/1) dry; weak medium and fine subangular blocky structure; soft, very friable, nonsticky, nonplastic; strong effervescence; moderately alkaline; clear wavy boundary.

C1ca—15 to 23 inches; grayish brown (2.5Y 5/2) loamy fine sand, light gray (10YR 7/2) dry; single grained; loose, nonsticky, nonplastic; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—23 to 40 inches; light yellowish brown (2.5Y 6/4) fine sand, light gray (2.5Y 7/2) dry; single grained; loose, nonsticky, nonplastic; strong effervescence; moderately alkaline; gradual wavy boundary.

C3—40 to 48 inches; yellowish brown (10YR 5/6) fine sand, brownish yellow (10YR 6/6) dry; single grained; loose, nonsticky, nonplastic; strong effervescence; moderately alkaline; gradual wavy boundary.

C4—48 to 60 inches; light olive brown (2.5Y 5/4) and yellowish brown (10YR 5/6) fine sand, light gray (2.5Y 7/2) dry; single grained; loose, nonsticky, nonplastic; strong effervescence; moderately alkaline.

The mollic epipedon is more than 10 inches thick, and the calcic horizon is within 16 inches of the surface. The control section is dominantly loamy fine sand or fine sand.

The A horizon has hue of 10YR, value of 2 or 3, 3 through 5 dry, and chroma of 1. The Cca horizon has hue of 10YR or 2.5Y, value of 4 or 5, 5 through 7 dry, and chroma of 1 through 3. The C horizon has hue of 10YR or 2.5Y, value of 4 through 6, 6 or 7 dry, and chroma of 2 through 6.

Vallers series

The Vallers series consists of deep, poorly drained, moderately slowly permeable soils on glacial till plains. These soils formed in material derived from calcareous loamy glacial till. Slopes are 0 to 1 percent.

Vallers soils are associated on the landscape with Emrick, Fram, Hamerly, Parnell, Svea, and Tonka soils. Hamerly, Fram, Emrick, and Svea soils are better drained than Vallers soils. Parnell and Tonka soils have argillic horizons. Emrick, Svea, Parnell, and Tonka soils do not have calcic horizons within a depth of 16 inches.

Typical pedon in area of Vallers loam, 2,300 feet west and 100 feet south of northeast corner sec. 25, T. 158 N., R. 69 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate medium granular structure; slightly hard, friable, sticky, plastic; violent effervescence; moderately alkaline; clear wavy boundary.

C1ca—8 to 16 inches; dark grayish brown (2.5Y 4/2) loam, grayish brown (2.5Y 5/2) dry; weak medium subangular blocky structure; hard, friable, sticky, plastic; violent effervescence; moderately alkaline; clear smooth boundary.

C2ca—16 to 30 inches; light olive gray (5Y 6/2) loam, white (5Y 8/1) dry; common medium prominent olive yellow (2.5Y 6/6) mottles; massive; hard, friable, sticky, plastic; strong effervescence; moderately alkaline; gradual wavy boundary.

C3—30 to 42 inches; olive gray (5Y 4/2) loam, light olive gray (5Y 6/2) dry; common medium distinct pale yellow (2.5Y 7/4) mottles; massive; hard, friable, sticky, plastic; strong effervescence; moderately alkaline; gradual wavy boundary.

C4—42 to 60 inches; dark grayish brown (2.5Y 4/2) loam, light yellowish brown (2.5Y 6/4) dry; common medium distinct reddish yellow (7.5YR 6/8) and few medium distinct light gray (N 7/0) mottles; massive; hard, friable, sticky, plastic; 1 to 3 percent coarse fragments; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick. The control section is loam or light clay loam that averages between 18 and 30 percent clay.

The A horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. The Cca horizon has hue of 2.5Y or 5Y, value of 4 through 6, 5 through 8 dry, and chroma of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 4 through 6, 5 through 7 dry, and chroma of 2 through 4.

Wyndmere series

The Wyndmere series consists of deep, somewhat poorly drained, moderately rapidly permeable soils on glaciolacustrine plains. These soils formed in material weathered from calcareous sandy sediment. Slopes are 0 to 1 percent.

Wyndmere soils are associated on the landcape with Embden, Swenoda, and Tiffany soils. Embden and Swenoda soils are better drained than Wyndmere soils. Tiffany soils are wetter. None of those soils have calcic horizons within a depth of 16 inches.

Typical pedon in area of Wyndmere fine sandy loam, 1,880 feet north and 100 feet west of southeast corner sec. 3, T. 158 N., R. 74 W.

A1—0 to 10 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; soft, very friable, nonsticky, nonplastic; moderately alkaline; abrupt smooth boundary.

C1ca—10 to 19 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; soft, very friable, nonsticky, nonplastic; strong effervescence; moderately alkaline; clear wavy boundary.

C2ca—19 to 34 inches; grayish brown (2.5Y 5/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; weak fine subangular blocky structure; soft, very friable, nonsticky, nonplastic; strong effervescence; moderately alkaline; clear wavy boundary.

C3—34 to 60 inches; light olive brown (2.5Y 5/4) fine sand, pale yellow (2.5Y 7/4) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; single grained, loose, nonsticky, nonplastic; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick, and the calcic horizon is within 16 inches of the surface. The control section is dominantly fine sandy loam or sandy loam.

The A horizon has hue of 10YR, value of 2 or 3, 3 or 4 dry, and chroma of 1. The Cca horizon has hue of 10YR or 2.5Y, value of 3 through 5, 4 through 7 dry, and chroma of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 4 through 6, 5 through 7 dry, and chroma of 2 through 4.

Formation of the soils

Soil is produced by soil-forming processes acting on material deposited or accumulated by geologic processes. 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 developed since accumulation, (3) and plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time 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 to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. It may be much or little, but some time is always required for horizon differentiation. 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. Many of the processes of soil development are unknown.

Parent material

All the soils in Pierce County formed in glacial material derived from preglacial granite, gneiss, sandstone, shale, limestone, and basalt. The glacier picked up these materials, ground and mixed them as it transported them across the country, and then deposited them as it melted. Some soils, such as Barnes and Svea, consist of unsorted material, or glacial till. Sardena and Eckman soils, for example, consist of material sorted by water deposition. Serden and Aylmer soils consist of material sorted by wind and water after deposition.

Climate

Pierce County has a cool, dry-subhumid, continental climate characterized by long cold winters and a short growing season during which the distribution of rainfall is erratic. The climate does not vary much from place to place and probably has not changed much during the period of soil formation. The climate is favorable for prairie vegetation.

Temperature and moisture affect the growth of plants, the activity of micro-organisms, and the speed of chemical reactions, particularly during the growing season. Rainfall has not been sufficient for the deep leaching of the soils, nor has it caused more than a minor amount of erosion. Freezing and thawing help to disintegrate parts of the glacial debris, and frost heaving helps mix soil materials, thus affecting soil structure. The cool temperatures slow the decay of plant and animal materials, thus promoting the accumulation of organic matter. This process is responsible for the large amount of organic matter in Svea and Emrick soils.

Plant and animal life

Soil formation started in Pierce County when plants began to grow in the unconsolidated material deposited by the glacier. Well drained soils, such as Barnes and Heimdal, formed under predominantly cool-season, drought-resistant grasses. Tall, warm-season grasses grow where the soils receive extra moisture.

Plant roots loosen the soil material and bring minerals from the parent material upward toward the surface. As the plants die and decay, they contribute organic matter, which bacteria and other micro-organisms help to decompose. Thus, nutrients leached out of the surface layer are replaced, and a good supply is maintained for other plants.

Earthworms and burrowing animals help mix the soil material from various horizons and bring some fresh parent material to the surface layer. Man's activities, particularly in altering drainage conditions, maintaining fertility, and changing the kinds of vegetation, will have an important effect on the rate and the direction of future soil formation.

Relief

Relief influences the formation of soils through its effect on runoff and drainage. If other soil-forming factors are equal, relief largely determines the degree of profile development, mainly because it controls the amount of moisture in the soil. Because of excessive drainage, only a little water is in the more sloping and coarser textured soils; consequently vegetation is sparse and profile development is slow. Among the soils affected by excessive drainage are Buse, Esmond, and Sioux soils. On the other hand, the excess water in areas that have poor drainage also disturbs the process of soil formation. Parnell, Borup, Colvin, Tonka, and other soils are affected by poor drainage.

Time

Time is necessary for the soil forming factors to act on parent material. Generally, the length of time determines whether the soil has reached an equilibrium with the environment.

The degree of profile development in most of the soils in Pierce County has been affected more by other differences than by the length of time, because the length of time has been about the same for all soils. In terms of geologic time, the soils are young because they formed from material deposited in late Pleistocene time, which ended about 11,000 years ago.

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Glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim. 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 mapping 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	More than 9

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Coarse fragments. Mineral or rock particles up to 3 inches (2 millimeters to 7.5 centimeters) in diameter.

Coarse textured (light textured) soil. Sand or loamy sand.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

Complex, soil. A mapping unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Compressible. Excessive decrease in volume of soft soil under load.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is 40 or 80 inches (1 or 2 meters).

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.

Deferred grazing. A delay in grazing until range plants have reached a specified stage of growth. Grazing is deferred in order to increase the vigor of forage and to allow desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops

cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Erosion. The wearing away of the land surface by running 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 a bare surface.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Excess salts. Excess water soluble salts. Excessive salts restrict the growth of most plants.

Fast intake. The rapid movement of water into the soil.

Favorable. Favorable soil features for the specified use.

Fine textured (heavy textured) soil. Sandy clay, silty clay, and clay.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; *November-May*, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by melt water as it flows from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes by water originating mainly from the melting of glacial ice. Many are interbedded or laminated.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Habitat. The natural abode of a plant or animal; refers to the kind of environment in which a plant or animal normally lives, as opposed to the range or geographical distribution.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered, but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

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. Rock fragments 10 inches (25 centimeters) or more across. Large stones adversely affect the specified use.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Low strength. Inadequate strength for supporting loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Miscellaneous areas. Areas that have little or no natural soil, are too nearly inaccessible for orderly examination, or cannot otherwise be feasibly classified.

Moderately coarse textured (moderately light textured) soil. Sandy loam and fine sandy loam.

Moderately fine textured (moderately heavy textured) soil. Clay loam, sandy clay loam, and silty clay loam.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few*, *common*, and *many*; size—*fine*, *medium*, and *coarse*; and contrast—*faint*, *distinct*, and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse* more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material mixed with mineral soil material. The content of organic matter is more than 20 percent.

Neutral soil. A soil having a pH value between 6.6 and 7.3.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by water that originated mainly from the melting of glacial ice. Glacial outwash is commonly in valleys on landforms known as valley trains, outwash terraces, eskers, kame terraces, kames, outwash fans, or deltas.

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 great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are *very slow* (less than 0.06 inch), *slow* (0.06 to 0.20 inch), *moderately slow* (0.2 to 0.6 inch), *moderate* (0.6 to 2.0 inches), *moderately rapid* (2.0 to 6.0 inches), *rapid* (6.0 to 20 inches), and *very rapid* (more than 20 inches).

Phase, soil. A subdivision of a soil series or other unit in the soil classification system based on differences in the soil that affect its management. A soil series, for example, may be divided into phases on the basis of differences in slope, stoniness, thickness, or some other characteristic that affects management. These differences are too small to justify separate series.

Piping. Moving water forms subsurface tunnels or pipelike cavities in the soil.

Pitting. Formation of pits as a result of the melting of ground ice after the removal of plant cover.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Poor outlets. Surface or subsurface drainage outlets difficult or expensive to install.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots. See Root zone.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline-alkali soil. A soil that contains a harmful concentration of salts and exchangeable sodium; contains harmful salts and is strongly alkaline; or contains harmful salts and exchangeable sodium and is very strongly alkaline. The salts, exchangeable sodium, and alkaline reaction are in the soil in such location that growth of most crop plants is less than normal.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

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. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

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.

Slick spot. Locally, a small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake. The slow movement of water into the soil.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil, or partly worked into the soil, to provide protection from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use or management.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand*, *loamy sand*, *sandy loam*, *loam*, *silt*, *silt loam*, *sandy clay loam*, *clay loam*, *silty clay loam*, *sandy clay*, *silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Illustrations

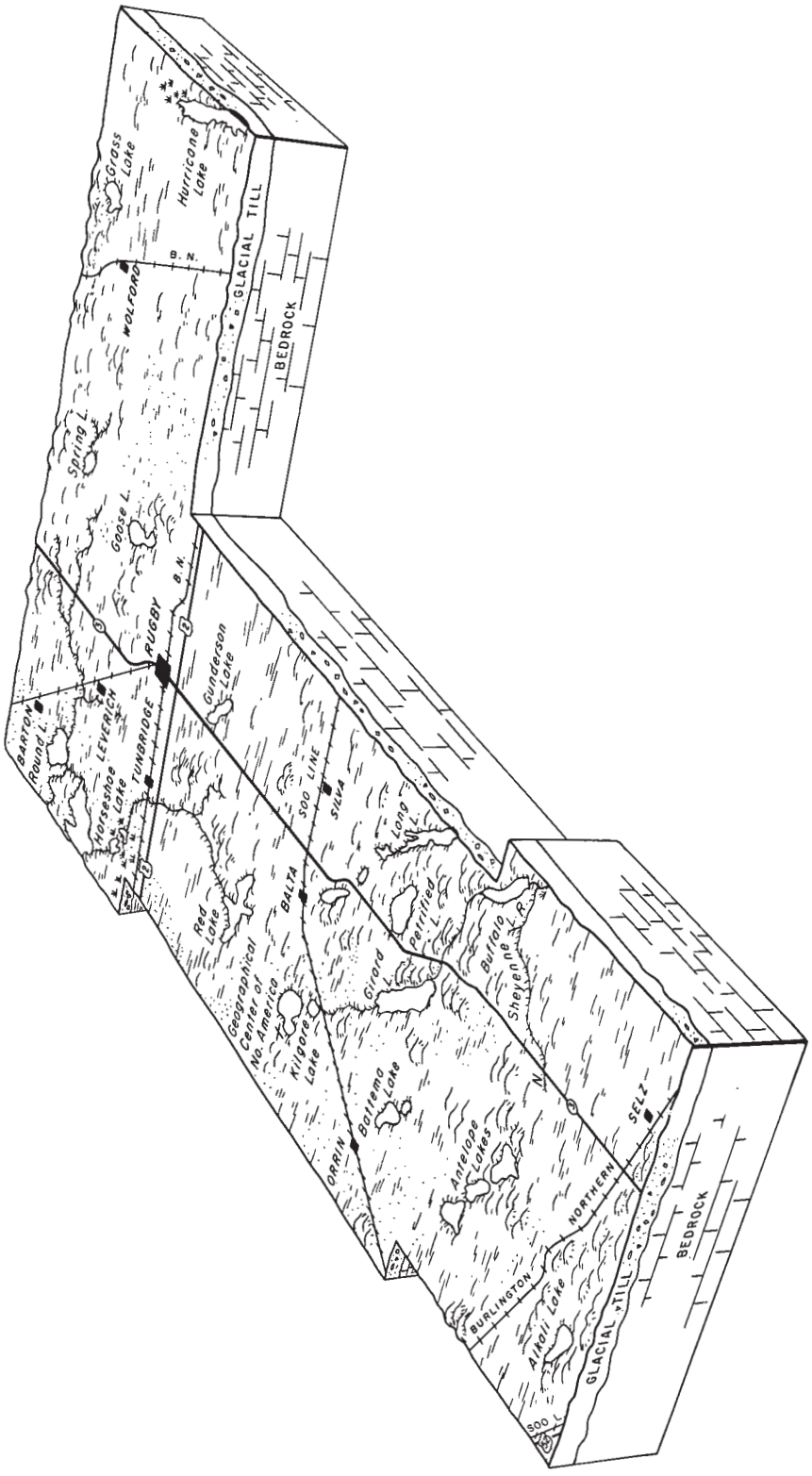

Figure 1.—Relief and drainage in Pierce County.

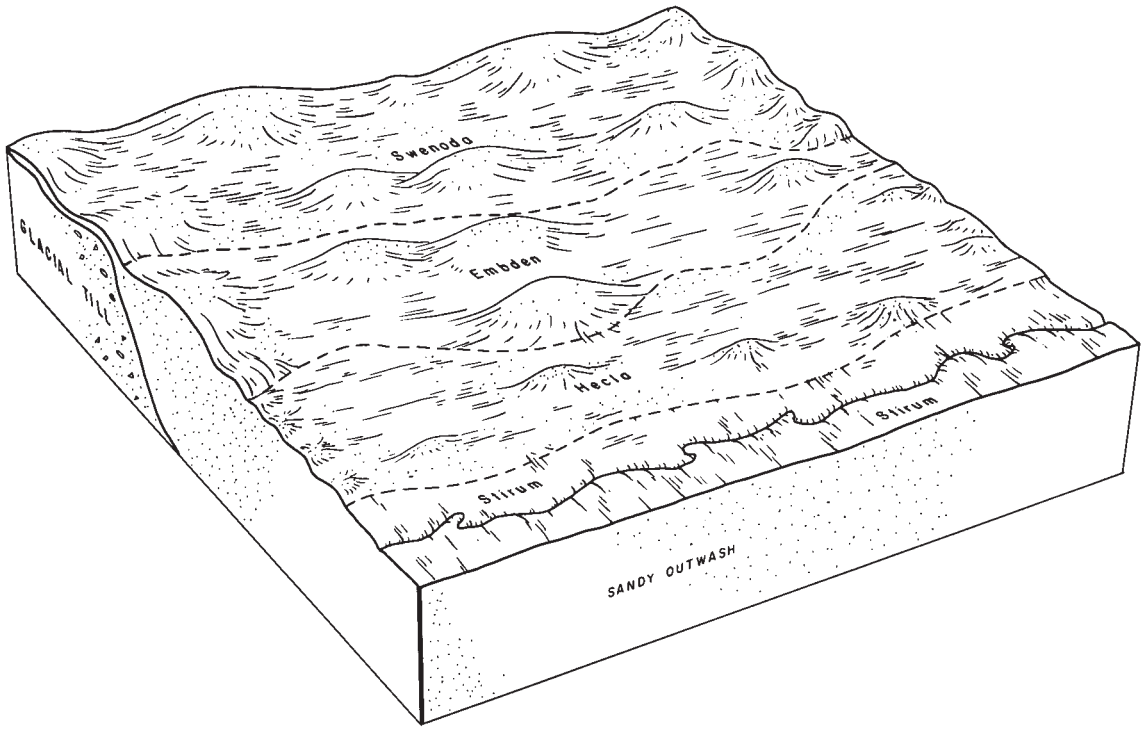

Figure 2.—Typical pattern of soils and underlying material in Swenoda-Hecla-Embden-Stirum.

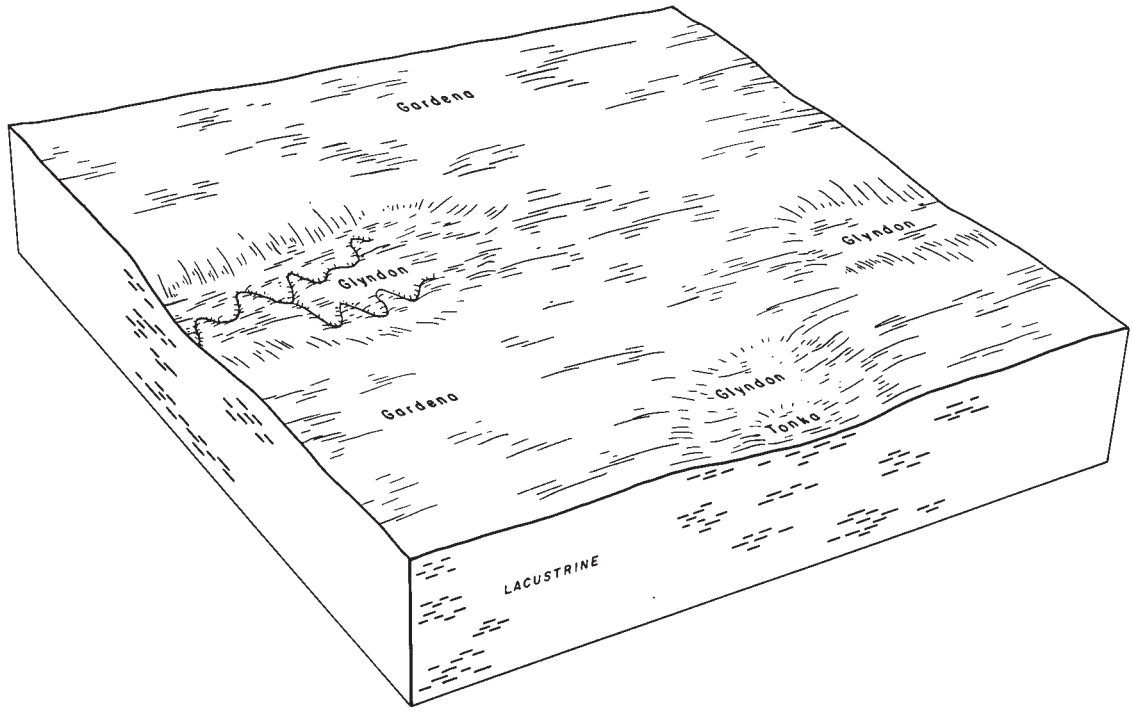

Figure 3.—Typical pattern of soils and underlying material in Gardena.

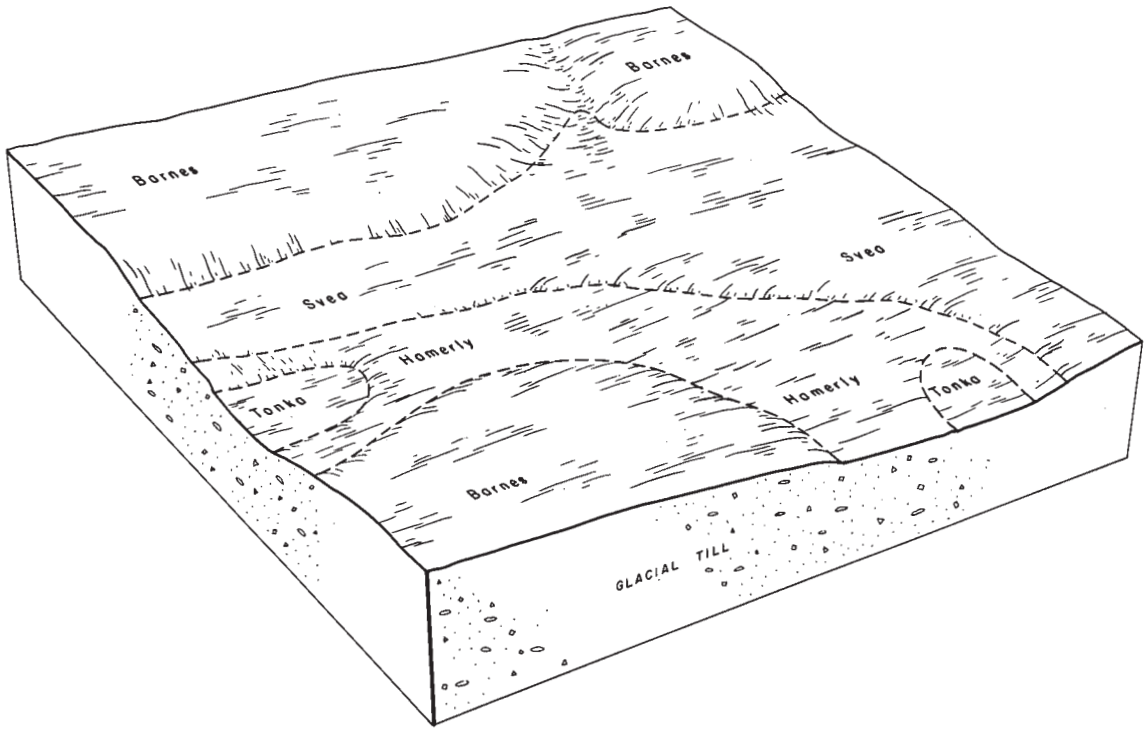

Figure 4.—Typical pattern of soils and underlying material in Barnes-Svea-Hamerly.

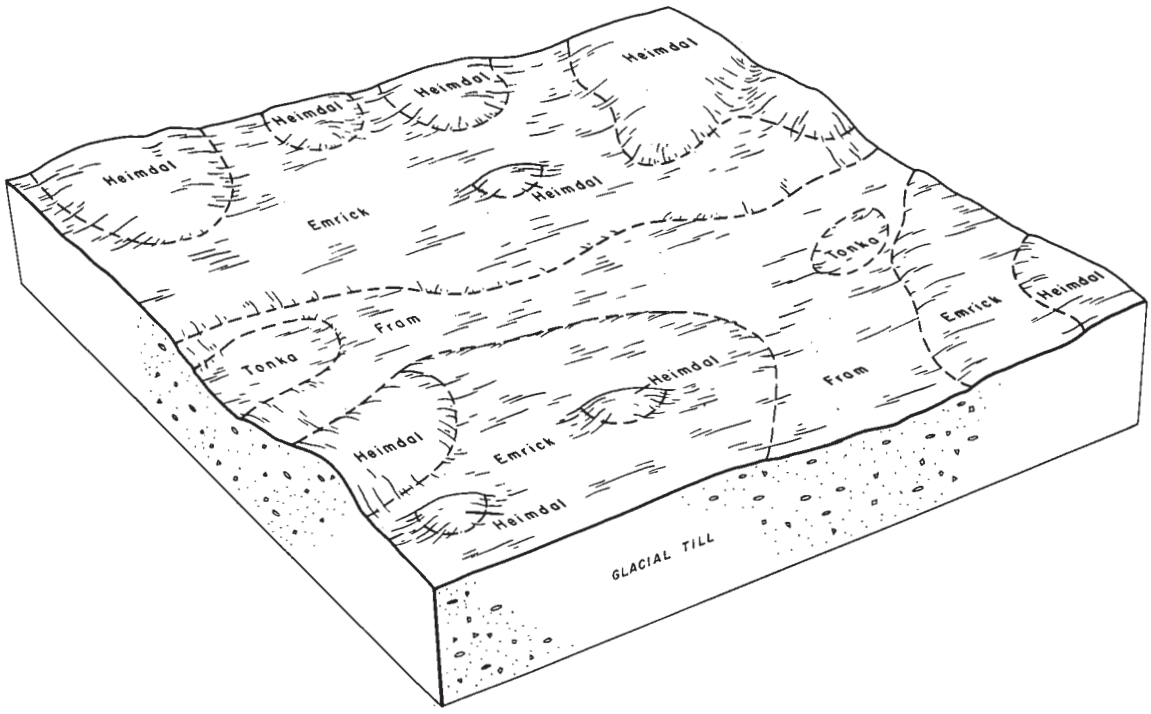

Figure 5.—Typical pattern of soils and underlying material in Emrick-Heimdal-Fram.

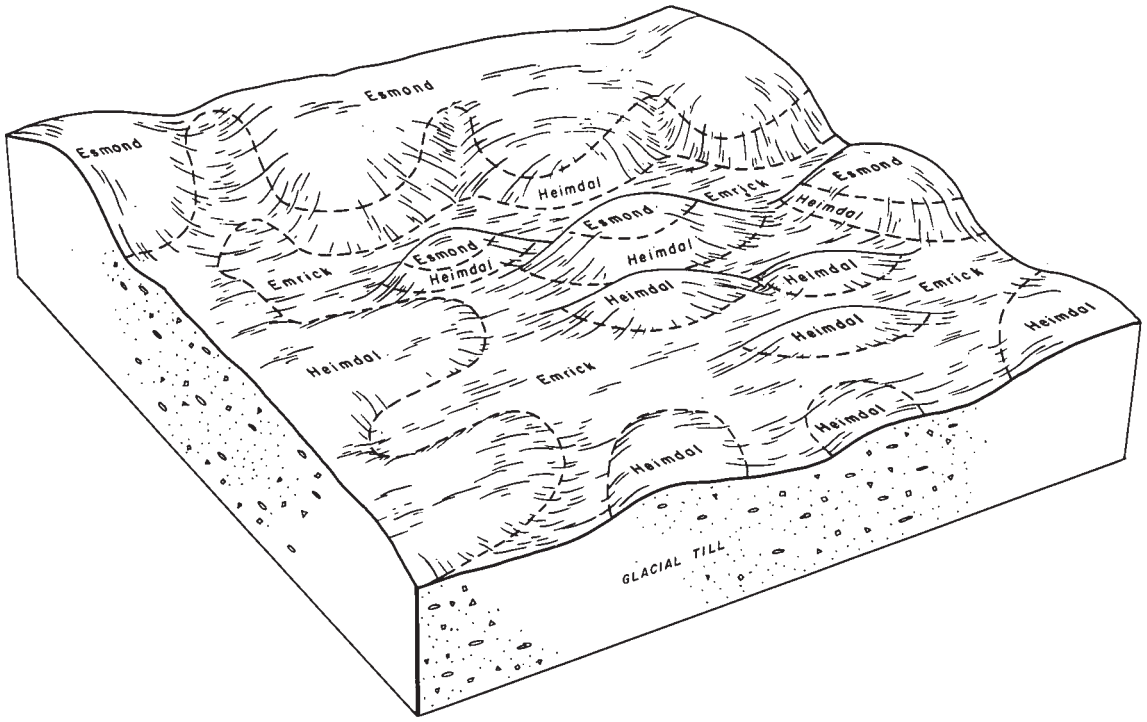

Figure 6.—Typical pattern of soils and underlying material in Heimdal-Esmond-Emrick.

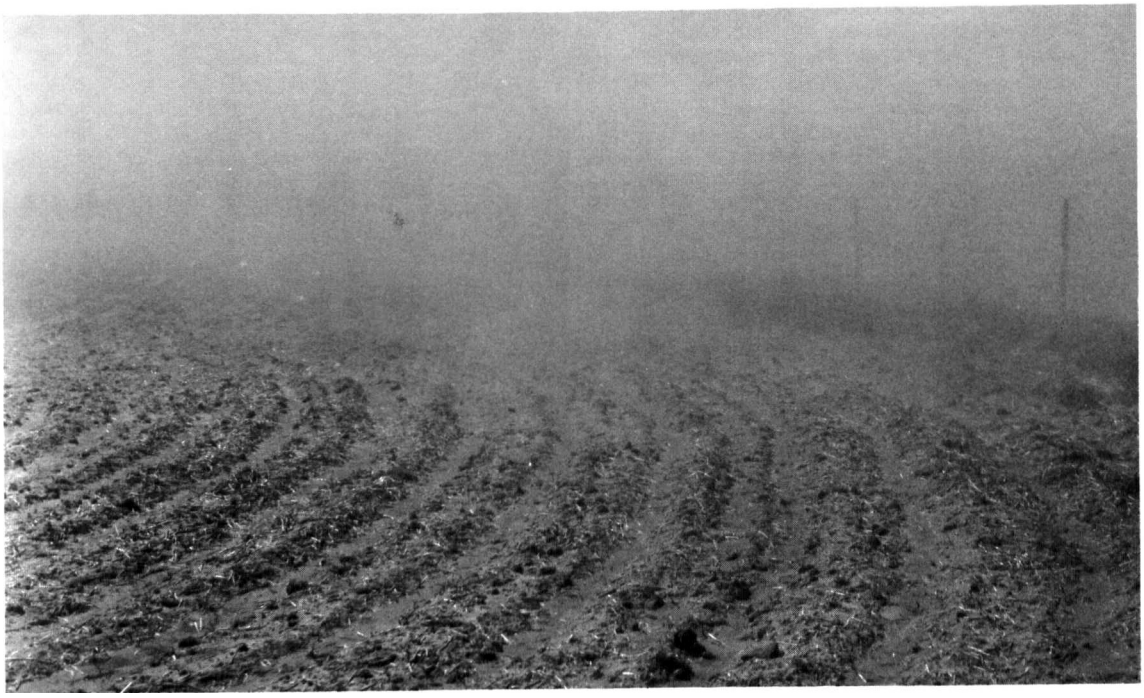

Figure 7.—Hazard of soil blowing on Hecla loamy fine sand, 0 to 3 percent slopes.

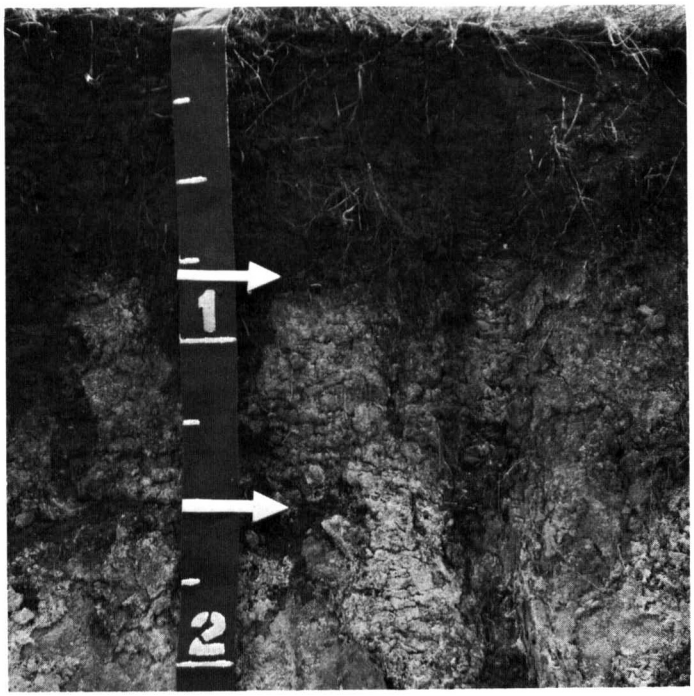

Figure 8.—Profile of Hamerly loam showing the dark colored surface layer and the light colored layer of lime accumulation.

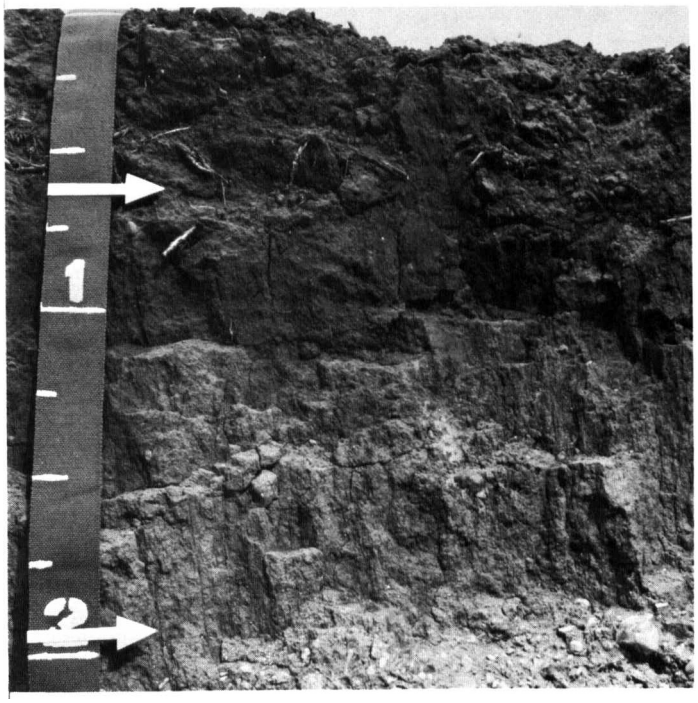

Figure 9.—Profile of Barnes loam showing the dark colored surface layer and the subsoil and the light colored underlying material.

Figure 10.—Grazing on Esmond-Heimdal very stony loams, 9 to 25 percent slopes, in background. Typical landscape of Emrick loam in foreground.

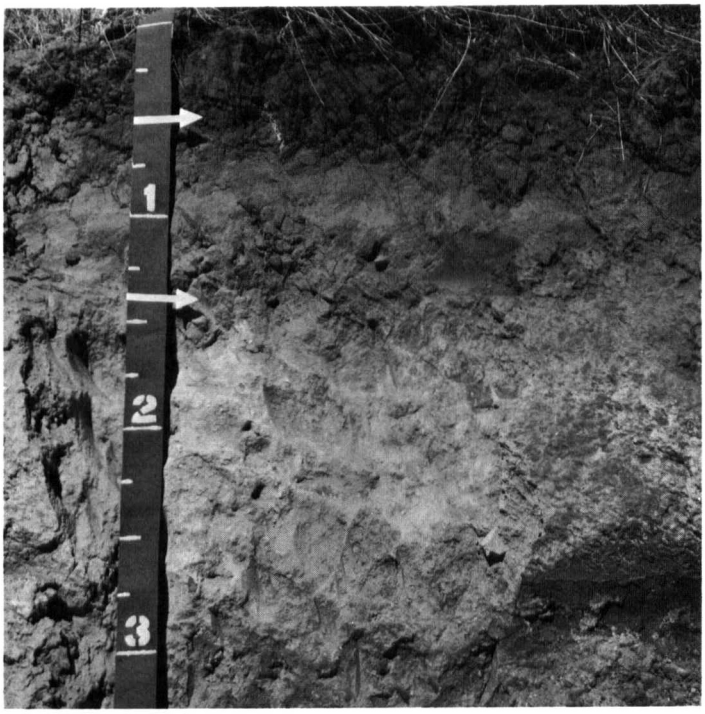

Figure 11.—Profile of Heimdal loam.

Figure 12.—Landscape of Heimdal-Esmond loams, 3 to 9 percent slopes. The light colored ridge crests and knolls are Esmond loams. The dark areas are Heimdal loam.

Figure 13.—Small grain stubble on Gardena silt loam, 0 to 3 percent slopes, on glacial lake plain. In background is the glacial till plain.

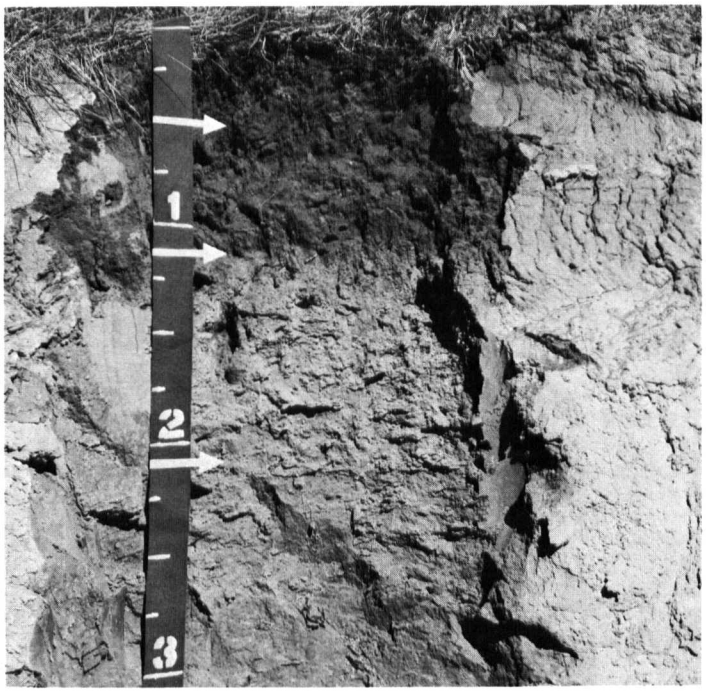

Figure 14.—Profile of Eckman silt loam showing the dark colored surface layer and subsoil and the light colored underlying material.

Figure 15.—Small grain on Letcher fine sandy loam, 0 to 3 percent slopes.

Figure 16.—Profile of Sioux sandy loam showing the thin dark surface layer and the gravelly subsoil.

Figure 17.—Blowout in native grass pasture of Serden soils, 0 to 15 percent slopes.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION DATA

Month	Temperature[1]						Precipitation[1]				
	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[2]	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----	14.2	-5.8	4.2	42	-35	0	.58	.20	.89	2	9.1
February---	21.6	.9	11.3	45	-29	0	.43	.15	.65	1	6.5
March------	33.0	12.7	22.9	62	-22	50	.64	.23	.97	2	5.8
April------	52.6	30.0	41.3	83	7	135	1.26	.39	1.95	3	4.2
May--------	67.5	41.5	54.5	91	22	450	2.06	.94	2.96	5	.6
June-------	77.2	52.2	64.7	96	36	741	3.23	1.60	4.56	6	.0
July-------	83.0	56.6	69.8	100	42	924	2.52	1.50	3.43	6	.0
August-----	82.6	54.9	68.8	99	39	893	2.50	1.20	3.55	5	.0
September--	69.7	43.8	56.8	94	25	504	1.66	.58	2.53	4	.2
October----	58.4	34.0	46.2	84	13	244	.91	.23	1.46	2	1.5
November---	36.1	18.2	27.2	64	-14	30	.51	.16	.79	2	5.4
December---	21.9	3.5	12.7	46	-31	10	.51	.25	.70	2	7.3
Year-----	51.5	28.5	40.0	100	-36	3,981	16.81	14.65	18.92	40	40.6

[1]Recorded in the period 1951-74 at Rugby, N. Dak.

[2]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° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Temperature[1]		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 7	May 18	May 30
2 years in 10 later than--	May 2	May 14	May 25
5 years in 10 later than--	April 23	May 6	May 16
First freezing temperature in fall:			
1 year in 10 earlier than--	September 26	September 13	September 4
2 years in 10 earlier than--	October 2	September 19	September 9
5 years in 10 earlier than--	October 12	September 30	September 18

[1]Recorded in the period 1951-74 at Rugby, N. Dak.

TABLE 3.--GROWING SEASON LENGTH

Probability	Daily minimum temperature during growing season[1]		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	152	126	106
8 years in 10	159	133	112
5 years in 10	172	147	124
2 years in 10	185	160	137
1 year in 10	191	167	143

[1]Recorded in the period 1951-74 at Rugby, N. Dak.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
1	Tonka silt loam	3,775	0.6
2	Parnell silty clay loam	6,745	1.0
3	Colvin silty clay loam, wet	1,085	0.2
7	Fossum soils, saline	540	0.1
12	Hegne silty clay	2,430	0.4
13	Hegne silty clay, wet	1,560	0.2
14	Bearden silty clay loam	3,480	0.5
15	Bearden silty clay loam, saline	2,465	0.4
16	Overly silty clay loam	2,865	0.4
17	Colvin silty clay loam	2,010	0.3
18	Colvin silty clay loam, channeled	2,600	0.4
20	Pits, gravel	275	(1)
24	Hecla-Ulen loamy fine sands, 0 to 3 percent slopes	8,920	1.3
25	Hecla loamy fine sand, 0 to 3 percent slopes	26,055	3.9
26B	Maddock loamy fine sand, 3 to 6 percent slopes	7,395	1.1
27C	Maddock loamy fine sand, 6 to 15 percent slopes	820	0.1
29	Towner loamy fine sand, 0 to 3 percent slopes	1,690	0.3
31B	Towner-Dickey loamy fine sands, 3 to 6 percent slopes	8,680	1.3
32C	Dickey loamy fine sand, 6 to 15 percent slopes	4,780	0.7
34	Tiffany fine sandy loam	710	0.1
35	Embden fine sandy loam, 0 to 3 percent slopes	17,625	2.7
36B	Embden-Egeland fine sandy loams, 3 to 6 percent slopes	5,605	0.8
37C	Egeland fine sandy loam, 6 to 9 percent slopes	490	0.1
39	Swenoda fine sandy loam, 0 to 3 percent slopes	8,615	1.3
41B	Swenoda fine sandy loam, 3 to 6 percent slopes	22,345	3.4
42C	Swenoda fine sandy loam, 6 to 9 percent slopes	8,760	1.3
43	Wyndmere fine sandy loam	3,770	0.6
44	Fossum soils	9,445	1.4
49	Hamerly loam, 0 to 3 percent slopes	3,115	0.5
50	Svea loam, 0 to 3 percent slopes	1,345	0.2
51	Barnes-Svea loams, 0 to 3 percent slopes	23,160	3.5
51B	Barnes-Svea loams, 3 to 6 percent slopes	9,410	1.4
53B	Barnes-Buse loams, 3 to 6 percent slopes	2,665	0.4
53C	Barnes-Buse loams, 6 to 9 percent slopes	1,920	0.3
55F	Esmond-Heimdal very stony loams, 9 to 25 percent slopes	6,320	1.0
56	Cresbard-Svea loams, 0 to 3 percent slopes	2,885	0.4
57	Vallers loam	3,630	0.5
58	Vallers loam, saline	3,245	0.5
59	Hamerly-Tonka complex, 0 to 3 percent slopes	11,485	1.7
60	Emrick loam, 0 to 3 percent slopes	8,530	1.3
60B	Emrick loam, 3 to 6 percent slopes	2,465	0.4
61B	Heimdal and Emrick very stony loams, 3 to 9 percent slopes	1,165	00.2
62	Emrick-Heimdal loams, 0 to 3 percent slopes	41,940	6.3
62B	Emrick-Heimdal loams, 3 to 6 percent slopes	90,430	13.6
62C	Heimdal-Emrick loams, 6 to 9 percent slopes	16,985	2.6
63D	Esmond-Heimdal loams, 9 to 15 percent slopes	29,195	4.4
63F	Esmond-Heimdal loams, 15 to 35 percent slopes	4,245	0.6
64C	Heimdal-Esmond loams, 3 to 9 percent slopes	21,925	3.3
65	Fram loam, 0 to 3 percent slopes	17,510	2.6
66	Gardena silt loam, 0 to 3 percent slopes	36,125	5.5
67B	Gardena silt loam, 3 to 6 percent slopes	7,515	1.1
68C	Eckman silt loam, 6 to 9 percent slopes	815	0.1
70	Glyndon silt loam, 0 to 3 percent slopes	5,610	0.8
71	Gardena silt loam, clayey substratum, 0 to 3 percent slopes	12,840	1.9
72	Glyndon silt loam, saline, 0 to 3 percent slopes	6,060	0.9
73	Borup and Fossum soils, wet	4,180	0.6
74	Borup silt loam	3,005	0.5
75	Borup silt loam, saline	3,025	0.5
78	Emrick-Cathay loams, 0 to 3 percent slopes	1,345	0.2
80	Cathay loam, 0 to 3 percent slopes	9,075	1.4
80B	Cathay loam, 3 to 6 percent slopes	2,975	0.4
81	Cathay-Gardena silt loams, 0 to 3 percent slopes	7,825	1.2
82	Letcher fine sandy loam, 0 to 3 percent slopes	4,190	0.6
88B	Arvilla soils, 0 to 6 percent slopes	10,080	1.5
89C	Sioux soils, 1 to 15 percent slopes	3,505	0.5
90C	Serden soils, 0 to 15 percent slopes	8,835	1.3
95	Divide loam, 0 to 3 percent slopes	2,080	0.3
96	Aquents	7,960	1.2
100	Stirum soils, 0 to 3 percent slopes	32,930	5.0
104	Aquolls	19,025	2.9

See footnote at end of table.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
105	Aylmer-Fossum complex, 0 to 6 percent slopes	5,615	0.9
	Water less than 40 acres	536	0.1
	Total survey area	664,256	100.0
	Water greater than 40 inches	28,864	
	Total area	693,120	

[1]Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[All yields were estimated for a high level of management in 1975. Absence of a yield figure indicates the crop is seldom grown or is not suited]

Soil name and map symbol	Wheat, spring	Oats	Barley	Rye	Flax	Grass-legume hay
	Bu	Bu	Bu	Bu	Bu	Ton
Tonka:						
1	21	44	34	---	9	2.5
Parnell:						
2	---	---	---	---	---	---
Colvin:						
3	---	---	---	---	---	---
Fossum:						
17	---	---	---	---	---	---
Hegne:						
12	29	61	46	29	13	3.0
13	---	---	---	---	---	---
Bearden:						
14	36	76	58	36	16	3.0
15	25	53	41	26	11	2.0
Overly:						
16	40	84	64	40	18	3.0
Colvin:						
17, [1]18	---	---	---	---	---	---
Pits, gravel:						
20.						
Hecla:						
[1]24	19	45	34	25	9	2.0
25	19	45	34	25	9	2.0
Maddock:						
26B	14	28	20	18	5	1.4
27C	---	---	---	---	---	---
Towner:						
29	21	44	32	23	9	1.8
[1]31B	18	38	28	21	8	1.5
Dickey:						
32C	---	---	---	---	---	---
Tiffany:						
34	18	36	24	24	6	1.9
Embden:						
35	30	63	48	35	14	2.7
[1]36B	27	58	43	32	12	2.6
Egeland:						
37C	22	46	36	25	10	2.3
Swenoda:						
39	32	60	53	35	14	2.7
41B	29	54	46	33	13	2.6
42C	26	50	42	30	12	2.5

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Wheat, spring	Oats	Barley	Rye	Flax	Grass-legume hay
	Bu	Bu	Bu	Bu	Bu	Ton
Wyndmere: 43	29	61	46	35	13	2.4
Fossum: 144	17	36	27	28	7	3.0
Hamerly: 49	34	71	55	37	15	2.7
Svea: 50	38	80	61	38	17	2.9
Barnes: 151	37	77	59	37	16	2.8
151B	34	72	55	34	15	2.6
153B	27	58	43	29	12	2.5
153C	25	53	40	27	11	2.1
Esmond: 155F	---	---	---	---	---	---
Cresbard: 156	27	55	42	28	14	2.4
Vallers: 57, 58	17	36	27	24	5	2.1
Hamerly: 159	32	65	52	35	6	2.5
Emrick: 60	38	80	61	38	17	2.9
60B	36	76	58	36	16	2.8
Heimdal: 161B	---	---	---	---	---	---
Emrick: 162	37	78	59	36	16	2.9
162B	35	73	57	34	15	2.7
Heimdal: 162C	29	62	47	29	13	2.4
Esmond: 163D	---	---	---	---	---	---
163F	---	---	---	---	---	---
Heimdal: 164C	21	44	34	26	9	2.4
Fram: 65	33	69	53	36	14	2.7
Gardena: 66	40	84	64	40	18	3.0
67B	36	76	58	36	16	2.8
Eckman: 68C	25	53	40	25	11	2.1
Glyndon: 70	40	75	61	38	17	2.9

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Wheat, spring	Oats	Barley	Rye	Flax	Grass-legume hay
	Bu	Bu	Bu	Bu	Bu	Ton
Gardena: 71	40	84	64	40	18	3.0
Glyndon: 72	27	58	43	29	12	2.4
Borup: [1]73	---	---	---	---	---	---
74, 75	---	---	---	---	---	---
Emrick: [1]78	34	72	55	36	16	2.6
Cathay: 80	29	61	46	30	13	2.3
80B	27	58	43	28	12	2.1
[1]81	30	61	46	30	13	2.3
Letcher: 82	21	38	30	22	9	2.1
Arvilla: [1]88B	15	30	24	18	6	1.1
Sioux: [1]89C	---	---	---	---	---	---
Serden: 90C	---	---	---	---	---	---
Divide: 95	27	58	43	35	13	2.3
Aquents: 96.						
Stirum: [1]100	---	---	---	---	---	---
Aquolls: 104.						
Aylmer: [1]105	---	---	---	---	---	---

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; the symbol > means greater than. Absence of an entry means soil does not normally grow trees of this height class]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Tonka: 1----------	Siberian peashrub, Tatarian honeysuckle.	Eastern redcedar, Rocky Mt. juniper, common chokecherry.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce.	Siberian elm------	Eastern cottonwood.
Parnell: 2.					
Colvin: 3----------	---	---	---	---	---
Fossum: [1]7.					
Hegne: 12----------	---	Tall purple willow, redosier dogwood, Tatarian honeysuckle, Siberian peashrub.	Russian-olive, eastern redcedar, northern white-cedar.	Green ash, American elm.	Eastern cottonwood, golden willow, Siberian elm.
13.					
Bearden: 14----------	---	Eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Ponderosa pine, Black Hills spruce.	Siberian elm, American elm, green ash.	Eastern cottonwood.
15.					
Overly: 16----------	---	Eastern redcedar, Rocky Mt. juniper, common chokecherry, Siberian peashrub.	Ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm, American elm, green ash.	Eastern cottonwood.
Colvin: 17, [1]18----------	---	---	---	---	---
Pits, gravel: 20.					
Hecla: [1]24: Hecla part-----	---	Common chokecherry, Siberian peashrub, lilac, American plum.	Hackberry, blue spruce, green ash, Siberian crabapple, eastern redcedar.	Golden willow, ponderosa pine.	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Hecla:					
Ulen part------	---	Eastern redcedar, Russian-olive, Siberian crabapple, silver buffaloberry, Tatarian honeysuckle, Siberian peashrub.	Red pine, jack pine, ponderosa pine, Austrian pine, hackberry, bur oak.	---	---
25----------	---	Common chokecherry, Siberian peashrub, lilac, American plum.	Hackberry, blue spruce, green ash, Siberian crabapple, eastern redcedar.	Golden willow, ponderosa pine.	Eastern cottonwood.
Maddock:					
26B----------	---	---	Siberian elm, American elm, green ash, ponderosa pine.	---	---
27C.					
Towner:					
29----------	---	Eastern redcedar, Siberian peashrub, Rocky Mt. juniper, common chokecherry, Tatarian honeysuckle, American plum.	Siberian elm, ponderosa pine, green ash, Russian-olive.	---	---
[1]31B:					
Towner part----	---	Eastern redcedar, Siberian peashrub, Rocky Mt. juniper, common chokecherry, Tatarian honeysuckle, American plum.	Siberian elm, ponderosa pine, green ash, Russian-olive.	---	---
Dickey part----	Lilac, Tatarian honeysuckle, American plum, golden currant.	Green ash, eastern redcedar, Russian-olive.	Siberian elm, ponderosa pine.	---	---
Dickey:					
32C.					
Tiffany:					
34----------	---	Eastern redcedar, American plum, common chokecherry, Siberian peashrub, Tatarian honeysuckle.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce.	Siberian elm------	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Embden: 35	---	Eastern redcedar, Rocky Mt. juniper, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Ponderosa pine, Black Hills spruce.	Siberian elm, American elm, green ash.	Eastern cottonwood.
[1]36B: Embden part	---	Eastern redcedar, Rocky Mt. juniper, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Ponderosa pine, Black Hills spruce.	Siberian elm, American elm, green ash.	Eastern cottonwood.
Egeland part	Silver buffaloberry, Peking cotoneaster, lilac, American plum.	Eastern redcedar, common chokecherry, Siberian peashrub.	Green ash, hackberry, ponderosa pine, Siberian crabapple, Russian-olive.	---	---
Egeland: 37C	Silver buffaloberry, Peking cotoneaster, lilac, American plum.	Eastern redcedar, common chokecherry, Siberian peashrub.	Green ash, hackberry, ponderosa pine, Siberian crabapple, Russian-olive.	---	---
Swenoda: 39, 41B, 42C	Silver buffaloberry, Peking cotoneaster, lilac, American plum.	Eastern redcedar, common chokecherry, Siberian peashrub.	Green ash, hackberry, ponderosa pine, Siberian crabapple, Russian-olive.	---	---
Wyndmere: 43	---	Eastern redcedar, Rocky Mt. juniper, common chokecherry, Siberian peashrub.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm	Eastern cottonwood.
Fossum: [1]44	---	Tatarian honeysuckle, Siberian peashrub.	Russian-olive	Green ash	Eastern cottonwood, Siberian elm.
Hamerly: 49	---	Eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm, American elm, green ash.	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Svea:					
50	---	Siberian peashrub, Tatarian honeysuckle, American plum.	American elm, Black Hills spruce, blue spruce, green ash, ponderosa pine, common chokecherry, eastern redcedar.	Siberian elm	Eastern cottonwood.
Barnes:					
[1]51:					
Barnes part	---	Siberian peashrub, common chokecherry, Tatarian honeysuckle.	American elm, green ash, ponderosa pine, eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Russian-olive.	Siberian elm	---
Svea part	---	Siberian peashrub, Tatarian honeysuckle, American plum.	American elm, Black Hills spruce, blue spruce, green ash, ponderosa pine, common chokecherry, eastern redcedar.	Siberian elm	Eastern cottonwood.
[1]51B:					
Barnes part	---	Siberian peashrub, common chokecherry, Tatarian honeysuckle.	American elm, green ash, ponderosa pine, eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Russian-olive.	Siberian elm	---
Svea part	---	Siberian peashrub, Tatarian honeysuckle, American plum.	American elm, Black Hills spruce, blue spruce, green ash, ponderosa pine, common chokecherry, eastern redcedar.	Siberian elm	Eastern cottonwood.
[1]53B:					
Barnes part	---	Siberian peashrub, common chokecherry, Tatarian honeysuckle.	American elm, green ash, ponderosa pine, eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Russian-olive.	Siberian elm	---
Buse part	---	Northern white-cedar, lilac, Siberian peashrub, Tatarian honeysuckle.	White spruce, ponderosa pine, Siberian crabapple.	Green ash, American elm, Russian-olive.	Siberian elm.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Barnes: [1]53C:					
Barnes part----	---	Siberian peashrub, common chokecherry, Tatarian honeysuckle.	American elm, green ash, ponderosa pine, eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Russian-olive.	Siberian elm------	---
Buse part------	---	Northern white-cedar, lilac, Siberian peashrub, Tatarian honeysuckle.	White spruce, ponderosa pine, Siberian crabapple.	Green ash, American elm, Russian-olive.	Siberian elm.
Esmond: [1]55F:					
Esmond part.					
Heimdal part.					
Cresbard: [1]56:					
Cresbard part--	Siberian peashrub, silver buffaloberry, American plum, Peking cotoneaster, lilac.	Green ash, Rocky Mt. juniper, Russian-olive, Siberian crabapple, common chokecherry.	Siberian elm, ponderosa pine.	---	---
Svea part------	---	Siberian peashrub, Tatarian honeysuckle, American plum.	American elm, Black Hills spruce, blue spruce, green ash, ponderosa pine, common chokecherry, eastern redcedar.	Siberian elm------	Eastern cottonwood.
Vallers:					
[1]57----------	---	Tall purple willow, redosier dogwood, Tatarian honeysuckle, Siberian peashrub.	Russian-olive, eastern redcedar, northern white-cedar.	Green ash, American elm.	Eastern cottonwood, golden willow, Siberian elm.
[1]58.					
Hamerly: [1]59:					
Hamerly part---	---	Eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm, American elm, green ash.	Eastern cottonwood.
Tonka part.					

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Emrick: 60, 60B----------	---	Eastern redcedar, Rocky Mt. juniper, common chokecherry, Siberian peashrub.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm------	Eastern cottonwood.
Heimdal: [1]61B: Heimdal part.					
Emrick part.					
Emrick: [1]62: Emrick part----	---	Eastern redcedar, Rocky Mt. juniper, common chokecherry, Siberian peashrub.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm------	Eastern cottonwood.
Heimdal part---	---	Eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Russian-olive, Siberian peashrub, common chokecherry, Tatarian honeysuckle.	American elm, green ash, ponderosa pine.	Siberian elm------	---
[1]62B: Emrick part----	---	Eastern redcedar, Rocky Mt. juniper, common chokecherry, Siberian peashrub.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm------	Eastern cottonwood.
Heimdal part---	---	Eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Russian-olive, Siberian peashrub, common chokecherry, Tatarian honeysuckle.	American elm, green ash, ponderosa pine.	Siberian elm------	---
Heimdal: [1]62C: Heimdal part---	---	Eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Russian-olive, Siberian peashrub, common chokecherry, Tatarian honeysuckle.	American elm, green ash, ponderosa pine.	Siberian elm------	---

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Heimdal:					
Emrick part----	---	Eastern redcedar, Rocky Mt. juniper, common chokecherry, Siberian peashrub.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm------	Eastern cottonwood.
Esmond:					
[1]63D:					
Esmond part----	Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, Russian-olive, eastern redcedar, Rocky Mt. juniper.	Green ash, Siberian elm.	---	---
Heimdal part---	---	Eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Russian-olive, Siberian peashrub, common chokecherry, Tatarian honeysuckle.	American elm, green ash, ponderosa pine.	Siberian elm------	---
[1]63F:					
Esmond part.					
Heimdal part---	---	Eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Russian-olive, Siberian peashrub, common chokecherry, Tatarian honeysuckle.	American elm, green ash, ponderosa pine.	Siberian elm------	---
Heimdal:					
[1]64C:					
Heimdal part---	---	Eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Russian-olive, Siberian peashrub, common chokecherry, Tatarian honeysuckle.	American elm, green ash, ponderosa pine.	Siberian elm------	---
Esmond part----	Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, Russian-olive, eastern redcedar, Rocky Mt. juniper.	Green ash, Siberian elm.	---	---
Fram:					
65----------	---	Eastern redcedar, Rocky Mt. juniper, common chokecherry, Siberian peashrub.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm------	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Gardena: 66, 67B	---	Eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm, American elm, green ash.	Eastern cottonwood.
Eckman: 68C	---	Siberian peashrub, common chokecherry, Tatarian honeysuckle.	American elm, green ash, ponderosa pine, eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Russian-olive.	Siberian elm	---
Glyndon: 70	---	Tall purple willow, northern white-cedar.	Eastern redcedar, white spruce.	Green ash, Russian-olive, golden willow, American elm.	Eastern cottonwood, Siberian elm.
Gardena: 71	---	Eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm, American elm, green ash.	Eastern cottonwood.
Glyndon: 72.					
Borup: 73: Borup part.					
Fossum part.					
74, 75.					
Emrick: 178: Emrick part	---	Eastern redcedar, Rocky Mt. juniper, common chokecherry, Siberian peashrub.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm	Eastern cottonwood.
Cathay part	Siberian peashrub, American plum.	Ponderosa pine, common chokecherry, eastern redcedar, Rocky Mt. juniper, Russian-olive, American elm.	Siberian elm, green ash.	---	---
Cathay: 80, 80B	Siberian peashrub, American plum.	Ponderosa pine, common chokecherry, eastern redcedar, Rocky Mt. juniper, Russian-olive, American elm.	Siberian elm, green ash.	---	---

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Cathay: [1]81:					
Cathay part	Siberian peashrub, American plum.	Ponderosa pine, common chokecherry, eastern redcedar, Rocky Mt. juniper, Russian-olive, American elm.	Siberian elm, green ash.	---	---
Gardena part	---	Eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm, American elm, green ash.	Eastern cottonwood.
Letcher: 82	Silver buffaloberry, Peking cotoneaster, lilac, American plum.	Eastern redcedar, common chokecherry, Siberian peashrub.	Green ash, hackberry, ponderosa pine, Siberian crabapple, Russian-olive.	---	---
Arvilla: 188B	Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, Russian-olive, eastern redcedar.	Siberian elm	---	---
Sioux: [1]89C.					
Serden: 90C.					
Divide: 95	Siberian peashrub	Ponderosa pine, Black Hills spruce, blue spruce, Russian-olive, eastern redcedar, American plum, common chokecherry.	American elm, green ash.	Siberian elm	Eastern cottonwood.
Aquents: 96.					
Stirum: [1]100.					
Aquolls: 104.					
Aylmer: [1]105: Aylmer part.					
Fossum part	---	Tatarian honeysuckle, Siberian peashrub.	Russian-olive	Green ash	Eastern cottonwood, Siberian elm.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 7.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry means soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Tonka:					
1	Severe: wetness.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Parnell:					
2	Severe: floods, wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.
Colvin:					
3	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, frost action, low strength.
Fossum:					
[1]7	Severe: floods, wetness, cutbanks cave.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Hegne:					
12, 13	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.
Bearden:					
14	Moderate: wetness.	Moderate: wetness, shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: wetness, shrink-swell.	Severe: frost action.
15	Severe: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: frost action.
Overly:					
16	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: frost action.
Colvin:					
17, [1]18	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, frost action, low strength.
Pits, gravel:					
20.					
Hecla:					
[1]24:					
Hecla part	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
Ulen part	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
25	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
Maddock:					
26B	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.

See footnote at end of table.

TABLE 7.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Maddock: 27C	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Towner: 29	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
[1]31B: Towner part	Moderate: wetness.	Slight	Moderate: wetness.	Moderate: slope.	Moderate: frost action.
Dickey part	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
Dickey: 32C	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Tiffany: 34	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Embden: 35	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
[1]36B: Embden part	Moderate: wetness.	Slight	Moderate: wetness.	Moderate: slope.	Moderate: frost action.
Egeland part	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Moderate: frost action.
Egeland: 37C	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Moderate: frost action.
Swenoda: 39	Moderate: wetness.	Slight	Slight	Slight	Moderate: frost action.
41B, 42C	Moderate: wetness.	Slight	Slight	Moderate: slope.	Moderate: frost action.
Wyndmere: 43	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
Fossum: [1]44	Severe: wetness, floods, cutbanks cave.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Hamerly: 49	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
Svea: 50	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.
Barnes: [1]51: Barnes part	Slight	Slight	Slight	Slight	Moderate: frost action, low strength.

See footnote at end of table.

TABLE 7.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Barnes:					
Svea part	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, low strength.
[1]51B:					
Barnes part	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action, low strength.
Svea part	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell, slope.	Moderate: frost action, low strength.
[1]53B:					
Barnes part	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action, low strength.
Buse part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell.
[1]53C:					
Barnes part	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action, low strength.
Buse part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell.
Esmond:					
[1]55F:					
Esmond part	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Heimdal part	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Cresbard:					
[1]56:					
Cresbard part	Moderate: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Svea part	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell, slope.	Moderate: frost action, low strength.
Vallers:					
57, 58	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
Hamerly:					
[1]59:					
Hamerly part	Severe: wetness.	Severe: frost action.	Severe: wetness.	Severe: wetness.	Severe: frost action.
Tonka part	Severe: wetness.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Emrick:					
60	Moderate: wetness.	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.	Moderate: frost action, low strength.
60B	Moderate: wetness.	Moderate: low strength.	Moderate: low strength.	Moderate: slope, low strength.	Moderate: frost action, low strength.

See footnote at end of table.

TABLE 7.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Heimdal:					
[1]61B:					
Heimdal part---	Moderate: large stones.	Moderate: large stones, low strength.	Moderate: low strength, large stones.	Moderate: low strength, large stones, slope.	Moderate: frost action, low strength, large stones.
Emrick part----	Moderate: wetness, large stones.	Moderate: large stones.	Moderate: wetness, large stones.	Moderate: large stones. slope.	Moderate: frost action, large stones.
Emrick:					
[1]62:					
Emrick part----	Moderate: wetness.	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.	Moderate: frost action, low strength.
Heimdal part---	Slight----------	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.	Moderate: frost action, low strength.
[1]62B:					
Emrick part----	Moderate: wetness.	Moderate: low strength.	Moderate: low strength.	Moderate: slope, low strength.	Moderate: frost action, low strength.
Heimdal part---	Slight----------	Moderate: low strength.	Moderate: low strength.	Moderate: slope, low strength.	Moderate: frost action, low strength.
Heimdal:					
[1]62C:					
Heimdal part---	Slight----------	Moderate: low strength.	Moderate: low strength.	Moderate: slope, low strength.	Moderate: frost action, low strength.
Emrick part----	Moderate: wetness.	Moderate: low strength.	Moderate: low strength.	Moderate: slope, low strength.	Moderate: frost action, low strength.
Esmond:					
[1]63D:					
Esmond part----	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action, low strength.
Heimdal part---	Moderate: slope.	Moderate: slope, low strength.	Moderate: slope.	Severe: slope.	Moderate: frost action, low strength, slope.
[1]63F:					
Esmond part----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Heimdal part---	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Heimdal:					
[1]64C:					
Heimdal part---	Slight----------	Moderate: low strength.	Moderate: low strength.	Moderate: slope, low strength.	Moderate: frost action, low strength.
Esmond part----	Slight----------	Slight----------	Slight----------	Moderate: slope.	Moderate: frost action, low strength.

See footnote at end of table.

TABLE 7.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Fram:					
65	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.
Gardena:					
66	Moderate: wetness.	Moderate: low strength.	Moderate: low strength, wetness.	Moderate: low strength.	Severe: frost action.
67B	Moderate: wetness.	Moderate: low strength.	Moderate: low strength, wetness.	Moderate: slope, low strength.	Severe: frost action.
Eckman:					
68C	Slight	Moderate: low strength.	Moderate: low strength.	Moderate: slope, low strength.	Severe: frost action.
Glyndon:					
70	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Severe: frost action.
Gardena:					
71	Slight	Slight	Severe: low strength.	Slight	Severe: frost action.
Glyndon:					
72	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Severe: frost action.
Borup:					
[1]73:					
Borup part	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
Fossum part	Severe: wetness, floods, cutbanks cave.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
74	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
75	Severe: wetness, cutbanks cave.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, frost action.
Emrick:					
[1]78:					
Emrick part	Moderate: wetness.	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.	Moderate: frost action, low strength.
Cathay part	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.
Cathay:					
80	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.
80B	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope.	Moderate: frost action, shrink-swell.

See footnote at end of table.

TABLE 7.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Cathay: [1]81:					
Cathay part----	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.
Gardena part---	Moderate: wetness.	Moderate: low strength.	Moderate: low strength, wetness.	Moderate: low strength.	Severe: frost action.
Letcher: 82----------	Moderate: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, low strength, frost action.
Arvilla: [1]88B----------	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight.
Sioux: [1]89C----------	Moderate: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Serden: 90C----------	Severe: cutbanks cave.	Slight----------	Slight----------	Moderate: slope.	Slight.
Divide: 95----------	Severe: wetness, cutbanks cave.	Moderate: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.
Aquents: 96.					
Stirum: [1]100----------	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.
Aquolls: 104.					
Aylmer: [1]105:					
Aylmer part----	Severe: wetness, cutbanks cave.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Slight.
Fossum part----	Severe: wetness, floods, cutbanks cave.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 8.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms used to rate soils]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Tonka:					
1	Severe: wetness, floods.	Slight	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Parnell:					
2	Severe: floods, wetness, percs slowly.	Severe: floods, wetness, excess humus.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: wetness.
Colvin:					
3	Severe: percs slowly, wetness, floods.	Slight	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Fossum:					
[1]7	Severe: wetness, floods.	Severe: seepage, floods, wetness.	Severe: seepage, floods, wetness.	Severe: wetness, floods, seepage.	Poor: wetness, too sandy.
Hegne:					
12, 13	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey.
Bearden:					
14	Severe: wetness, percs slowly.	Slight	Severe: wetness.	Moderate: wetness.	Good.
15	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness.	Good.
Overly:					
16	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
Colvin:					
17, [1]18	Severe: percs slowly, wetness, floods.	Slight	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Pits, gravel:					
20.					
Hecla:					
[1]24:					
Hecla part	Moderate: wetness.	Severe: seepage.	Severe: wetness.	Severe: seepage.	Fair: too sandy.
Ulen part	Moderate: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage.	Severe: wetness, seepage.	Fair: too sandy, thin layer.
25	Moderate: wetness.	Severe: seepage.	Severe: wetness.	Severe: seepage.	Fair: too sandy.
Maddock:					
26B	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Fair: too sandy, seepage.

See footnote at end of table.

TABLE 8.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Maddock:					
27C	Moderate: slope.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Fair: too sandy, seepage.
Towner:					
29	Severe: percs slowly.	Slight	Severe: wetness.	Moderate: wetness.	Fair: too sandy, thin layer.
[1]31B:					
Towner part	Severe: percs slowly.	Moderate: slope.	Severe: wetness.	Moderate: wetness.	Fair: too sandy, thin layer.
Dickey part	Severe: percs slowly.	Moderate: slope, seepage.	Severe: seepage.	Severe: seepage.	Fair: too sandy.
Dickey:					
32C	Severe: percs slowly.	Severe: slope.	Severe: seepage.	Severe: seepage.	Fair: too sandy, slope.
Tiffany:					
34	Severe: wetness, floods.	Severe: wetness, seepage.	Severe: wetness, seepage.	Severe: wetness, seepage.	Poor: wetness.
Embden:					
35	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
[1]36B:					
Embden part	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
Egeland part	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
Egeland:					
37C	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
Swenoda:					
39	Moderate: percs slowly.	Moderate: seepage.	Slight	Severe: seepage.	Good.
41B	Moderate: percs slowly.	Moderate: slope, seepage.	Slight	Severe: seepage.	Good.
42C	Moderate: percs slowly.	Severe: slope.	Slight	Severe: seepage.	Good.
Wyndmere:					
43	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage.	Severe: wetness, seepage.	Fair: thin layer.
Fossum:					
[1]44	Severe: wetness, floods.	Severe: wetness, seepage.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Poor: wetness, too sandy.
Hamerly:					
49	Severe: percs slowly.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Good.

See footnote at end of table.

TABLE 8.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Svea:					
50	Severe: percs slowly.	Slight	Severe: wetness.	Moderate: wetness.	Good.
Barnes:					
[1]51:					
Barnes part	Severe: percs slowly.	Slight	Slight	Slight	Good.
Svea part	Severe: percs slowly.	Slight	Severe: wetness.	Moderate: wetness.	Good.
[1]51B:					
Barnes part	Severe: percs slowly.	Moderate: slope.	Slight	Slight	Good.
Svea part	Severe: percs slowly.	Moderate: slope.	Severe: wetness.	Moderate: wetness.	Good.
[1]53B:					
Barnes part	Severe: percs slowly.	Moderate: slope.	Slight	Slight	Good.
Buse part	Severe: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
[1]53C:					
Barnes part	Severe: percs slowly.	Severe: slope.	Slight	Slight	Good.
Buse part	Severe: percs slowly.	Severe: slope.	Slight	Slight	Good.
Esmond:					
[1]55F:					
Esmond part	Severe: slope.	Severe: slope.	Moderate: large stones, slope.	Severe: slope.	Poor: slope.
Heimdal part	Severe: slope.	Severe: slope.	Moderate: large stones, slope.	Severe: slope.	Poor: slope.
Cresbard:					
[1]56:					
Cresbard part	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
Svea part	Severe: percs slowly.	Slight	Severe: wetness.	Moderate: wetness.	Good.
Vallers:					
57, 58	Severe: percs slowly, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Hamerly:					
[1]59:					
Hamerly part	Severe: percs slowly.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Good.
Tonka part	Severe: wetness, floods.	Slight	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Emrick:					
60	Slight	Moderate: seepage.	Slight	Slight	Good.
60B	Slight	Moderate: slope, seepage.	Slight	Slight	Good.

See footnote at end of table.

TABLE 8.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Heimdal:					
161B:					
Heimdal part	Moderate: large stones.	Moderate: large stones, slope.	Moderate: large stones.	Slight	Fair: large stones.
Emrick part	Moderate: large stones.	Moderate: seepage, large stones, slope.	Moderate: large stones.	Moderate: large stones.	Fair: large stones.
Emrick:					
162:					
Emrick part	Slight	Moderate: seepage.	Slight	Slight	Good.
Heimdal part	Slight	Moderate: seepage.	Slight	Slight	Good.
162B:					
Emrick part	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
Heimdal part	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
Heimdal:					
162C:					
Heimdal part	Slight	Severe: slope.	Slight	Slight	Good.
Emrick part	Slight	Severe: slope.	Slight	Slight	Good.
Esmond:					
163D:					
Esmond part	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.	Fair: slope.
Heimdal part	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.	Fair: slope.
163F:					
Esmond part	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Heimdal part	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.	Poor: slope.
Heimdal:					
164C:					
Heimdal part	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
Esmond part	Slight	Moderate: slope.	Slight	Slight	Good.
Fram:					
65	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Good.
Gardena:					
66	Moderate: wetness.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Good.

See footnote at end of table.

TABLE 8.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Gardena:					
67B	Moderate: wetness.	Moderate: slope, wetness, seepage.	Severe: wetness.	Moderate: wetness.	Good.
Eckman:					
68C	Slight	Severe: slope.	Slight	Slight	Good.
Glyndon:					
70	Moderate: wetness.	Severe: seepage.	Severe: seepage, wetness.	Severe: seepage.	Good.
Gardena:					
71	Severe: percs slowly.	Slight	Slight	Slight	Fair: thin layer.
Glyndon:					
72	Severe: wetness.	Severe: seepage.	Severe: seepage, wetness.	Severe: seepage.	Good.
Borup:					
[1]73:					
Borup part	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage.	Severe: wetness, seepage.	Poor: wetness.
Fossum part	Severe: wetness, floods.	Severe: wetness, seepage.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Poor: wetness, too sandy.
74, 75	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage.	Severe: wetness, seepage.	Poor: wetness.
Emrick:					
[1]78:					
Emrick part	Slight	Moderate: seepage.	Slight	Slight	Good.
Cathay part	Severe: percs slowly.	Slight	Severe: wetness.	Slight	Fair: hard to pack.
Cathay:					
80	Severe: percs slowly.	Slight	Severe: wetness.	Slight	Fair: hard to pack.
80B	Severe: percs slowly.	Moderate: slope.	Severe: wetness.	Slight	Fair: hard to pack.
[1]81:					
Cathay part	Severe: percs slowly.	Slight	Severe: wetness.	Slight	Fair: hard to pack.
Gardena part	Moderate: wetness.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Good.
Letcher:					
82	Severe: percs slowly.	Severe: seepage.	Severe: seepage.	Moderate: wetness.	Good.
Arvilla:					
[1]88B	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: thin layer.

See footnote at end of table.

TABLE 8.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Sioux: [1]89C	Moderate: slope.	Severe: slope, seepage.	Severe: seepage.	Severe: seepage.	Poor: thin layer.
Serden: 90C	Slight	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: too sandy.
Divide: 95	Severe: wetness.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: thin layer.
Aquents: 96.					
Stirum: [1]100	Severe: floods, wetness.	Severe: floods, wetness, seepage.	Severe: floods, wetness, seepage.	Severe: floods, wetness.	Poor: wetness.
Aquolls: 104.					
Aylmer: [1]105:					
Aylmer part	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness.	Severe: wetness.	Poor: too sandy.
Fossum part	Severe: wetness, floods.	Severe: wetness, seepage.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Poor: wetness, too sandy.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 9.--CONSTRUCTION MATERIALS

["Shrink-swell" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor." Absence of an entry means soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Tonka:				
1	Poor: wetness, low strength.	Unsuited	Unsuited	Poor: wetness.
Parnell:				
2	Poor: wetness, shrink-swell.	Unsuited	Unsuited	Poor: wetness.
Colvin:				
3	Poor: wetness, low strength.	Unsuited	Unsuited	Poor: wetness.
Fossum:				
[1]7	Poor: wetness.	Fair: excess fines.	Unsuited	Poor: wetness, excess salt.
Hegne:				
12, 13	Poor: shrink-swell, wetness, low strength.	Unsuited	Unsuited	Poor: too clayey, wetness.
Bearden:				
14	Poor: low strength.	Unsuited	Unsuited	Fair: excess lime.
15	Poor: low strength.	Unsuited	Unsuited	Fair: excess lime, excess salt.
Overly:				
16	Poor: low strength.	Unsuited	Unsuited	Fair: too clayey.
Colvin:				
17, [1]18	Poor: wetness, low strength.	Unsuited	Unsuited	Poor: wetness.
Pits, gravel:				
20.				
Hecla:				
[1]24:				
Hecla part	Fair: wetness.	Poor: excess fines.	Unsuited	Poor: too sandy.
Ulen part	Good	Fair: excess fines.	Unsuited	Poor: too sandy, excess lime.
25	Fair: wetness.	Poor: excess fines.	Unsuited	Poor: too sandy.
Maddock:				
26B, 27C	Good	Fair: excess fines.	Unsuited	Poor: too sandy.

See footnote at end of table.

TABLE 9.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Towner:				
29	Good	Unsuited	Unsuited	Poor: too sandy.
[1]31B:				
Towner part	Good	Unsuited	Unsuited	Poor: too sandy.
Dickey part	Poor: thin layer.	Unsuited	Unsuited	Poor: too sandy.
Dickey:				
32C	Poor: thin layer.	Unsuited	Unsuited	Poor: too sandy.
Tiffany:				
34	Poor: wetness.	Poor: excess fines.	Unsuited	Poor: wetness.
Embden:				
35	Fair: wetness, low strength.	Poor: excess fines.	Unsuited	Good.
[1]36B:				
Embden part	Fair: wetness, low strength.	Poor: excess fines.	Unsuited	Good.
Egeland part	Fair: low strength.	Poor: excess fines.	Unsuited	Good.
Egeland:				
37C	Fair: low strength.	Poor: excess fines.	Unsuited	Good.
Swenoda:				
39, 41B, 42C	Fair: low strength.	Unsuited	Unsuited	Good.
Wyndmere:				
43	Fair: low strength, wetness.	Poor: excess fines.	Unsuited	Poor: excess lime.
Fossum:				
[1]44	Poor: wetness.	Fair: excess fines.	Unsuited	Poor: wetness.
Hamerly:				
49	Poor: low strength.	Unsuited	Unsuited	Fair: thin layer.
Svea:				
50	Fair: shrink-swell, low strength.	Unsuited	Unsuited	Good.
Barnes:				
[1]51:				
Barnes part	Fair: low strength.	Unsuited	Unsuited	Good.
Svea part	Fair: shrink-swell, low strength.	Unsuited	Unsuited	Good.

See footnote at end of table.

TABLE 9.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Barnes:				
[1]51B:				
Barnes part	Fair: low strength.	Unsuited	Unsuited	Good.
Svea part	Fair: shrink-swell, low strength.	Unsuited	Unsuited	Good.
[1]53B:				
Barnes part	Fair: low strength.	Unsuited	Unsuited	Good.
Buse part	Fair: shrink-swell.	Unsuited	Unsuited	Good.
[1]53C:				
Barnes part	Fair: low strength.	Unsuited	Unsuited	Good.
Buse part	Fair: shrink-swell.	Unsuited	Unsuited	Good.
Esmond:				
[1]55F:				
Esmond part	Fair: slope, large stones.	Unsuited	Unsuited	Poor: large stones, slope.
Heimdal part	Fair: low strength, large stones.	Unsuited	Unsuited	Poor: large stones, slope.
Cresbard:				
[1]56:				
Cresbard part	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Fair: thin layer.
Svea part	Fair: shrink-swell, low strength.	Unsuited	Unsuited	Good.
Vallers:				
57	Poor: wetness.	Unsuited	Unsuited	Poor: wetness, excess lime.
58	Poor: wetness.	Unsuited	Unsuited	Poor: wetness, excess salt.
Hamerly:				
[1]59:				
Hamerly part	Poor: low strength.	Unsuited	Unsuited	Fair: thin layer.
Tonka part	Poor: wetness, low strength.	Unsuited	Unsuited	Poor: wetness.
Emrick:				
60, 60B	Fair: low strength.	Unsuited	Unsuited	Good.
Heimdal:				
[1]61B:				
Heimdal part	Fair: low strength, large stones.	Unsuited	Unsuited	Poor: large stones.

See footnote at end of table.

TABLE 9.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Heimdal:				
Emrick part	Fair: large stones.	Unsuited	Unsuited	Poor: large stones.
Emrick:				
[1]62:				
Emrick part	Fair: low strength.	Unsuited	Unsuited	Good.
Heimdal part	Fair: low strength.	Unsuited	Unsuited	Good.
[1]62B:				
Emrick part	Fair: low strength.	Unsuited	Unsuited	Good.
Heimdal part	Fair: low strength.	Unsuited	Unsuited	Good.
Heimdal:				
[1]62C:				
Heimdal part	Fair: low strength.	Unsuited	Unsuited	Good.
Emrick part	Fair: low strength.	Unsuited	Unsuited	Good.
Esmond:				
[1]63D:				
Esmond part	Fair: low strength.	Unsuited	Unsuited	Fair: slope.
Heimdal part	Fair: low strength.	Unsuited	Unsuited	Fair: slope.
[1]63F:				
Esmond part	Poor: slope.	Unsuited	Unsuited	Poor: slope.
Heimdal part	Fair: low strength, slope.	Unsuited	Unsuited	Poor: slope.
Heimdal:				
[1]64C:				
Heimdal part	Fair: low strength.	Unsuited	Unsuited	Good.
Esmond part	Fair: low strength.	Unsuited	Unsuited	Good.
Fram:				
65	Fair: low strength, wetness.	Unsuited	Unsuited	Fair: excess lime.
Gardena:				
66, 67B	Fair: low strength.	Unsuited	Unsuited	Good.
Eckman:				
68C	Fair: low strength.	Unsuited	Unsuited	Good.
Glyndon:				
70	Fair: low strength, wetness.	Unsuited	Unsuited	Fair: excess lime.

See footnote at end of table.

TABLE 9.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Gardena:				
71	Fair: low strength.	Unsuited	Unsuited	Good.
Glyndon:				
72	Fair: low strength, wetness.	Unsuited	Unsuited	Poor: excess salt.
Borup:				
[1]73:				
Borup part	Poor: wetness.	Poor: excess fines.	Unsuited	Poor: wetness, excess lime.
Fossum part	Poor: wetness.	Fair: excess fines.	Unsuited	Poor: wetness.
74	Poor: wetness.	Poor: excess fines.	Unsuited	Poor: wetness, excess lime.
75	Poor: wetness.	Poor: excess fines.	Unsuited	Poor: wetness, excess salt.
Emrick:				
[1]78:				
Emrick part	Fair: low strength.	Unsuited	Unsuited	Good.
Cathay part	Fair: low strength, shrink-swell.	Unsuited	Unsuited	Fair: excess sodium.
Cathay:				
80, 80B	Fair: low strength, shrink-swell.	Unsuited	Unsuited	Fair: excess sodium.
[1]81:				
Cathay part	Fair: low strength, shrink-swell.	Unsuited	Unsuited	Fair: excess sodium.
Gardena part	Fair: low strength.	Unsuited	Unsuited	Good.
Letcher:				
82	Fair: low strength.	Poor: excess fines.	Unsuited	Fair: thin layer.
Arvilla:				
[1]88B	Good	Fair: excess fines.	Fair: excess fines.	Fair: thin layer.
Sioux:				
[1]89C	Good	Fair: excess fines.	Fair: excess fines.	Poor: thin layer.
Serden:				
90C	Good	Poor: excess fines.	Unsuited	Poor: too sandy.

See footnote at end of table.

TABLE 9.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Divide: 95	Poor: low strength.	Poor: excess fines.	Poor: excess fines.	Good.
Aquents: 96.				
Stirum: [1]100	Poor: wetness.	Poor: excess fines.	Unsuited	Poor: wetness.
Aquolls: 104.				
Aylmer: [1]105:				
Aylmer part	Good	Fair: excess fines.	Unsuited	Poor: too sandy.
Fossum part	Poor: wetness.	Fair: excess fines.	Unsuited	Poor: wetness.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 10.--WATER MANAGEMENT

["Seepage" and some of the other terms that describe restrictive soil features are defined in the Glossary. Absence of an entry means soil was not evaluated]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Tonka: 1	Favorable	Low strength, shrink-swell.	Poor outlets	Wetness	Wetness	Not needed.
Parnell: 2	Favorable	Low strength, hard to pack.	Floods, percs slowly, frost action.	Floods, wetness, slow intake.	Not needed	Not needed.
Colvin: 3	Favorable	Low strength, compressible.	Poor outlets, wetness, percs slowly.	Floods, wetness, percs slowly.	Not needed	Not needed.
Fossum: [1]7	Seepage	Seepage, piping.	Wetness, floods, cutbanks cave	Wetness, floods, excess salt.	Not needed	Not needed.
Hegne: 12, 13	Favorable	Compressible, low strength, shrink-swell.	Wetness, percs slowly.	Wetness, slow intake.	Not needed	Wetness, percs slowly.
Bearden: 14	Favorable	Low strength, shrink-swell, piping.	Poor outlets	Wetness	Not needed	Not needed.
15	Favorable	Low strength, shrink-swell.	Poor outlets	Wetness, excess salt.	Not needed	Not needed.
Overly: 16	Favorable	Compressible, shrink-swell.	Not needed	Percs slowly	Piping	Favorable.
Colvin: 17, [1]18	Favorable	Low strength, compressible.	Poor outlets, wetness, percs slowly.	Floods, wetness, percs slowly.	Not needed	Not needed.
Pits, gravel: 20.						
Hecla: [1]24: Hecla part	Seepage	Seepage, erodes easily, piping.	Not needed	Fast intake, soil blowing.	Not needed	Not needed.
Ulen part	Seepage	Piping	Not needed	Fast intake, seepage.	Not needed	Not needed.
25	Seepage	Seepage, erodes easily, piping.	Not needed	Fast intake, soil blowing.	Not needed	Not needed.
Maddock: 26B, 27C	Seepage	Seepage	Not needed	Seepage, soil blowing, fast intake.	Soil blowing	Soil blowing.
Towner: 29	Favorable	Compressible, piping.	Not needed	Erodes easily, fast intake.	Erodes easily	Favorable.

See footnote at end of table.

TABLE 10.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Towner:						
[1]31B:						
Towner part	Favorable	Compressible, piping.	Not needed	Erodes easily, fast intake.	Erodes easily	Slope, erodes easily
Dickey part	Seepage	Piping, hard to pack.	Not needed	Fast intake	Soil blowing, piping, slope.	Slope.
Dickey:						
32C	Seepage	Piping, hard to pack.	Not needed	Slope	Soil blowing, piping, slope.	Slope.
Tiffany:						
34	Seepage	Low strength, piping.	Poor outlets, floods.	Wetness, seepage, soil blowing.	Wetness, piping.	Not needed.
Embden:						
35	Seepage	Piping	Not needed	Fast intake, erodes easily	Piping, erodes easily	Not needed.
[1]36B:						
Embden part	Seepage	Piping	Not needed	Fast intake, erodes easily	Piping, erodes easily	Not needed.
Egeland part	Seepage, slope.	Piping, seepage.	Not needed	Fast intake	Piping, soil blowing.	Slope, erodes easily
Egeland:						
37C	Seepage, slope.	Piping, seepage.	Not needed	Slope, fast intake.	Piping, soil blowing.	Slope, erodes easily
Swenoda:						
39	Seepage	Piping, low strength.	Not needed	Favorable	Not needed	Favorable.
41B	Slope, seepage.	Piping, low strength.	Not needed	Favorable	Complex slope	Slope, erodes easily
42C	Slope, seepage.	Piping, low strength.	Not needed	Slope	Complex slope	Slope, erodes easily
Wyndmere:						
43	Seepage	Seepage, piping.	Poor outlets	Seepage, wetness, soil blowing.	Wetness	Not needed.
Fossum:						
[1]44	Seepage	Seepage, piping.	Wetness, cutbanks cave floods.	Wetness, floods, fast intake.	Not needed	Not needed.
Hamerly:						
49	Favorable	Compressible, piping, low strength.	Percs slowly	Slow intake	Percs slowly, poor outlets, piping.	Percs slowly.
Svea:						
50	Favorable	Low strength, shrink-swell, piping.	Not needed	Percs slowly, wetness.	Percs slowly, piping.	Percs slowly, wetness.
Barnes:						
[1]51:						
Barnes part	Favorable	Low strength	Not needed	Slow intake	Complex slope, poor outlets.	Favorable.

See footnote at end of table.

TABLE 10.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Barnes:						
Svea part	Favorable	Low strength, shrink-swell, piping.	Not needed	Percs slowly, wetness.	Percs slowly, piping.	Percs slowly, wetness.
[1]51B:						
Barnes part	Slope	Low strength	Not needed	Slow intake	Complex slope, poor outlets.	Slope.
Svea part	Favorable	Low strength, shrink-swell, piping.	Not needed	Percs slowly, wetness.	Percs slowly, piping.	Percs slowly, wetness.
[1]53B:						
Barnes part	Slope	Low strength	Not needed	Slow intake	Complex slope, poor outlets.	Slope.
Buse part	Slope, seepage.	Shrink-swell, low strength.	Not needed	Complex slope	Complex slope	Slope.
[1]53C:						
Barnes part	Slope	Low strength	Not needed	Slope	Complex slope, poor outlets.	Slope.
Buse part	Slope, seepage.	Shrink-swell, low strength.	Not needed	Complex slope	Complex slope	Slope.
Esmond:						
[1]55F:						
Esmond part	Seepage, slope.	Compressible, piping, large stones.	Not needed	Complex slope, erodes easily	Complex slope, erodes easily large stones.	Slope, erodes easily large stones.
Heimdal part	Seepage	Compressible, piping, large stones.	Not needed	Complex slope	Piping, large stones.	Erodes easily, large stones.
Cresbard:						
[1]56:						
Cresbard part	Favorable	Low strength, shrink-swell, compressible.	Not needed	Slow intake, excess salt, excess sodium	Not needed	Percs slowly.
Svea part	Favorable	Low strength, shrink-swell, piping.	Not needed	Percs slowly, wetness.	Percs slowly, piping.	Percs slowly, wetness.
Vallers:						
57	Favorable	Compressible, piping.	Percs slowly, wetness, poor outlets.	Slow intake, wetness, excess lime.	Not needed	Not needed.
58	Favorable	Compressible, piping.	Percs slowly, wetness, poor outlets.	Slow intake, wetness, excess salt.	Not needed	Not needed.
Hamerly:						
[1]59:						
Hamerly part	Favorable	Compressible, piping, low strength.	Percs slowly	Slow intake	Percs slowly, poor outlets, piping.	Percs slowly.
Tonka part	Favorable	Low strength, shrink-swell.	Poor outlets	Wetness	Wetness	Not needed.
Emrick:						
60, 60B	Seepage	Piping, low strength.	Not needed	Favorable	Piping	Favorable.

See footnote at end of table.

TABLE 10.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Heimdal:						
[1]61B:						
Heimdal part---	Seepage--------	Compressible, piping, large stones.	Not needed----	Complex slope	Piping, large stones.	Erodes easily, large stones.
Emrick part----	Seepage--------	Piping, low strength, large stones.	Not needed----	Favorable-----	Piping, large stones.	Large stones.
Emrick:						
[1]62:						
Emrick part----	Seepage--------	Piping, low strength.	Not needed----	Favorable-----	Piping--------	Favorable.
Heimdal part---	Seepage--------	Compressible, piping.	Not needed----	Complex slope	Piping--------	Erodes easily.
[1]62B:						
Emrick part----	Seepage--------	Piping, low strength.	Not needed----	Favorable-----	Piping--------	Favorable.
Heimdal part---	Seepage--------	Compressible, piping.	Not needed----	Complex slope	Piping--------	Erodes easily.
Heimdal:						
[1]62C:						
Heimdal part---	Seepage--------	Compressible, piping.	Not needed----	Complex slope	Piping--------	Erodes easily.
Emrick part----	Seepage--------	Piping, low strength.	Not needed----	Favorable-----	Piping--------	Favorable.
Esmond:						
[1]63D:						
Esmond part----	Seepage, slope.	Compressible, piping.	Not needed----	Complex slope, erodes easily	Complex slope, erodes easily	Slope, erodes easily.
Heimdal part---	Seepage--------	Compressible, piping.	Not needed----	Complex slope	Piping--------	Erodes easily.
[1]63F:						
Esmond part----	Seepage, slope.	Compressible, piping.	Not needed----	Complex slope, erodes easily	Complex slope, erodes easily	Slope, erodes easily.
Heimdal part---	Seepage--------	Compressible, piping.	Not needed----	Complex slope	Piping--------	Erodes easily.
Heimdal:						
[1]64C:						
Heimdal part---	Seepage--------	Compressible, piping.	Not needed----	Complex slope	Piping--------	Erodes easily.
Esmond part----	Seepage, slope.	Compressible, piping.	Not needed----	Complex slope, erodes easily	Complex slope, erodes easily	Slope, erodes easily.
Fram:						
65----------	Seepage--------	Piping, low strength.	Poor outlets	Wetness-------	Wetness, poor outlets.	Favorable.
Gardena:						
66, 67B-----	Seepage--------	Compressible, piping, low strength.	Not needed----	Favorable-----	Piping--------	Erodes easily.
Eckman:						
68C----------	Slope, seepage.	Compressible, piping.	Not needed----	Slope---------	Piping--------	Slope, erodes easily.

See footnote at end of table.

TABLE 10.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Glyndon:						
70	Seepage	Seepage, piping, low strength.	Not needed	Favorable	Not needed	Not needed.
Gardena:						
71	Favorable	Low strength, compressible, piping.	Not needed	Percs slowly	Piping, percs slowly.	Erodes easily, percs slowly.
Glyndon:						
72	Seepage	Seepage, piping, low strength.	Not needed	Excess salt	Not needed	Not needed.
Borup:						
[1]73:						
Borup part	Seepage	Seepage, piping.	Wetness, poor outlets, cutbanks cave	Wetness	Not needed	Not needed.
Fossum part	Seepage	Seepage, piping.	Wetness, cutbanks cave floods.	Wetness, floods, fast intake.	Not needed	Not needed.
74	Seepage	Seepage, piping.	Wetness, poor outlets, cutbanks cave	Wetness	Not needed	Not needed.
75	Seepage	Seepage, piping.	Wetness, cutbanks cave poor outlets.	Wetness, excess salt.	Not needed	Not needed.
Emrick:						
[1]78:						
Emrick part	Seepage	Piping, low strength.	Not needed	Favorable	Piping	Favorable.
Cathay part	Favorable	Low strength, piping, shrink-swell.	Not needed	Excess sodium, slow intake.	Percs slowly	Excess sodium.
Cathay:						
80, 80B	Favorable	Low strength, piping, shrink-swell.	Not needed	Excess sodium, slow intake.	Percs slowly	Excess sodium.
[1]81:						
Cathay part	Favorable	Low strength, piping, shrink-swell.	Not needed	Excess sodium, slow intake.	Percs slowly	Excess sodium.
Gardena part	Seepage	Compressible, piping, low strength.	Not needed	Favorable	Piping	Erodes easily.
Letcher:						
82	Seepage	Piping	Percs slowly, excess sodium excess salt.	Percs slowly, excess salt.	Not needed	Not needed.
Arvilla:						
[1]88B	Seepage	Seepage	Not needed	Seepage, soil blowing.	Soil blowing, piping.	Droughty, rooting depth.
Sioux:						
[1]89C	Seepage	Seepage	Not needed	Complex slope, droughty, fast intake.	Too sandy	Slope, droughty.

See footnote at end of table.

TABLE 10.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Serden: 90C	Seepage	Seepage	Not needed	Complex slope, soil blowing, seepage.	Soil blowing	Soil blowing.
Divide: 95	Seepage	Seepage	Wetness, cutbanks cave	Wetness, seepage.	Not needed	Not needed.
Aquents: 96C.						
Stirum: [1]100	Seepage	Piping	Excess salt, floods, wetness.	Excess salt, floods, wetness.	Not needed	Not needed.
Aquolls: 104.						
Aylmer: [1]105:						
Aylmer part	Seepage	Seepage, piping.	Not needed	Soil blowing, droughty, fast intake.	Soil blowing	Too sandy, soil blowing, droughty.
Fossum part	Seepage	Seepage, piping.	Wetness, cutbanks cave floods.	Wetness, floods, fast intake.	Not needed	Not needed.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 11.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry means soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Tonka:				
1	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Parnell:				
2	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.
Colvin:				
3	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Fossum:				
[1]7	Severe: wetness, floods.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Hegne:				
12, 13	Severe: wetness, too clayey.	Severe: wetness, too clayey.	Severe: wetness, too clayey.	Severe: wetness, too clayey.
Bearden:				
14, 15	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.
Overly:				
16	Moderate: too clayey, percs slowly.	Moderate: too clayey.	Moderate: too clayey, percs slowly.	Moderate: too clayey.
Colvin:				
17, [1]18	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Pits, gravel:				
20.				
Hecla:				
[1]24:				
Hecla part	Moderate: too sandy.	Moderate: too sandy.	Severe: too sandy.	Moderate: too sandy.
Ulen part	Moderate: wetness, too sandy.	Moderate: wetness, too sandy.	Moderate: wetness, too sandy.	Moderate: wetness, too sandy.
25	Moderate: too sandy.	Moderate: too sandy.	Severe: too sandy.	Moderate: too sandy.
Maddock:				
26B	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.
27C	Moderate: too sandy.	Moderate: too sandy.	Severe: slope.	Moderate: too sandy.
Towner:				
29	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.

See footnote at end of table.

TABLE 11.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Towner:				
[1]31B:				
Towner part	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.
Dickey part	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
Dickey:				
32C	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
Tiffany:				
34	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Embden:				
35	Slight	Slight	Slight	Slight.
[1]36B:				
Embden part	Slight	Slight	Moderate: slope.	Slight.
Egeland part	Slight	Slight	Moderate: slope.	Slight.
Egeland:				
37C	Slight	Slight	Severe: slope.	Slight.
Swenoda:				
39	Slight	Slight	Slight	Slight.
41B	Slight	Slight	Moderate: slope.	Slight.
42C	Slight	Slight	Severe: slope.	Slight.
Wyndmere:				
43	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.
Fossum:				
[1]44	Severe: wetness, floods.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Hamerly:				
49	Moderate: wetness, percs slowly.	Moderate: wetness.	Moderate: wetness, percs slowly.	Moderate: wetness.
Svea:				
50	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Barnes:				
[1]51:				
Barnes part	Slight	Slight	Slight	Slight.
Svea part	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
[1]51B:				
Barnes part	Slight	Slight	Moderate: slope.	Slight.

See footnote at end of table.

TABLE 11.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Barnes:				
Svea part	Moderate: percs slowly.	Slight	Moderate: percs slowly, slope.	Slight.
[1]53B:				
Barnes part	Slight	Slight	Moderate: slope.	Slight.
Buse part	Slight	Slight	Moderate: slope.	Slight.
[1]53C:				
Barnes part	Slight	Slight	Severe: slope.	Slight.
Buse part	Slight	Slight	Severe: slope.	Slight.
Esmond:				
[1]55F:				
Esmond part	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: large stones, slope.
Heimdal part	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: large stones, slope.
Cresbard:				
[1]56:				
Cresbard part	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Svea part	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Vallers:				
57, 58	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Hamerly:				
[1]59:				
Hamerly part	Moderate: wetness, percs slowly.	Moderate: wetness.	Moderate: wetness, percs slowly.	Moderate: wetness.
Tonka part	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Emrick:				
60	Slight	Slight	Slight	Slight.
60B	Slight	Slight	Moderate: slope.	Slight.
Heimdal:				
[1]61B:				
Heimdal part	Moderate: large stones.	Slight	Severe: slope.	Moderate: large stones.
Emrick part	Moderate: large stones.	Slight	Severe: slope.	Moderate: large stones.
Emrick:				
[1]62:				
Emrick part	Slight	Slight	Slight	Slight.
Heimdal part	Slight	Slight	Slight	Slight.

See footnote at end of table.

TABLE 11.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Emrick:				
[1]62B:				
Emrick part	Slight	Slight	Moderate: slope.	Slight.
Heimdal part	Slight	Slight	Moderate: slope.	Slight.
Heimdal:				
[1]62C:				
Heimdal part	Slight	Slight	Severe: slope.	Slight.
Emrick part	Slight	Slight	Severe: slope.	Slight.
Esmond:				
[1]63D:				
Esmond part	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Heimdal part	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
[1]63F:				
Esmond part	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Heimdal part	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Heimdal:				
[1]64C:				
Heimdal part	Slight	Slight	Severe: slope.	Slight.
Esmond part	Slight	Slight	Severe: slope.	Slight.
Fram:				
65	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.
Gardena:				
66	Slight	Slight	Slight	Slight.
67B	Slight	Slight	Moderate: slope.	Slight.
Eckman:				
68C	Slight	Slight	Severe: slope.	Slight.
Glyndon:				
70	Slight	Slight	Slight	Slight.
Gardena:				
71	Slight	Slight	Slight	Slight.
Glyndon:				
72	Slight	Slight	Slight	Slight.
Borup:				
[1]73:				
Borup part	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Fossum part	Severe: wetness, floods.	Severe: wetness.	Severe: wetness.	Severe: wetness.

See footnote at end of table.

TABLE 11.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Borup: 74, 75	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Emrick: [1]78:				
Emrick part	Slight	Slight	Slight	Slight.
Cathay part	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Cathay: 80	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
80B	Moderate: percs slowly.	Slight	Moderate: percs slowly, slope.	Slight.
[1]81:				
Cathay part	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Gardena part	Slight	Slight	Slight	Slight.
Letcher: 82	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Arvilla: [1]88B	Slight	Slight	Moderate: slope.	Slight.
Sioux: [1]89C	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Serden: 90C	Severe: too sandy.	Moderate: too sandy.	Severe: too sandy, slope.	Severe: too sandy.
Divide: 95	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.
Aquents: 96.				
Stirum: [1]100	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Aquolls: 104.				
Aylmer: [1]105:				
Aylmer part	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
Fossum part	Severe: wetness, floods.	Severe: wetness.	Severe: wetness.	Severe: wetness.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 12.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates the soil was not rated]

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
Tonka:									
1	Good	Good	Fair	Poor	Good	Good	Good	Good	Poor.
Parnell:									
2	Very poor	Very poor	Poor	---	Good	Good	Very poor	Good	Poor.
Colvin:									
3	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
Fossum:									
[1]7	Poor	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
Hegne:									
12, 13	Poor	Fair	Fair	---	Poor	Good	Fair	Fair	Poor.
Bearden:									
14	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
15	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Poor.
Overly:									
16	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Colvin:									
17, [1]18	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
Pits, gravel:									
20.									
Hecla:									
[1]24:									
Hecla part	Fair	Fair	Good	Good	Poor	Poor	Fair	Poor	Good.
Ulen part	Fair	Good	Good	Fair	Poor	Poor	Fair	Poor	Fair.
25	Fair	Fair	Good	Good	Poor	Poor	Fair	Poor	Good.
Maddock:									
26B	Fair	Good	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
27C	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Towner:									
29	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
[1]31B:									
Towner part	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Dickey part	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Dickey:									
32C	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Tiffany:									
34	Poor	Fair	Good	Fair	Good	Fair	Fair	Fair	Fair.
Embden:									
35	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
[1]36B:									
Embden part	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Egeland part	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.

See footnote at end of table.

TABLE 12.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
Egeland:									
37C	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
Swenoda:									
39, 41B, 42C	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Good.
Wyndmere:									
43	Fair	Good	Good	Fair	Fair	Poor	Good	Poor	Fair.
Fossum:									
[1]44	Poor	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
Hamerly:									
49	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Svea:									
50	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Barnes:									
[1]51:									
Barnes part	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Svea part	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
[1]51B:									
Barnes part	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Svea part	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
[1]53B:									
Barnes part	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse part	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
[1]53C:									
Barnes part	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse part	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Esmond:									
[1]55F:									
Esmond part	Poor	Poor	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Heimdal part	Very poor	Poor	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Cresbard:									
[1]56:									
Cresbard part	Good	Good	Good	Poor	Poor	Poor	Good	Very poor	Fair.
Svea part	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Vallers:									
57	Poor	Poor	Fair	Fair	Good	Good	Poor	Good	Fair.
58	Fair	Fair	Very poor	Fair	Good	Good	Fair	Good	Poor.
Hamerly:									
[1]59:									
Hamerly part	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Tonka part	Poor	Poor	Fair	Poor	Good	Good	Poor	Good	Poor.
Emrick:									
60	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
60B	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.

See footnote at end of table.

TABLE 12.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
Heimdal: [1]61B:									
Heimdal part	Poor	Poor	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
Emrick part	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Emrick: [1]62:									
Emrick part	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Heimdal part	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
[1]62B:									
Emrick part	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Heimdal part	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Heimdal: [1]62C:									
Heimdal part	Fair	Good	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
Emrick part	Fair	Good	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
Esmond: [1]63D:									
Esmond part	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Heimdal part	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
[1]63F:									
Esmond part	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Heimdal part	Poor	Fair	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Heimdal: [1]64C:									
Heimdal part	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Esmond part	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Fram: 65	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Gardena: 66	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
67B	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Eckman: 68C	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Glyndon: 70	Good	Good	Good	Poor	Poor	Poor	Good	Poor	Fair.
Gardena: 71	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Glyndon: 72	Fair	Fair	Good	Fair	Poor	Poor	Fair	Poor	Fair.
Borup: [1]73:									
Borup part	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
Fossum part	Very poor	Very poor	Fair	Fair	Good	Good	Very poor	Good	Fair.
74	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.

See footnote at end of table.

TABLE 12.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
Borup:									
75	Fair	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
Emrick:									
[1]78:									
Emrick part	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Cathay part	Fair	Good	Good	Poor	Poor	Poor	Fair	Poor	Fair.
Cathay:									
80	Fair	Good	Good	Poor	Poor	Poor	Fair	Poor	Fair.
80B	Fair	Good	Good	Poor	Poor	Very poor	Fair	Very poor	Fair.
[1]81:									
Cathay part	Fair	Good	Good	Poor	Poor	Poor	Fair	Poor	Fair.
Gardena part	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Letcher:									
82	Fair	Good	Good	---	Poor	Poor	Fair	Poor	Good.
Arvilla:									
[1]88B	Fair	Good	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
Sioux:									
[1]89C	Poor	Poor	Fair	---	Very poor	Very poor	Poor	Very poor	Fair.
Serden:									
90C	Poor	Fair	Fair	Good	Very poor	Very poor	Fair	Very poor	Fair.
Divide:									
95	Fair	Fair	Good	Fair	Fair	Very poor	Fair	Poor	Fair.
Aquents:									
96.									
Stirum:									
[1]100	Very poor	Very poor	Very poor	Fair	Good	Fair	Very poor	Fair	Poor.
Aquolls:									
104.									
Aylmer:									
[1]105:									
Aylmer part	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
Fossum part	Poor	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol < means less than; > means greater than. Absence of an entry means data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Tonka:											
1	0-24	Silt loam	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-40	5-25
	24-37	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
	37-60	Silty clay loam, clay loam.	CL	A-6, A-7	0-3	100	95-100	90-100	70-90	20-50	10-30
Parnell:											
2	0-8	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-95	40-60	15-30
	8-46	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-95	40-80	20-50
	46-60	Clay 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
Colvin:											
3	0-60	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	11-30
Fossum:											
[1]7	0-12	Fine sandy loam	SM	A-4	0	100	100	60-85	35-50	<20	<10
	12-22	Loamy sand, sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	100	60-80	5-30	---	NP
	22-60	Sand, fine sand	SM, SP-SM	A-3, A-2	0	95-100	95-100	60-80	5-20	---	NP
Hegne:											
12, 13	0-8	Silty clay	OH, CH	A-7	0	100	100	95-100	90-98	50-70	22-40
	8-32	Silty clay, clay	CH	A-7	0	100	100	95-100	95-98	50-70	22-40
	32-60	Clay, silty clay	CH	A-7	0	100	100	95-100	95-100	50-70	22-40
Bearden:											
14	0-8	Silty clay loam	CL, CL-ML	A-6, A-7	0	100	100	95-100	80-95	30-50	10-25
	8-14	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	30-50	10-25
	14-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	30-50	10-25
15	0-8	Silty clay loam	ML, CL	A-6, A-7	0	100	100	95-100	80-95	30-50	7-27
	8-14	Silt loam, silty clay loam.	ML, CL	A-6, A-7	0	100	100	95-100	80-95	30-50	7-27
	14-60	Silt loam, silty clay loam.	ML, CL	A-6, A-7	0	100	100	95-100	80-95	30-50	7-27
Overly:											
16	0-9	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	30-45	10-25
	9-32	Silty clay loam, silt loam, clay loam.	CL, CL-ML	A-6, A-7	0	100	100	90-100	80-95	25-50	5-30
	32-60	Stratified silt loam to silty clay.	CL, CL-ML	A-6, A-7	0	100	100	90-100	80-95	25-50	5-30
Colvin:											
17, [1]18	0-60	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	11-30
Pits, gravel:											
20.											
Hecla:											
[1]24:											
Hecla part	0-18	Loamy fine sand	SM, SM-SC	A-2	0	100	95-100	85-100	15-35	<25	NP-5
	18-60	Loamy sand, fine sand, loamy fine sand.	SM, SM-SC	A-2	0	100	95-100	85-100	15-35	<25	NP-5

See footnote at end of table.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Hecla:											
Ulen part-------	0-15	Loamy fine sand	SM	A-4, A-2	0	100	100	80-100	20-50	<20	NP-4
	15-23	Loamy fine sand, fine sand.	SM	A-2	0	100	95-100	70-95	12-35	---	NP
	23-60	Fine sand-------	SP-SM, SM	A-3, A-2-4	0	100	95-100	80-100	5-35	---	NP
25----------	0-18	Loamy fine sand	SM, SM-SC	A-2	0	100	95-100	85-100	15-35	<25	NP-5
	18-60	Loamy sand, fine sand, loamy fine sand.	SM, SM-SC	A-2	0	100	95-100	85-100	15-35	<25	NP-5
Maddock:											
26B, 27C----------	0-11	Loamy fine sand	SM	A-2	0	100	100	50-80	15-35	---	NP
	11-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	95-100	60-95	5-35	---	NP
Towner:											
29----------	0-6	Loamy fine sand	SM, SM-SC	A-2	0	100	100	50-80	15-35	<25	NP-5
	6-29	Loamy sand, loamy fine sand, fine sand.	SM, SM-SC	A-2	0	100	95-100	50-80	15-35	<25	NP-5
	29-60	Loam, silt loam, silty clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-80	25-50	5-30
[1]31B:											
Towner part-----	0-6	Loamy fine sand	SM, SM-SC	A-2	0	100	100	50-80	15-35	<25	NP-5
	6-29	Loamy sand, loamy fine sand, fine sand.	SM, SM-SC	A-2	0	100	95-100	50-80	15-35	<25	NP-5
	29-60	Loam, silt loam, silty clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-80	25-50	5-30
Dickey part-----	0-12	Loamy fine sand	SM	A-2-4	0	100	100	50-75	15-30	---	NP
	12-30	Loamy fine sand, loamy sand, fine sand.	SM	A-2-4	0	100	100	50-80	15-35	---	NP
	30-60	Loam, clay loam, silty clay loam.	ML, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-100	60-90	24-40	4-20
Dickey:											
32C----------	0-12	Loamy fine sand	SM	A-2-4	0	100	100	50-75	15-30	---	NP
	12-30	Loamy fine sand, loamy sand, fine sand.	SM	A-2-4	0	100	100	50-80	15-35	---	NP
	30-60	Loam, clay loam, silty clay loam.	ML, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-100	60-90	24-40	4-20
Tiffany:											
34----------	0-21	Fine sandy loam	SM, ML, SM-SC, CL-ML	A-2, A-4	0	100	100	60-85	30-55	<30	NP-10
	21-60	Fine sandy loam, loamy fine sand, loamy very fine sand.	SM, ML	A-2, A-4	0	100	100	50-95	20-55	---	NP

See footnote at end of table.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Embden:											
35	0-14	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-95	30-65	<35	NP-10
	14-32	Fine sandy loam, sandy loam.	SM	A-2, A-4	0	100	100	60-85	30-50	---	NP
	32-60	Fine sandy loam, sandy loam, loamy fine sand.	SM	A-2, A-4	0	100	100	50-80	15-50	---	NP
[1]36B:											
Embden part	0-14	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-95	30-65	<35	NP-10
	14-32	Fine sandy loam, sandy loam.	SM	A-2, A-4	0	100	100	60-85	30-50	---	NP
	32-60	Fine sandy loam, sandy loam, loamy fine sand.	SM	A-2, A-4	0	100	100	50-80	15-50	---	NP
Egeland part	0-21	Fine sandy loam	SM, SM-SC	A-2, A-4	0	100	95-100	75-100	30-50	20-30	NP-5
	21-65	Loamy sand, loamy fine sand.	SM, SM-SC, SP-SM	A-2	0	95-100	85-100	70-90	10-35	<30	NP-5
Egeland:											
37C	0-21	Fine sandy loam	SM, SM-SC	A-2, A-4	0	100	95-100	75-100	30-50	20-30	NP-5
	21-65	Loamy sand, loamy fine sand.	SM, SM-SC, SP-SM	A-2	0	95-100	85-100	70-90	10-35	<30	NP-5
Swenoda:											
39, 41B, 42C	0-8	Fine sandy loam	SM, SM-SC	A-2, A-4	0	100	95-100	70-100	30-50	20-30	NP-5
	8-29	Fine sandy loam, sandy loam.	SM-SC, SM, ML, CL-ML	A-2, A-4	0	100	95-100	60-85	30-55	20-30	NP-10
	29-60	Silt loam, silty clay loam, loam.	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	75-100	50-95	25-45	5-25
Wyndmere:											
43	0-10	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	10-34	Sandy loam, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	34-60	Fine sand, loamy fine sand, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-85	20-55	---	NP
Fossum:											
[1]44	0-12	Fine sandy loam	SM, SC	A-4	0	100	100	60-85	35-50	<20	NP-10
	12-22	Loamy sand, sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	100	60-80	5-30	---	NP
	22-60	Sand, fine sand	SP-SM, SM	A-3, A-2	0	95-100	95-100	60-80	5-20	---	NP
Hamerly:											
49	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-25
	7-16	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
	16-60	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

See footnote at end of table.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Svea:											
50	0-12	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	12-27	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
	27-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-80	20-50	5-30
Barnes:											
[1]51:											
Barnes part	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-100	60-90	20-40	5-15
	7-19	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-80	25-40	5-20
	19-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-80	25-40	5-20
Svea part	0-12	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	12-27	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
	27-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-80	20-50	5-30
[1]51B:											
Barnes part	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-100	60-90	20-40	5-15
	7-19	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-80	25-40	5-20
	19-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-80	25-40	5-20
Svea part	0-12	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	12-27	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
	27-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-80	20-50	5-30
[1]53B:											
Barnes part	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-100	60-90	20-40	5-15
	7-19	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-80	25-40	5-20
	19-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-80	25-40	5-20
Buse part	0-7	Loam	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-20
	7-60	Loam, clay loam	CL	A-4, A-6	0	90-100	85-95	70-90	60-80	25-40	7-22
[1]53C:											
Barnes part	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-100	60-90	20-40	5-15
	7-19	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-80	25-40	5-20
	19-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-80	25-40	5-20
Buse part	0-7	Loam	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-20
	7-60	Loam, clay loam	CL	A-4, A-6	0	90-100	85-95	70-90	60-80	25-40	7-22
Esmond:											
[1]55F:											
Esmond part	0-7	Very stony loam	ML, CL, CL-ML	A-4	1-15	95-100	95-100	85-95	60-75	20-40	NP-10
	7-60	Loam, fine sandy loam, silt loam.	ML, CL, SM, SC	A-4	1-10	95-100	95-100	70-100	40-90	20-40	NP-10
Heimdal part	0-8	Very stony loam	ML, CL-ML, CL	A-4	1-15	95-100	95-100	85-100	60-90	20-40	NP-10
	8-20	Loam	ML, CL-ML, CL	A-4	1-10	95-100	95-100	85-95	60-75	20-40	NP-10
	20-60	Loam, silt, fine sand.	ML, SM, SC, CL	A-4, A-2	1-10	95-100	95-100	65-100	30-90	15-40	NP-15

See footnote at end of table.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Cresbard:											
156:											
Cresbard part---	0-10	Loam----------	ML, CL, CL-ML	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	10-19	Clay loam-------	CL, CH	A-7	0	100	100	90-100	70-80	40-60	15-30
	19-60	Clay loam, loam	CL, CH	A-6, A-7	0-5	100	100	85-100	60-80	35-55	10-30
Svea part-------	0-12	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	12-27	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
	27-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-80	20-50	5-30
Vallers:											
57----------	0-8	Loam----------	OL, ML	A-4	0	95-100	90-100	80-90	65-80	30-40	4-10
	8-30	Clay loam, loam	CL	A-6	0	95-100	90-97	90-95	70-80	30-40	11-20
	30-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-97	85-95	60-75	20-40	5-20
58----------	0-8	Loam----------	OL, ML, CL-ML	A-4	0	95-100	90-100	80-90	65-80	25-40	3-10
	8-30	Clay loam, loam	CL	A-6	0	95-100	90-100	90-95	70-80	30-40	10-20
	30-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-100	85-95	60-75	20-40	5-20
Hamerly:											
159:											
Hamerly part----	0-7	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-25
	7-16	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
	16-60	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
Tonka part------	0-24	Silt loam-------	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-40	5-25
	24-37	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
	37-60	Silty clay loam, clay loam.	CL	A-6, A-7	0-3	100	95-100	90-100	70-90	20-50	10-30
Emrick:											
60, 60B-----------	0-11	Loam----------	ML, CL-ML, CL	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-15
	11-22	Loam----------	ML, CL-ML, CL	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	22-60	Loam, sandy loam, fine sand.	ML, CL, SM, SC	A-4, A-2	0-5	95-100	95-100	65-100	30-90	20-40	NP-10
Heimdal:											
161B:											
Heimdal part----	0-8	Very stony loam	ML, CL-ML, CL	A-4	1-15	95-100	95-100	85-100	60-90	20-40	NP-10
	8-20	Loam----------	ML, CL-ML, CL	A-4	1-10	95-100	95-100	85-95	60-75	20-40	NP-10
	20-60	Loam, silt, fine sand.	ML, SM, SC, CL	A-4, A-2	1-10	95-100	95-100	65-100	30-90	15-40	NP-15
Emrick part-----	0-11	Very stony loam	ML, CL, CL-ML	A-4	1-15	95-100	95-100	85-100	60-90	20-40	NP-10
	11-22	Loam----------	ML, CL, CL-ML	A-4	1-10	95-100	95-100	85-95	60-75	20-40	NP-10
	22-60	Loam, sandy loam, fine sand.	ML, CL, SM, SC	A-4, A-2	1-10	95-100	95-100	65-100	30-90	20-40	NP-10

See footnote at end of table.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Emrick:											
[1]62:											
Emrick part-----	0-11	Loam----------	ML, CL-ML, CL	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-15
	11-22	Loam----------	ML, CL-ML, CL	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	22-60	Loam, sandy loam, fine sand.	ML, CL, SM, SC	A-4, A-2	0-5	95-100	95-100	65-100	30-90	20-40	NP-10
Heimdal part----	0-8	Loam----------	ML, CL-ML, CL	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	8-20	Loam----------	ML, CL, CL-ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	20-60	Loam, silt, fine sand.	ML, SM, CL, SC	A-4, A-2	0-5	95-100	95-100	65-100	30-90	20-40	NP-10
[1]62B:											
Emrick part-----	0-11	Loam----------	ML, CL-ML, CL	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-15
	11-22	Loam----------	ML, CL-ML, CL	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	22-60	Loam, sandy loam, fine sand.	ML, CL, SM, SC	A-4, A-2	0-5	95-100	95-100	65-100	30-90	20-40	NP-10
Heimdal part----	0-8	Loam----------	ML, CL-ML, CL	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	8-20	Loam----------	ML, CL, CL-ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	20-60	Loam, silt, fine sand.	ML, SM, CL, SC	A-4, A-2	0-5	95-100	95-100	65-100	30-90	20-40	NP-10
Heimdal:											
[1]62C:											
Heimdal part----	0-8	Loam----------	ML, CL-ML, CL	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	8-20	Loam----------	ML, CL, CL-ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	20-60	Loam, silt, fine sand.	ML, SM, CL, SC	A-4, A-2	0-5	95-100	95-100	65-100	30-90	20-40	NP-10
Emrick part-----	0-11	Loam----------	ML, CL-ML, CL	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-15
	11-22	Loam----------	ML, CL-ML, CL	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	22-60	Loam, sandy loam, fine sand.	ML, CL, SM, SC	A-4, A-2	0-5	95-100	95-100	65-100	30-90	20-40	NP-10
Esmond:											
[1]63D:											
Esmond part-----	0-7	Loam----------	ML, CL-ML, CL	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	7-60	Loam, fine sandy loam, silt loam.	ML, CL-ML, SM, CL	A-4	0-5	95-100	95-100	70-100	40-90	20-40	NP-10

See footnote at end of table.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Esmond:											
Heimdal part----	0-8	Loam----------	ML, CL-ML, CL	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	8-20	Loam----------	ML, CL, CL-ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	20-60	Loam, silt, fine sand.	ML, SM, CL, SC	A-4, A-2	0-5	95-100	95-100	65-100	30-90	20-40	NP-10
[1]63F:											
Esmond part-----	0-7	Loam----------	ML, CL-ML, CL	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	7-60	Loam, fine sandy loam, silt loam.	ML, CL-ML, SM, CL	A-4	0-5	95-100	95-100	70-100	40-90	20-40	NP-10
Heimdal part----	0-8	Loam----------	ML, CL-ML, CL	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	8-20	Loam----------	ML, CL, CL-ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	20-60	Loam, silt, fine sand.	ML, SM, CL, SC	A-4, A-2	0-5	95-100	95-100	65-100	30-90	20-40	NP-10
Heimdal:											
[1]64C:											
Heimdal part----	0-8	Loam----------	ML, CL-ML, CL	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-10
	8-20	Loam----------	ML, CL, CL-ML	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	20-60	Loam, silt, fine sand.	ML, SM, CL, SC	A-4, A-2	0-5	95-100	95-100	65-100	30-90	20-40	NP-10
Esmond part-----	0-7	Loam----------	ML, CL-ML, CL	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	7-60	Loam, fine sandy loam, silt loam.	ML, CL-ML, SM, CL	A-4	0-5	95-100	95-100	70-100	40-90	20-40	NP-10
Fram:											
65----------	0-28	Loam----------	ML, CL, SM, SC	A-4	0-1	90-100	70-100	55-75	40-70	20-40	NP-10
	28-60	Sandy loam, fine sandy loam, loam.	SM, SC, SM-SC	A-2, A-4	0-1	90-100	70-95	45-70	25-50	<30	NP-10
Gardena:											
66, 67B----------	0-20	Silt loam-------	ML, CL-ML, CL	A-4	0	100	100	75-95	60-90	25-40	NP-10
	20-60	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4	0	100	100	75-95	55-90	20-40	NP-10
Eckman:											
68C----------	0-8	Silt loam-------	ML, CL-ML, CL	A-4	0	100	100	85-100	60-90	20-40	NP-10
	8-29	Silt loam, very fine sandy loam.	ML, CL, CL-ML	A-4	0	100	100	85-95	55-90	20-40	NP-10
	29-60	Silt loam, very fine sandy loam, fine sandy loam.	ML, SM	A-4	0	100	100	65-95	40-90	<40	NP-10

See footnote at end of table.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Glyndon:											
70	0-7	Silt loam	OL, ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	7-33	Silt loam, very fine sandy loam.	ML, CL-ML	A-4	0	100	100	90-100	60-95	20-30	NP-10
	33-60	Loamy very fine sand, very fine sand.	ML, SM	A-4	0	100	100	85-100	35-75	10-30	NP-4
Gardena:											
71	0-17	Silt loam	ML, CL, CL-ML	A-4	0	100	100	75-95	60-90	20-40	NP-10
	17-40	Silt loam, very fine sandy loam, loam.	ML, CL, CL-ML	A-4	0	100	100	75-95	55-90	20-40	NP-10
	40-60	Silty clay, silty clay loam.	CL, MH, CH	A-7	0	100	100	95-100	85-95	45-75	15-45
Glyndon:											
72	0-7	Silt loam	OL, ML, CL-ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	7-33	Silt loam, very fine sandy loam.	ML, CL-ML	A-4	0	100	100	90-100	60-95	20-30	NP-10
	33-60	Loamy very fine sand, very fine sand.	ML, CL-ML	A-4	0	100	100	85-100	50-90	10-30	NP-10
Borup:											
[1]73:											
Borup part	0-11	Silt loam	OL, ML, CL-ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	11-29	Very fine sandy loam, loamy very fine sand, silt loam.	ML, CL-ML	A-4	0	100	100	90-100	60-95	<30	NP-10
	29-60	Loamy very fine sand, very fine sand, very fine sandy loam, silt loam.	ML, CL-ML	A-4	0	100	100	85-100	50-90	<30	NP-10
Fossum part	0-12	Fine sandy loam	SM, SC	A-4	0	100	100	60-85	35-50	<20	NP-10
	12-22	Loamy sand, sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	100	60-80	5-30	---	NP
	22-60	Sand, fine sand	SP-SM, SM	A-3, A-2	0	95-100	95-100	60-80	5-20	---	NP
74	0-11	Silt loam	OL, ML, CL-ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	11-29	Very fine sandy loam, loamy very fine sand, silt loam.	ML, CL-ML	A-4	0	100	100	90-100	60-95	<30	NP-10
	29-60	Loamy very fine sand, very fine sand, very fine sandy loam, silt loam.	ML, CL-ML	A-4	0	100	100	85-100	50-90	<30	NP-10
75	0-11	Silt loam	OL, ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	11-29	Very fine sandy loam, loamy very fine sand, silt loam.	ML, CL-ML	A-4	0	100	100	90-100	60-95	20-30	NP-10
	29-60	Loamy very fine sand, very fine sand, very fine sandy loam, silt loam.	ML, CL-ML	A-4	0	100	100	85-100	50-90	10-30	NP-10

See footnote at end of table.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Emrick:											
[1]78:											
Emrick part-----	0-11	Loam----------	ML, CL-ML, CL	A-4	0-1	95-100	95-100	85-100	60-90	20-40	NP-15
	11-22	Loam----------	ML, CL-ML, CL	A-4	0-1	95-100	95-100	85-95	60-75	20-40	NP-10
	22-60	Loam, sandy loam, fine sand.	ML, CL, SM, SC	A-4, A-2	0-5	95-100	95-100	65-100	30-90	20-40	NP-10
Cathay part-----	0-10	Loam----------	ML, CL, CL-ML	A-4	0-5	95-100	90-100	75-95	50-95	25-35	5-10
	10-24	Clay loam, loam	CL	A-6	0-5	95-100	90-100	85-95	65-85	25-40	10-25
	24-60	Loam----------	ML, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-75	25-40	3-18
Cathay:											
80, 80B----------	0-10	Loam----------	ML, CL, CL-ML	A-4	0-5	95-100	90-100	75-95	50-95	25-35	5-10
	10-24	Clay loam, loam	CL	A-6	0-5	95-100	90-100	85-95	65-85	25-40	10-25
	24-60	Loam----------	ML, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-75	25-40	3-18
[1]81:											
Cathay part-----	0-10	Silt loam-------	ML, CL, CL-ML	A-4	0-5	95-100	90-100	75-95	50-95	25-35	5-10
	10-24	Clay loam, loam, silty clay loam	CL	A-6	0-5	95-100	90-100	85-95	65-85	25-40	10-25
	24-60	Loam, silt loam	ML, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-75	25-40	3-18
Gardena part----	0-20	Silt loam-------	ML, CL-ML, CL	A-4	0	100	100	75-95	60-90	25-40	NP-10
	20-60	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4	0	100	100	75-95	55-90	20-40	NP-10
Letcher:											
82----------	0-13	Fine sandy loam	SM, SM-SC, ML, CL-ML	A-2, A-4	0	100	100	60-85	30-55	<30	NP-8
	13-25	Sandy loam, fine sandy loam.	SM, SM-SC, ML, CL-ML	A-2, A-4	0	100	100	60-85	30-55	<30	NP-8
	25-38	Loam, sandy loam	CL-ML, SC, CL, SM-SC	A-2, A-4, A-6	0	100	100	60-95	30-75	15-35	5-15
	38-60	Sandy loam, loamy sand.	SM, SC, SM-SC	A-2, A-4	0	100	100	60-70	30-40	<30	NP-10
Arvilla:											
[1]88B----------	0-7	Sandy loam------	SM, SC, SM-SC	A-2, A-4	0	100	100	60-80	30-45	10-30	NP-10
	7-18	Coarse sandy loam, sandy loam.	SM, SC, SM-SC	A-2, A-4	0	95-100	90-100	60-70	30-40	10-30	NP-10
	18-60	Sand and gravel	SP-SM	A-1	0	35-95	25-80	10-50	0-10	---	NP
Sioux:											
[1]89C----------	0-6	Loam----------	SM, SC, ML, CL	A-2, A-4, A-1	0	60-100	45-100	30-90	15-80	<30	NP-10
	6-60	Sand and gravel	GM, GP, SM, SP	A-1, A-2	0	25-75	10-60	5-35	0-25	<25	NP-5

See footnote at end of table.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Serden:											
90C	0-2	Fine sand	SM	A-2	0	100	100	65-85	15-25	---	NP
	2-60	Fine sand	SM	A-2	0	100	100	65-85	15-25	---	NP
Divide:											
95	0-8	Loam	ML, CL	A-4, A-6	0	95-100	95-100	85-95	60-85	15-40	5-25
	8-20	Loam, clay loam, gravelly loam.	ML, CL	A-4, A-6	0-3	95-100	80-100	60-90	55-80	15-40	5-25
	20-60	Stratified sand to gravelly sand.	GM, SM	A-1, A-2	0-5	25-75	15-65	10-40	5-25	---	NP
Aquents:											
96.											
Stirum:											
[1]100	0-5	Fine sandy loam	SM, ML, CL-ML, SM-SC	A-4	0	100	100	70-95	40-75	15-25	NP-5
	5-14	Loam, fine sandy loam, sandy loam.	SC, CL, ML, SM	A-2, A-4	0	100	100	60-95	30-75	15-30	NP-10
	14-60	Stratified silt loam to loamy sand.	SM, CL, ML, SC	A-2, A-4	0	100	100	50-100	15-90	<30	NP-10
Aquolls:											
104.											
Aylmer:											
[1]105:											
Aylmer part	0-60	Sand	SM, SP-SM	A-2, A-3	0	100	100	55-75	5-30	---	NP
Fossum part	0-12	Fine sandy loam	SM, SC	A-4	0	100	100	60-85	35-50	<20	NP-10
	12-22	Loamy sand, sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	100	60-80	5-30	---	NP
	22-60	Sand, fine sand	SP-SM, SM	A-3, A-2	0	95-100	95-100	60-80	5-20	---	NP

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than; > means greater than. Absence of an entry means data were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
Tonka:									
1	0-24	0.6-2.0	0.18-0.23	5.6-6.5	<2	Low	High	Low	6
	24-37	0.06-0.2	0.14-0.19	5.6-7.3	<2	High	High	Low	
	37-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	High	Low	
Parnell:									
2	0-8	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	High	Low	7
	8-46	0.06-0.2	0.13-0.19	6.6-7.8	<2	High	High	Low	
	46-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High	High	Low	
Colvin:									
3	0-60	0.2-2.0	0.16-0.22	7.4-9.0	<2	High	High	Low	4L
Fossum:									
[1]7	0-12	2.0-6.0	0.09-0.12	7.4-8.4	4-16	Low	High	Moderate	3
	12-22	6.0-20	0.04-0.08	7.4-8.4	4-16	Low	High	Moderate	
	22-60	6.0-20	0.03-0.06	7.4-8.4	4-16	Low	High	Moderate	
Hegne:									
12, 13	0-8	<0.2	0.14-0.17	7.4-8.4	<2	High	High	Low	4
	8-32	<0.2	0.13-0.16	7.4-8.4	<2	High	High	Low	
	32-60	<0.06	0.09-0.13	7.4-8.4	<2	High	High	Low	
Bearden:									
14	0-8	0.2-0.6	0.17-0.23	7.4-8.4	<2-4	Moderate	High	Low	4L
	8-14	0.2-2.0	0.16-0.22	7.4-8.4	<2-8	Moderate	High	Low	
	14-60	0.06-2.0	0.16-0.22	7.4-8.4	<2-8	Moderate	High	Low	
15	0-8	0.6-2.0	0.14-0.16	7.4-7.8	4-16	Moderate	High	Moderate	4L
	8-14	0.6-2.0	0.14-0.16	7.9-8.4	4-16	Moderate	High	Moderate	
	14-60	0.2-2.0	0.11-0.13	7.9-8.4	4-16	Moderate	High	Moderate	
Overly:									
16	0-9	0.2-0.6	0.17-0.23	6.6-7.8	<2	Moderate	High	Low	7
	9-32	0.2-0.6	0.17-0.22	7.4-8.4	<2	Moderate	High	Low	
	32-60	0.06-0.6	0.13-0.22	7.9-8.4	<2	Moderate	High	Low	
Colvin:									
17, [1]18	0-60	0.2-2.0	0.16-0.22	7.4-9.0	<2	High	High	Low	4L
Pits, gravel:									
20.									
Hecla:									
[1]24:									
Hecla part	0-18	2.0-20	0.10-0.12	6.1-7.8	<2	Low	Low	Low	2
	18-60	2.0-20	0.06-0.13	6.1-7.8	<2	Low	Moderate	Low	
Ulen part	0-15	6.0-20.0	0.16-0.18	7.9-8.4	<2	Low	Low	Low	2
	15-23	6.0-20.0	0.10-0.12	7.9-8.4	<2	Low	Low	Low	
	23-60	6.0-20.0	0.06-0.08	7.9-8.4	<2	Low	Low	Low	
25	0-18	2.0-20	0.10-0.12	6.1-7.8	<2	Low	Low	Low	2
	18-60	2.0-20	0.06-0.13	6.1-7.8	<2	Low	Moderate	Low	
Maddock:									
26B, 27C	0-11	6.0-20	0.08-0.12	6.6-7.8	<2	Low	Moderate	Low	2
	11-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low	Moderate	Low	
Towner:									
29	0-6	6.0-20	0.08-0.12	6.6-7.8	<2	Low	Moderate	Low	2
	6-29	6.0-20	0.06-0.13	6.6-7.8	<2	Low	High	Low	
	29-60	0.2-2.0	0.14-0.22	7.4-8.4	<2	Moderate	High	Low	
[1]31B:									
Towner part	0-6	6.0-20	0.08-0.12	6.6-7.8	<2	Low	Moderate	Low	2
	6-29	6.0-20	0.06-0.13	6.6-7.8	<2	Low	High	Low	
	29-60	0.2-2.0	0.14-0.22	7.4-8.4	<2	Moderate	High	Low	

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
Towner:									
Dickey part-----	0-12	6.0-20	0.08-0.12	7.4-7.8	<2	Low-------	Moderate-----	Low----------	2
	12-30	6.0-20	0.06-0.12	6.6-7.3	<2	Low-------	Moderate-----	Low----------	
	30-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Low-------	High---------	Low----------	
Dickey:									
32C----------	0-12	6.0-20	0.08-0.12	7.4-7.8	<2	Low-------	Moderate-----	Low----------	2
	12-30	6.0-20	0.06-0.12	6.6-7.3	<2	Low-------	Moderate-----	Low----------	
	30-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Low-------	High---------	Low----------	
Tiffany:									
34----------	0-21	0.6-2.0	0.13-0.18	6.1-7.8	<2	Low-------	High---------	Low----------	3
	21-60	0.6-6.0	0.10-0.17	6.6-7.8	<2	Low-------	High---------	Low----------	
Embden:									
35----------	0-14	2.0-6.0	0.13-0.18	6.6-7.3	<2	Low-------	High---------	Low----------	3
	14-32	2.0-6.0	0.12-0.17	6.6-7.8	<2	Low-------	High---------	Low----------	
	32-60	2.0-6.0	0.06-0.16	7.9-8.4	<2	Low-------	High---------	Low----------	
[1]36B:									
Embden part-----	0-14	2.0-6.0	0.13-0.18	6.6-7.3	<2	Low-------	High---------	Low----------	3
	14-32	2.0-6.0	0.12-0.17	6.6-7.8	<2	Low-------	High---------	Low----------	
	32-60	2.0-6.0	0.06-0.16	7.9-8.4	<2	Low-------	High---------	Low----------	
Egeland part----	0-21	2.0-6.0	0.11-0.17	5.6-7.3	<2	Low-------	Moderate-----	Low----------	3
	21-65	2.0-6.0	0.08-0.10	6.6-7.8	<2	Low-------	Moderate-----	Low----------	
Egeland:									
37C----------	0-21	2.0-6.0	0.11-0.17	5.6-7.3	<2	Low-------	Moderate-----	Low----------	3
	21-65	2.0-6.0	0.08-0.10	6.6-7.8	<2	Low-------	Moderate-----	Low----------	
Swenoda:									
39, 41B, 42C------	0-8	2.0-6.0	0.11-0.17	6.1-7.3	<2	Low-------	Moderate-----	Low----------	3
	8-29	2.0-6.0	0.11-0.17	6.6-7.8	<2	Low-------	High---------	Low----------	
	29-60	0.2-2.0	0.17-0.20	7.4-8.4	<2	Moderate	High---------	Low----------	
Wyndmere:									
43----------	0-10	2.0-6.0	0.13-0.18	7.9-8.4	<2	Low-------	High---------	Low----------	3
	10-34	2.0-6.0	0.12-0.17	7.9-8.4	<2	Low-------	High---------	Low----------	
	34-60	2.0-6.0	0.06-0.16	7.9-8.4	<2	Low-------	High---------	Low----------	
Fossum:									
[1]44----------	0-12	2.0-6.0	0.13-0.18	7.4-8.4	<2	Low-------	High---------	Low----------	3
	12-22	6.0-20	0.06-0.11	7.4-8.4	<2	Low-------	High---------	Low----------	
	22-60	6.0-20	0.05-0.09	7.4-8.4	<2	Low-------	High---------	Low----------	
Hamerly:									
49----------	0-7	0.6-2.0	0.17-0.22	7.4-8.4	<2	Moderate	High---------	Low----------	4L
	7-16	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	High---------	Low----------	
	16-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	High---------	Low----------	
Svea:									
50----------	0-12	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	High---------	Low----------	6
	12-27	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	High---------	Low----------	
	27-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	High---------	Low----------	
Barnes:									
[1]51:									
Barnes part-----	0-7	0.6-2.0	0.13-0.24	6.6-7.8	<2	Low-------	High---------	Low----------	6
	7-19	0.6-2.0	0.15-0.19	6.6-7.8	<2	Low-------	High---------	Low----------	
	19-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Low-------	High---------	Low----------	
Svea part-------	0-12	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	High---------	Low----------	6
	12-27	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	High---------	Low----------	
	27-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	High---------	Low----------	

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
Barnes:									
[1]51B:									
Barnes part-----	0-7	0.6-2.0	0.13-0.24	6.6-7.8	<2	Low-------	High---------	Low----------	6
	7-19	0.6-2.0	0.15-0.19	6.6-7.8	<2	Low-------	High---------	Low----------	
	19-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Low-------	High---------	Low----------	
Svea part-------	0-12	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	High---------	Low----------	6
	12-27	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	High---------	Low----------	
	27-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	High---------	Low----------	
[1]53B:									
Barnes part-----	0-7	0.6-2.0	0.13-0.24	6.6-7.8	<2	Low-------	High---------	Low----------	6
	7-19	0.6-2.0	0.15-0.19	6.6-7.8	<2	Low-------	High---------	Low----------	
	19-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Low-------	High---------	Low----------	
Buse part-------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	Low----------	Low----------	4L
	7-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	Low----------	Low----------	
[1]53C:									
Barnes part-----	0-7	0.6-2.0	0.13-0.24	6.6-7.8	<2	Low-------	High---------	Low----------	6
	7-19	0.6-2.0	0.15-0.19	6.6-7.8	<2	Low-------	High---------	Low----------	
	19-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Low-------	High---------	Low----------	
Buse part-------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	Low----------	Low----------	4L
	7-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	Low----------	Low----------	
Esmond:									
[1]55F:									
Esmond part-----	0-7	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low-------	Moderate-----	Low----------	5
	7-60	0.6-6.0	0.14-0.22	7.9-8.4	<2	Low-------	High---------	Low----------	
Heimdal part----	0-8	0.6-2.0	0.20-0.24	6.6-7.3	<2	Low-------	Moderate-----	Low----------	8
	8-20	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low-------	Moderate-----	Low----------	
	20-60	0.6-6.0	0.11-0.21	7.9-8.4	<2	Low-------	High---------	Low----------	
Cresbard:									
[1]56:									
Cresbard part---	0-10	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low-------	Low----------	Low----------	6
	10-19	0.06-0.6	0.11-0.14	6.1-8.4	2-4	High------	High---------	Moderate-----	
	19-60	0.2-0.6	0.11-0.15	7.4-9.0	2-8	High------	High---------	Moderate-----	
Svea part-------	0-12	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	High---------	Low----------	6
	12-27	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	High---------	Low----------	
	27-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	High---------	Low----------	
Vallers:									
57----------	0-8	0.6-2.0	0.22-0.24	7.4-8.4	<2	Low-------	High---------	Low----------	4L
	8-30	0.2-0.6	0.15-0.19	7.9-8.4	<2	Low-------	High---------	Low----------	
	30-60	0.2-0.6	0.17-0.19	7.4-8.4	<2	Low-------	High---------	Low----------	
58----------	0-8	0.6-2.0	0.14-0.16	7.4-8.4	4-16	Low-------	High---------	Moderate-----	4L
	8-30	0.2-0.6	0.10-0.13	7.9-8.4	4-16	Low-------	High---------	Moderate-----	
	30-60	0.2-0.6	0.11-0.13	7.4-8.4	4-16	Low-------	High---------	Moderate-----	
Hamerly:									
[1]59:									
Hamerly part----	0-7	0.6-2.0	0.17-0.22	7.4-8.4	<2	Moderate	High---------	Low----------	4L
	7-16	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	High---------	Low----------	
	16-60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	High---------	Low----------	
Tonka part------	0-24	0.6-2.0	0.18-0.23	5.6-6.5	<2	Low-------	High---------	Low----------	6
	24-37	0.06-0.2	0.14-0.19	5.6-7.3	<2	High------	High---------	Low----------	
	37-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	High---------	Low----------	
Emrick:									
60, 60B----------	0-11	0.6-2.0	0.20-0.24	6.6-7.3	<2	Low-------	Moderate-----	Low----------	5
	11-22	0.6-2.0	0.17-0.19	6.6-7.3	<2	Low-------	Moderate-----	Low----------	
	22-60	0.6-6.0	0.11-0.21	7.4-8.4	<2	Low-------	High---------	Low----------	

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
Heimdal:									
[1]61B:									
Heimdal part----	0-8	0.6-2.0	0.20-0.24	6.6-7.3	<2	Low-------	Moderate-----	Low----------	8
	8-20	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low-------	Moderate-----	Low----------	
	20-60	0.6-6.0	0.11-0.21	7.4-8.4	<2	Low-------	High---------	Low----------	
Emrick part-----	0-11	0.6-2.0	0.20-0.24	6.6-7.3	<2	Low-------	Moderate-----	Low----------	8
	11-22	0.6-2.0	0.17-0.19	6.6-7.3	<2	Low-------	Moderate-----	Low----------	
	22-60	0.6-6.0	0.11-0.21	7.4-8.4	<2	Low-------	High---------	Low----------	
Emrick:									
[1]62:									
Emrick part-----	0-11	0.6-2.0	0.20-0.24	6.6-7.3	<2	Low-------	Moderate-----	Low----------	5
	11-22	0.6-2.0	0.17-0.19	6.6-7.3	<2	Low-------	Moderate-----	Low----------	
	22-60	0.6-6.0	0.11-0.21	7.4-8.4	<2	Low-------	High---------	Low----------	
Heimdal part----	0-8	0.6-2.0	0.20-0.24	6.6-7.3	<2	Low-------	Moderate-----	Low----------	5
	8-20	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low-------	Moderate-----	Low----------	
	20-60	0.6-6.0	0.11-0.21	7.4-8.4	<2	Low-------	High---------	Low----------	
[1]62B:									
Emrick part-----	0-11	0.6-2.0	0.20-0.24	6.6-7.3	<2	Low-------	Moderate-----	Low----------	5
	11-22	0.6-2.0	0.17-0.19	6.6-7.3	<2	Low-------	Moderate-----	Low----------	
	22-60	0.6-6.0	0.11-0.21	7.4-8.4	<2	Low-------	High---------	Low----------	
Heimdal part----	0-8	0.6-2.0	0.20-0.24	6.6-7.3	<2	Low-------	Moderate-----	Low----------	5
	8-20	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low-------	Moderate-----	Low----------	
	20-60	0.6-6.0	0.11-0.21	7.4-8.4	<2	Low-------	High---------	Low----------	
Heimdal:									
[1]62C:									
Heimdal part----	0-8	0.6-2.0	0.20-0.24	6.6-7.3	<2	Low-------	Moderate-----	Low----------	5
	8-20	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low-------	Moderate-----	Low----------	
	20-60	0.6-6.0	0.11-0.21	7.4-8.4	<2	Low-------	High---------	Low----------	
Emrick part-----	0-11	0.6-2.0	0.20-0.24	6.6-7.3	<2	Low-------	Moderate-----	Low----------	5
	11-22	0.6-2.0	0.17-0.19	6.6-7.3	<2	Low-------	Moderate-----	Low----------	
	22-60	0.6-6.0	0.11-0.21	7.4-8.4	<2	Low-------	High---------	Low----------	
Esmond:									
[1]63D:									
Esmond part-----	0-7	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low-------	Moderate-----	Low----------	5
	7-60	0.6-6.0	0.14-0.22	7.9-8.4	<2	Low-------	High---------	Low----------	
Heimdal part----	0-8	0.6-2.0	0.20-0.24	6.6-7.3	<2	Low-------	Moderate-----	Low----------	5
	8-20	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low-------	Moderate-----	Low----------	
	20-60	0.6-6.0	0.11-0.21	7.4-8.4	<2	Low-------	High---------	Low----------	
[1]63F:									
Esmond part-----	0-7	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low-------	Moderate-----	Low----------	5
	7-60	0.6-6.0	0.14-0.22	7.9-8.4	<2	Low-------	High---------	Low----------	
Heimdal part----	0-8	0.6-2.0	0.20-0.24	6.6-7.3	<2	Low-------	Moderate-----	Low----------	5
	8-20	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low-------	Moderate-----	Low----------	
	20-60	0.6-6.0	0.11-0.21	7.4-8.4	<2	Low-------	High---------	Low----------	
Heimdal:									
[1]64C:									
Heimdal part----	0-8	0.6-2.0	0.20-0.24	6.6-7.3	<2	Low-------	Moderate-----	Low----------	5
	8-20	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low-------	Moderate-----	Low----------	
	20-60	0.6-6.0	0.11-0.21	7.4-8.4	<2	Low-------	High---------	Low----------	
Esmond part-----	0-7	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low-------	Moderate-----	Low----------	5
	7-60	0.6-6.0	0.14-0.22	7.9-8.4	<2	Low-------	High---------	Low----------	
Fram:									
65----------	0-28	0.6-2.0	0.20-0.24	7.4-8.4	<2	Low-------	High---------	Low----------	4L
	28-60	0.6-6.0	0.13-0.20	7.4-8.4	<2	Low-------	High---------	Low----------	

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
Gardena:									
66, 67B	0-20	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low	Moderate	Low	5
	20-60	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low	Moderate	Low	
Eckman:									
68C	0-8	0.6-2.0	0.20-0.24	6.6-7.3	<2	Low	Moderate	Low	5
	8-29	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low	Moderate	Low	
	29-60	0.6-2.0	0.14-0.22	7.9-8.4	<2	Low	Moderate	Low	
Glyndon:									
70	0-7	0.6-2.0	0.20-0.23	7.4-9.0	<2	Low	High	Low	4L
	7-33	2.0-6.0	0.17-0.20	7.9-9.0	<2	Low	High	Low	
	33-60	2.0-20	0.15-0.19	7.9-8.4	<2	Low	High	Low	
Gardena:									
71	0-17	0.6-2.0	0.20-0.24	7.4-7.8	<2	Low	Moderate	Low	5
	17-40	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low	Moderate	Low	
	40-60	0.2-0.6	0.13-0.20	7.4-8.4	<2	Moderate	Moderate	Low	
Glyndon:									
72	0-7	0.6-2.0	0.13-0.15	7.4-9.0	4-16	Low	High	Moderate	4L
	7-33	2.0-6.0	0.11-0.13	7.9-9.0	4-16	Low	High	Moderate	
	33-60	2.0-20	0.09-0.12	7.9-8.4	4-16	Low	High	Moderate	
Borup:									
[1]73:									
Borup part	0-11	2.0-6.0	0.20-0.23	7.4-8.4	<2	Low	High	Low	4L
	11-29	2.0-6.0	0.17-0.20	7.4-8.4	<2	Low	High	Low	
	29-60	2.0-20	0.15-0.19	7.9-8.4	<2	Low	High	Low	
Fossum part	0-12	2.0-6.0	0.13-0.18	7.4-8.4	<2	Low	High	Low	3
	12-22	6.0-20	0.06-0.11	7.4-8.4	<2	Low	High	Low	
	22-60	6.0-20	0.05-0.09	7.4-8.4	<2	Low	High	Low	
74	0-11	2.0-6.0	0.20-0.23	7.4-8.4	<2	Low	High	Low	4L
	11-29	2.0-6.0	0.17-0.20	7.4-8.4	<2	Low	High	Low	
	29-60	2.0-20	0.15-0.19	7.9-8.4	<2	Low	High	Low	
75	0-11	2.0-6.0	0.13-0.15	7.4-8.4	4-16	Low	High	Moderate	4L
	11-29	2.0-6.0	0.11-0.13	7.9-8.4	4-16	Low	High	Moderate	
	29-60	2.0-20	0.09-0.13	7.9-8.4	4-16	Low	High	Moderate	
Emrick:									
[1]78:									
Emrick part	0-11	0.6-2.0	0.20-0.24	6.6-7.3	<2	Low	Moderate	Low	5
	11-22	0.6-2.0	0.17-0.19	6.6-7.3	<2	Low	Moderate	Low	
	22-60	0.6-6.0	0.11-0.21	7.4-8.4	<2	Low	High	Low	
Cathay part	0-10	0.6-2.0	0.20-0.23	6.1-7.8	<2	Low	High	Low	6
	10-24	0.06-0.6	0.16-0.19	6.6-8.4	4-8	Moderate	High	Moderate	
	24-60	0.2-0.6	0.17-0.19	7.4-9.0	4-8	Moderate	High	Moderate	
Cathay:									
80, 80B	0-10	0.6-2.0	0.20-0.23	6.1-7.8	<2	Low	High	Low	6
	10-24	0.06-0.6	0.16-0.19	6.6-8.4	4-8	Moderate	High	Moderate	
	24-60	0.2-0.6	0.17-0.19	7.4-9.0	4-8	Moderate	High	Moderate	
[1]81:									
Cathay part	0-10	0.6-2.0	0.20-0.23	6.1-7.8	<2	Low	High	Low	6
	10-24	0.06-0.6	0.16-0.19	6.6-8.4	4-8	Moderate	High	Moderate	
	24-60	0.2-0.6	0.17-0.19	7.4-9.0	4-8	Moderate	High	Moderate	
Gardena part	0-20	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low	Moderate	Low	5
	20-60	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low	Moderate	Low	
Letcher:									
82	0-13	0.6-2.0	0.11-0.20	5.1-8.4	<2	Low	Low	Low	3
	13-25	0.06-0.2	0.08-0.12	6.6-9.0	2-8	Low	High	Moderate	
	25-38	0.06-0.2	0.16-0.19	7.9-9.0	2-8	Moderate	High	Moderate	
	38-60	2.0-6.0	0.06-0.10	8.5-9.0	2-8	Low	High	Moderate	

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
Arvilla:									
[1]88B	0-7	2.0-6.0	0.13-0.15	6.6-7.3	<2	Low	Moderate	Low	3
	7-18	2.0-6.0	0.13-0.15	6.6-7.8	<2	Low	Moderate	Low	
	18-60	>6.0	0.02-0.05	7.4-8.4	<2	Low	Moderate	Low	
Sioux:									
[1]89C	0-6	0.6-6.0	0.10-0.20	6.6-8.4	<2	Low	Moderate	Low	8
	6-60	6.0-20	0.03-0.06	7.9-8.4	<2	Low	Low	Low	
Serden:									
90C	0-2	6.0-20	0.06-0.12	6.6-7.3	<2	Low	Moderate	Low	1
	2-60	6.0-20	0.05-0.07	6.6-7.3	<2	Low	Moderate	Low	
Divide:									
95	0-8	0.6-2.0	0.18-0.22	7.9-8.4	<2	Low	High	Low	4L
	8-20	0.6-2.0	0.16-0.19	7.9-8.4	<2	Low	High	Low	
	20-60	>20	0.03-0.07	7.9-8.4	<2	Low	High	Low	
Aquents:									
96.									
Stirum:									
[1]100	0-5	0.6-2.0	0.13-0.18	7.9-8.4	2-4	Low	High	Moderate	4
	5-14	0.2-0.6	0.12-0.18	>7.9	2-8	Low	High	Moderate	
	14-60	0.6-20	0.06-0.18	>7.9	2-8	Low	High	Moderate	
Aquolls:									
104.									
Aylmer:									
[1]105:									
Aylmer part	0-60	6.0-20	0.06-0.08	6.6-7.8	<2	Low	Moderate	Low	1
Fossum part	0-12	2.0-6.0	0.13-0.18	7.4-8.4	<2	Low	High	Low	3
	12-22	6.0-20	0.06-0.11	7.4-8.4	<2	Low	High	Low	
	22-60	6.0-20	0.05-0.09	7.4-8.4	<2	Low	High	Low	

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 15.--SOIL AND WATER FEATURES

[Absence of an entry indicates the feature is not a concern. See text for descriptions of symbols and such terms as "rare," "brief," and "perched." The symbol < means less than; > means greater than]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action
		Frequency	Duration	Months	Depth	Kind	Months	
					Ft			
Tonka: 1	C/D	Common	Long	Apr-Jun	3.0-5.0	Apparent	Sep-Jun	High.
Parnell: 2	D	Frequent	Long	Apr-Nov	0-2.0	Apparent	Jan-Dec	High.
Colvin: 3	C/D	None to common.	Long	Apr-Jun	0-3.0	Apparent	Apr-Jun	High.
Fossum: [1]7	A/D	Occasional	Brief	Apr-Jun	1.0-4.0	Apparent	Oct-Jun	Moderate.
Hegne: 12, 13	D	None to rare	---	---	0-4.0	Apparent	Apr-Jul	Moderate.
Bearden: 14, 15	C	None	---	---	3.0-5.0	Apparent	Sep-Jun	High.
Overly: 16	C	None	---	---	>6.0	---	---	High.
Colvin: 17, [1]18	C/D	None to common.	Long	Apr-Jun	0-3.0	Apparent	Apr-Jun	High.
Pits, gravel: 20.								
Hecla: [1]24:								
Hecla part	A	None	---	---	3.0-6.0	Apparent	Apr-Jun	Moderate.
Ulen part	B	None to rare	---	---	2.5-6.0	Apparent	Apr-Jul	Moderate.
25	A	None	---	---	3.0-6.0	Apparent	Apr-Oct	Moderate.
Maddock: 26B, 27C	A	None	---	---	>6.0	---	---	Low.
Towner: 29	B	None	---	---	3.0-6.0	Perched	Apr-Jun	Moderate.
[1]31B:								
Towner part	B	None	---	---	3.0-6.0	Perched	Apr-Jun	Moderate.
Dickey part	B	None	---	---	>6.0	---	---	Low.
Dickey: 32C	B	None	---	---	>6.0	---	---	Low.
Tiffany: 34	B/D	Common	Long	Sep-Jun	1.0-3.0	Apparent	Sep-Jun	High.
Embden: 35	B	None	---	---	>3.0	Apparent	Apr-Jun	Moderate.
[1]36B:								
Embden part	B	None	---	---	>3.0	Apparent	Apr-Jun	Moderate.
Egeland part	B	None	---	---	>6.0	---	---	Moderate.
Egeland: 37C	B	None	---	---	>6.0	---	---	Moderate.

See footnote at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action
		Frequency	Duration	Months	Depth	Kind	Months	
					Ft			
Swenoda: 39, 41B, 42C	B	None	---	---	1.5-4.0	Perched	Mar-Jun	Moderate.
Wyndmere: 43	B	None	---	---	2.0-5.0	Apparent	Sep-Jun	High.
Fossum: [1]44	A/D	Occasional	Brief	Apr-Jul	1.0-4.0	Apparent	Nov-Oct	Moderate.
Hamerly: 49	C	None	---	---	3.0-5.0	Apparent	Sep-Jun	High.
Svea: 50	B	None to common.	Very brief	Apr-Jul	4.0-6.0	Apparent	Apr-Jun	Moderate.
Barnes: [1]51:								
Barnes part	B	None	---	---	>6.0	---	---	Moderate.
Svea part	B	None to common.	Very brief	Apr-Jul	4.0-6.0	Apparent	Apr-Jun	Moderate.
[1]51B:								
Barnes part	B	None	---	---	>6.0	---	---	Moderate.
Svea part	B	None to common.	Very brief	Apr-Jul	4.0-6.0	Apparent	Apr-Jun	Moderate.
[1]53B:								
Barnes part	B	None	---	---	>6.0	---	---	Moderate.
Buse part	B	None	---	---	>6.0	---	---	Moderate.
[1]53C:								
Barnes part	B	None	---	---	>6.0	---	---	Moderate.
Buse part	B	None	---	---	>6.0	---	---	Moderate.
Esmond: [1]55F:								
Esmond part	B	None	---	---	>6.0	---	---	Moderate.
Heimdal part	B	None	---	---	>6.0	---	---	Moderate.
Cresbard: [1]56:								
Cresbard part	C	None	---	---	>6.0	---	---	Moderate.
Svea part	B	None to common.	Very brief	Apr-Jul	4.0-6.0	Apparent	Apr-Jun	Moderate.
Vallers: 57	C	Rare	---	---	2.0-6.0	Apparent	Nov-Jun	High.
58	C	Rare	---	---	2.0-6.0	Apparent	Nov-Jul	High.
Hamerly: [1]59:								
Hamerly part	C	None	---	---	3.0-5.0	Apparent	Sep-Jun	High.
Tonka part	C/D	Common	Long	Apr-Jun	3.0-5.0	Apparent	Sep-Jun	High.
Emrick: 60, 60B	B	None	---	---	>6.0	---	---	Moderate.
Heimdal: [1]61B:								
Heimdal part	B	None	---	---	>6.0	---	---	Moderate.

See footnote at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action
		Frequency	Duration	Months	Depth	Kind	Months	
					Ft			
Heimdal:								
Emrick part----	B	None--------	---	---	>6.0	---	---	Moderate.
Emrick:								
[1]62:								
Emrick part----	B	None--------	---	---	>6.0	---	---	Moderate.
Heimdal part---	B	None--------	---	---	>6.0	---	---	Moderate.
[1]62B:								
Emrick part----	B	None--------	---	---	>6.0	---	---	Moderate.
Heimdal part---	B	None--------	---	---	>6.0	---	---	Moderate.
Heimdal:								
[1]62C:								
Heimdal part---	B	None--------	---	---	>6.0	---	---	Moderate.
Emrick part----	B	None--------	---	---	>6.0	---	---	Moderate.
Esmond:								
[1]63D:								
Esmond part----	B	None--------	---	---	>6.0	---	---	Moderate.
Heimdal part---	B	None--------	---	---	>6.0	---	---	Moderate.
[1]63F:								
Esmond part----	B	None--------	---	---	>6.0	---	---	Moderate.
Heimdal part---	B	None--------	---	---	>6.0	---	---	Moderate.
Heimdal:								
[1]64C:								
Heimdal part---	B	None--------	---	---	>6.0	---	---	Moderate.
Esmond part----	B	None--------	---	---	>6.0	---	---	Moderate.
Fram:								
65----------	B	None--------	---	---	2.0-6.0	Apparent	Sep-Jun	High.
Gardena:								
66, 67B----------	B	None--------	---	---	>4.0	Apparent	Apr-Jun	High.
Eckman:								
68C----------	B	None--------	---	---	>6.0	---	---	High.
Glyndon:								
70----------	B	None--------	---	---	2.5-6.0	Apparent	Apr-Jul	High.
Gardena:								
71----------	B	None--------	---	---	>6.0	---	---	High.
Glyndon:								
72----------	B	None--------	---	---	2.5-6.0	Apparent	Apr-Jul	High.
Borup:								
[1]73:								
Borup part-----	B/D	None--------	---	---	1.0-3.0	Apparent	Apr-Jul	High.
Fossum part----	A/D	Occasional	Brief-----	Apr-Jul	1.0-4.0	Apparent	Nov-Oct	Moderate.
74----------	B/D	None--------	---	---	1.0-3.0	Apparent	Apr-Jul	High.
75----------	B/D	Rare--------	---	---	1.0-3.0	Apparent	Apr-Jul	High.
Emrick:								
[1]78:								
Emrick part----	B	None--------	---	---	>6.0	---	---	Moderate.

See footnote at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action
		Frequency	Duration	Months	Depth	Kind	Months	
					Ft			
Emrick:								
Cathay part----	C	None--------	---	---	3.0-5.0	Apparent	Apr-Jun	Moderate.
Cathay:								
80, 80B----------	C	None--------	---	---	3.0-5.0	Apparent	Apr-Jun	Moderate.
[1]81:								
Cathay part----	C	None--------	---	---	3.0-5.0	Apparent	Apr-Jun	Moderate.
Gardena part---	B	None--------	---	---	>4.0	Apparent	Apr-Jun	High.
Letcher:								
82---------------	D	None--------	---	---	3.0-6.0	Apparent	Nov-Jun	Moderate.
Arvilla:								
[1]88B------------	A	None--------	---	---	>6.0	---	---	Low.
Sioux:								
[1]89C------------	A	None--------	---	---	>6.0	---	---	Low.
Serden:								
90C---------------	A	None--------	---	---	>6.0	---	---	Low.
Divide:								
95---------------	B	None--------	---	---	3.0-5.0	Apparent	Sep-Jun	Moderate.
Aquents:								
96.								
Stirum:								
[1]100------------	B/D	Frequent----	Very long	Apr-Jun	1.0-3.0	Apparent	Apr-Jul	Moderate.
Aquolls:								
104.								
Aylmer:								
[1]105:								
Aylmer part----	A	Rare--------	---	---	1.5-3.5	Apparent	Apr-Jun	Low.
Fossum part----	A/D	Occasional	Brief-----	Apr-Jul	1.0-4.0	Apparent	Nov-Oct	Moderate.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 16.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Aquents	Sandy and loamy, mixed, frigid Aquents
Aquolls	Loamy and clayey, mixed, frigid Aquolls
Arvilla	Sandy, mixed Udic Haploborolls
Aylmer	Mixed, frigid Aquic Udipsamments
Barnes	Fine-loamy, mixed Udic Haploborolls
Bearden	Fine-silty, frigid Aeric Calciaquolls
Borup	Coarse-silty, frigid Typic Calciaquolls
Buse	Fine-loamy, mixed Udorthentic Haploborolls
Cathay	Fine-loamy, mixed Glossic Udic Natriborolls
Colvin	Fine-silty, frigid Typic Calciaquolls
Cresbard	Fine, montmorillonitic Glossic Udic Natriborolls
Dickey	Sandy over loamy, mixed Udorthentic Haploborolls
Divide	Fine-loamy over sandy or sandy-skeletal, frigid Aeric Calciaquolls
Eckman	Coarse-silty, mixed Udic Haploborolls
Egeland	Coarse-loamy, mixed Udic Haploborolls
Embden	Coarse-loamy, mixed Pachic Udic Haploborolls
Emrick	Coarse-loamy, mixed Pachic Udic Haploborolls
Esmond	Coarse-loamy, mixed Udorthentic Haploborolls
Fossum	Sandy, mixed, frigid Typic Haplaquolls
Fram	Coarse-loamy, frigid Aeric Calciaquolls
Gardena	Coarse-silty, mixed Pachic Udic Haploborolls
Glyndon	Coarse-silty, frigid Aeric Calciaquolls
Hamerly	Fine-loamy, frigid Aeric Calciaquolls
Hecla	Sandy, mixed Aquic Haploborolls
Hegne	Fine, frigid Typic Calciaquolls
Heimdal	Coarse-loamy, mixed Udic Haploborolls
Letcher	Coarse-loamy, mixed Udic Natriborolls
Maddock	Sandy, mixed Udorthentic Haploborolls
Overly	Fine-silty, mixed Pachic Udic Haploborolls
Parnell	Fine, montmorillonitic, frigid Typic Argiaquolls
Serden	Mixed, frigid Typic Udipsamments
Sioux	Sandy-skeletal, mixed Udorthentic Haploborolls
Stirum	Coarse-loamy, mixed, frigid Typic Natraquolls
Svea	Fine-loamy, mixed Pachic Udic Haploborolls
Swenoda	Coarse-loamy, mixed Pachic Udic Haploborolls
Tiffany	Coarse-loamy, mixed, frigid Typic Haplaquolls
Tonka	Fine, montmorillonitic, frigid Argiaquic Argialbolls
Towner	Sandy over loamy, mixed Udorthentic Haploborolls
Ulen	Sandy, frigid Aeric Calciaquolls
Vallers	Fine-loamy, frigid Typic Calciaquolls
Wyndmere	Coarse-loamy, frigid Aeric Calciaquolls

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