United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
Minnesota Agricultural
Experiment Station

Soil Survey of Traverse County, Minnesota

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How To Use This Soil Survey

General Soil Map

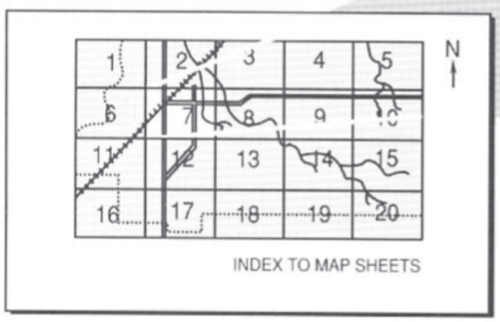
The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

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

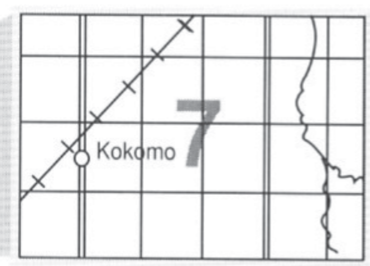
Detailed Soil Maps

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

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

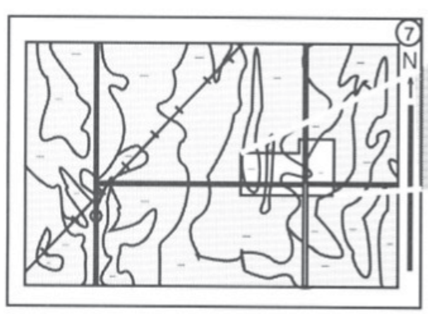


INDEX TO MAP SHEETS



MAP SHEET

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



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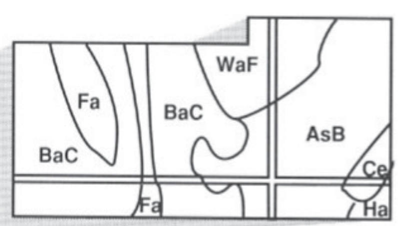

AREA OF INTEREST

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

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

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

Major fieldwork for this soil survey was completed in 1985. Soil names and descriptions were approved in May 1986. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1985. This survey was made cooperatively by the Soil Conservation Service and the Minnesota Agricultural Experiment Station. It was partially funded by the Legislative Commission for Minnesota Resources and by Traverse County. Other assistance was provided by the Minnesota Agricultural Extension Service and the Minnesota Soil and Water Conservation Board. The survey is part of the technical assistance furnished to the Traverse County Soil and Water Conservation District.

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

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

Cover: Swathed small grain in an area of Buse and Formdale soils.

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Issued June 1990

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Summary of Tables

Foreword

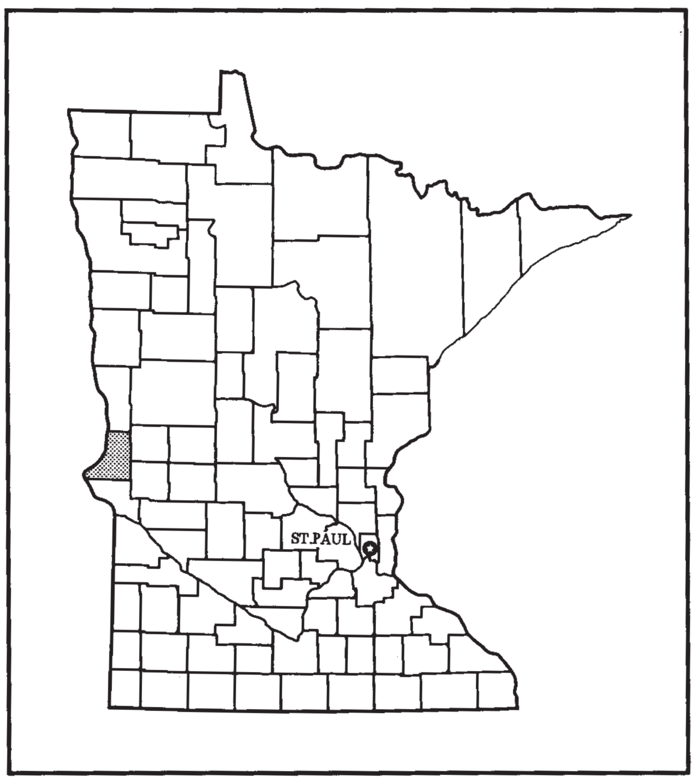
This soil survey contains information that can be used in land-planning programs in Traverse County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact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

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

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

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

Gary R. Nordstrom
State Conservationist
Soil Conservation Service



Location of Traverse County in Minnesota.

Soil Survey of Traverse County, Minnesota

By H. Gerald Floren, Jr., Minnesota Agricultural Experiment Station

Fieldwork by Donald E. DeMartelaere, Soil Conservation Service, and H. Gerald Floren, Jr., Peter R. Hartman, Bryan C. Hargrave, Grant K. Johnson, and David H. Tufvesson, Minnesota Agricultural Experiment Station

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

Traverse County is in west-central Minnesota. It has a land area of 363,520 acres, or about 568 square miles. Lake Traverse and the Bois de Sioux River form the western boundaries, separating the county from North Dakota and South Dakota. Wilkin County is on the north, Grant and Stevens Counties are on the east, and Big Stone County is on the south.

A reconnaissance soil survey of the Red River Valley of Minnesota, including Traverse County, was published in 1939 *(6)*. The present survey updates the earlier survey. It provides additional information and larger maps, which show the soils in greater detail.

General Nature of the County

This section gives general information about Traverse County. It describes history and development; climate; physiography, relief, and drainage; and farming.

History and Development

Traverse County was named after Lake Traverse, which was so named because it lies at an angle to the direction of Big Stone Lake. The county was established on February 20, 1862, and organized on March 8, 1881, at Browns Valley. The county has 15 townships. It has four incorporated cities: Wheaton, Browns Valley, Dumont, and Tintah. Wheaton, the county seat, was platted on September 1, 1884, and was incorporated as a city on May 24, 1887. The largest city in the county, it had a population of 1,986 in 1980. In that year, the population of the county was 6,150. Of this, 3,250, or about 53 percent, was classed as urban and 2,900, or 47 percent, as rural.

The first railroad in Traverse County was built in 1880. It was abandoned in 1980. The Burlington-Northern Railroad currently serves the county. A small aircraft airport is located about 3 miles southwest of Wheaton. The major highways and some of the county roads are paved or blacktopped. U.S. Highway 75 crosses the central part of the county from north to south. Minnesota Highway 27 crosses the central part from the east to Wheaton and follows Lake Traverse to the southwest corner of the county. County and township roads serve rural areas.

Grain elevators are located at Wheaton, Browns Valley, Dumont, Tintah, and Charlesville. Grain crops are marketed mainly at Duluth, Minneapolis, and St. Paul. Sugar beets are stockpiled at Charlesville and processed at a plant in Wahpeton, North Dakota. Livestock are generally marketed in Sisseton, South Dakota, and occasionally in South St. Paul, Minnesota, and West Fargo, North Dakota.

Climate

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

Table 1 gives data on temperature and precipitation for the survey area as recorded at Wheaton, Minnesota, in the period 1951 to 1980. 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 14 degrees F, and the average daily minimum temperature is 5 degrees. The lowest temperature on record, which occurred at Wheaton on January 9, 1977, is -33 degrees. In summer the average temperature is 71 degrees, and the average daily maximum temperature is 83 degrees. The highest recorded temperature, which occurred at Wheaton on July 11, 1966, is 105 degrees.

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

The total annual precipitation is about 21 inches. Of this, 16 inches, or about 75 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 12 inches. The heaviest 1-day rainfall during the period of record was 5.55 inches at Wheaton on June 27, 1959. Thunderstorms occur on about 33 days each year.

The average seasonal snowfall is about 36 inches. The greatest snow depth at any one time during the period of record was 31 inches. On the average, 55 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

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

Physiography, Relief, and Drainage

The highest elevation in Traverse County, about 1,180 feet above sea level, is on the rolling glacial moraine in the southwest part of the county. The lowest point, about 960 feet above sea level, is in the northwest corner, where the Bois de Sioux River leaves the county *(11)*.

The southeastern and northern parts of the county are in the basin of Glacial Lake Agassiz. The elevation of the highest beach ridge is about 1,060 feet above sea level. The influence of the glacial lake extends several miles outside of the beach ridge in the southeastern part of the county. Elevation drops about 5 feet per mile from south to north across the lake plain. The southwestern quarter of the county is an upland area consisting mainly of a nearly level till plain and a rolling glacial moraine. This area has many large depressions.

Lake Traverse and Mud Lake lie in a valley carved by the Glacial River Warren, the southern outlet of Glacial Lake Agassiz. The valley is incised 100 to 160 feet into the upland. Slopes on the edge of the upland are very steep and the foot slopes are gently sloping. A nearly level alluvial or lacustrine terrace is directly above the lake level.

Nearly all the county's surface water eventually flows north in the Bois de Sioux River *(10)*. The Mustinka River flows west and south across the northern half of the county and empties into Lake Traverse. Five Mile Creek, Eight Mile Creek, and Twelve Mile Creek drain the southeastern part of the county and flow north into the Mustinka River. Steer Creek, County Ditch 52, and several other small creeks drain the southwestern part of the county and empty into Lake Traverse. Lake Traverse is maintained at a fairly constant level by Reservation Dam, which is located at the northern end of the lake. Surface water elevation at full pool is 981 feet above sea level. The southern end of the lake is contained by the Browns Valley Dike. The elevation of Mud Lake is regulated at the White Rock Dam.

In the extreme southwest corner of the county, southwest of Browns Valley, the Little Minnesota River cuts in and out of the county as it flows south. Surface water in some areas in the southern parts of Folsom, Arthur, and Tara Townships drains to the south, eventually flowing into the Minnesota River. A divide that separates north-flowing waters from south-flowing waters lies in an irregular and indistinct path beginning south of Lake Traverse and extending across the three southwestern townships.

Farming

Most of the 363,520 acres in Traverse County is farmed. In 1982, about 323,500 acres was cropland and

16,500 acres was pasture. Since 1983, the amount of cropland has decreased. Farms are decreasing in number and increasing in size. During the period 1982 to 1987, the number of farms decreased from 560 to 495 and the average size increased from 609 to 683 acres.

Wheat is the most important cash crop in the county. In 1978, about 109,100 acres was used for wheat, 65,000 acres for sunflowers, 41,400 acres for barley, 29,500 acres for corn, and 28,000 acres for soybeans. In 1987, about 103,800 acres was planted to wheat, yielding 4,019,100 bushels. About 90,200 acres was used for soybeans, 30,000 acres for corn, and 30,800 acres for barley *(9)*.

The number of livestock in Traverse County has decreased in recent years. A few feedlots and dairy farms are located throughout the county.

How This Survey Was Made

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

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

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

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

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

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

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

Map Unit Composition

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

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

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

General Soil Map Units

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

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

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

As a result of changes in soil series concepts, different soil patterns, and variations in map unit design, some soil boundaries and names do not match those in the published soil surveys of Grant and Stevens Counties, Minnesota.

Soil Descriptions

1. Fargo-Lindaas Association

Level and nearly level, poorly drained soils that formed in silty or clayey lacustrine sediments; on lake plains

This association is characterized by a microrelief pattern of shallow depressions scattered across broad flats. Local relief is slight; differences in elevation generally are less than 8 inches. Slopes are 0 to 2 percent.

This association makes up about 6 percent of the county. It is about 55 percent Fargo soils, 20 percent Lindaas soils, and 25 percent soils of minor extent.

The Fargo soils are on low flats. They are nearly level. Typically, the surface layer is black silty clay loam about 8 inches thick. The subsoil is olive gray, mottled silty clay about 8 inches thick. The underlying material to a depth of about 60 inches is gray and olive gray, mottled, calcareous silty clay.

The Lindaas soils are in shallow depressions. They are level. Typically, the surface layer is black silty clay loam about 8 inches thick. The subsoil is very dark grayish brown and dark olive gray clay about 23 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous silty clay.

Of minor extent in this association are the poorly drained, saline Fargo soils, the somewhat poorly drained and moderately well drained Wheatville soils, and the somewhat poorly drained Doran and Bearden soils. The saline Fargo soils are in shallow swales. Bearden and Wheatville soils are on flats and slightly convex rises. Doran soils are on low-gradient slopes.

Most of the acreage in this association is farmed. Wheat, barley, soybeans, and corn are the chief crops. The major soils are well suited to cultivated crops. Wetness is the principal limitation. Controlling soil blowing and maintaining fertility are additional management concerns.

2. Fargo Association

Nearly level, poorly drained soils that formed in clayey sediments; on lake plains

This association is on low flats characterized by closely spaced shallow swales. Local relief is slight. Slopes are less than 2 percent.

This association makes up about 1 percent of the county. It is about 50 percent saline Fargo soils, 40 percent nonsaline Fargo soils, and 10 percent soils of minor extent.

The saline Fargo soils are in shallow swales. Typically, the surface layer is black clay about 10 inches thick. The subsoil is very dark gray, calcareous clay about 5 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous clay.

The nonsaline Fargo soils are on flats. Typically, the

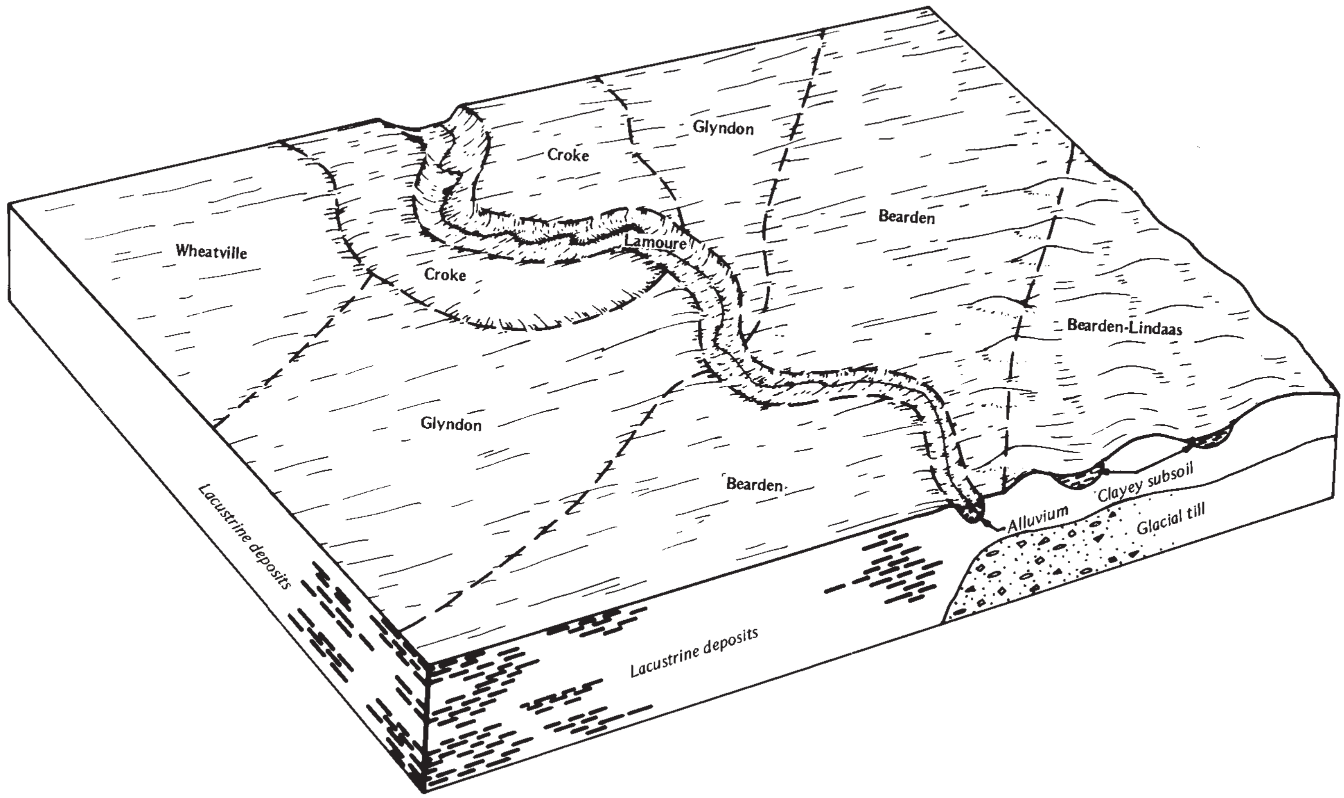


Figure 1.—Pattern of soils and parent material in the Bearden-Glyndon-Wheatville association.

surface layer is black silty clay about 7 inches thick. The subsoil is silty clay about 16 inches thick. The upper part is very dark gray, and the lower part is very dark grayish brown and calcareous. The underlying material to a depth of about 60 inches is gray and olive gray, mottled, calcareous silty clay.

Of minor extent in this association are the somewhat poorly drained and moderately well drained Hamerly soils, the somewhat poorly drained Doran soils, and the poorly drained Roliss soils. Hamerly soils are on flats and slightly convex rises. Doran soils are on low-gradient slopes. Roliss soils are on low flats and in shallow swales.

Most of the acreage in this association is farmed. Wheat, barley, and soybeans are the chief crops. The major soils are fairly well suited to cultivated crops. A high concentration of salts in the saline Fargo soils and the wetness of both the Fargo soils are the principal limitations. Controlling soil blowing and maintaining fertility are additional management concerns.

3. Bearden-Glyndon-Wheatville Association

Nearly level and gently sloping, somewhat poorly drained and moderately well drained soils that formed in silty or loamy lacustrine sediments; on lake plains

The major soils in this association are on flats and slightly convex rises. Local relief is slight. Slopes range from 0 to 6 percent.

This association makes up about 17 percent of the county. It is about 25 percent Bearden soils, 25 percent Glyndon soils, 20 percent Wheatville soils, and 30 percent soils of minor extent (fig. 1).

The Bearden soils are nearly level and gently sloping and are somewhat poorly drained. Typically, the surface layer is black, calcareous silt loam or silty clay loam about 11 inches thick. The subsoil is dark grayish brown and grayish brown, mottled, calcareous silt loam about 18 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous silt loam.

Glyndon soils are nearly level and are somewhat poorly drained and moderately well drained. Typically, the surface layer is black, calcareous loam about 10 inches thick. The subsoil is about 15 inches thick. It is dark grayish brown, calcareous loam in the upper part and grayish brown, calcareous very fine sandy loam in the lower part. The underlying material to a depth of about 60 inches is light olive brown and light brownish gray, mottled, calcareous very fine sandy loam and loamy very fine sand.

The Wheatville soils are nearly level and are somewhat poorly drained and moderately well drained. Typically, the surface layer is black, calcareous silt loam about 8 inches thick. The subsoil is about 17 inches thick. It is grayish brown, calcareous silt loam in the upper part and light brownish gray, calcareous very fine sandy loam in the lower part. The upper part of the underlying material is light olive brown, mottled, calcareous loamy very fine sand. The lower part to a depth of about 60 inches is olive, mottled, calcareous silty clay.

Of minor extent in this association are the moderately well drained Croke soils, the somewhat poorly drained and moderately well drained Hamerly soils, the somewhat poorly drained Doran soils, and the poorly drained Borup, Fargo, Lamoure, and Lindaas soils. Croke and Doran soils are on low-gradient slopes. Hamerly soils are on flats and slightly convex rises. Fargo soils are on low flats. Borup and Lindaas soils are on low flats and in shallow swales. Lamoure soils are on narrow bottom land.

Most of the acreage in this association is farmed. Wheat, barley, corn, and soybeans are the chief crops. The major soils are well suited to cultivated crops. Soil blowing is the principal hazard. Maintaining fertility and reducing wetness are additional management concerns.

4. Lohnes-Egeland-Clontarf Association

Nearly level and gently sloping, well drained and moderately well drained soils that formed in loamy and sandy lacustrine or outwash sediments; on old beach ridges, terraces, lake plains, and outwash plains

This association is on ridges and low-gradient slopes. Slopes range from 0 to 6 percent.

This association makes up about 4 percent of the county. It is about 30 percent Lohnes soil, 25 percent Egeland soils, 20 percent Clontarf soils, and 25 percent soils of minor extent (fig. 2).

The Lohnes soils are on the crests and upper side slopes of ridges. They are gently sloping and well drained. Typically, the surface layer is black sandy loam about 9 inches thick. The subsurface layer is very dark grayish brown sandy loam about 5 inches thick. The underlying material to a depth of about 60 inches is brown and yellowish brown, calcareous sand.

The Egeland soils are on low ridges and terraces. They are nearly level and well drained. Typically, the surface layer is black loam about 10 inches thick. The subsurface layer also is black loam. It is about 4 inches thick. The subsoil is dark brown sandy loam about 5 inches thick. The upper part of the underlying material is yellowish brown and light brownish gray, calcareous loamy sand and very fine sandy loam. The lower part to a depth of about 60 inches is yellowish brown and brown, calcareous sandy loam and loam.

The Clontarf soils are on low-gradient slopes and low ridges. They are nearly level and moderately well drained. Typically, the surface layer is black sandy loam about 8 inches thick. The subsurface layer is very dark brown sandy loam about 12 inches thick. The subsoil is dark brown sandy loam about 9 inches thick. The upper part of the underlying material is light olive brown, mottled sand. The lower part to a depth of about 60 inches is light brownish gray, mottled loamy fine sand.

Of minor extent in this association are the moderately well drained Swenoda soils, the somewhat poorly drained and moderately well drained Kittson soils, and the poorly drained Borup soils. Swenoda and Kittson soils are on low-gradient slopes. Borup soils are on low flats and in shallow swales.

Most of the acreage in this association is farmed. Wheat, barley, soybeans, and corn are the chief crops. The major soils are poorly suited or fairly well suited to cultivated crops. A low or moderate available water capacity is the principal limitation. Controlling soil blowing and water erosion and maintaining fertility are additional management concerns.

5. Lamoure-Ludden-Rauville Association

Level and nearly level, poorly drained and very poorly drained soils that formed in silty or clayey alluvial sediments; on flood plains

This association is on flats and low flood plains. Local relief is slight. Slopes are 0 to 2 percent.

This association makes up about 4 percent of the county. It is about 25 percent Lamoure soils, 20 percent Ludden soils, 15 percent Rauville soils, and 40 percent soils of minor extent.

The Lamoure soils are on flood plains. They are poorly drained and nearly level. Typically, the surface layer is black, calcareous silty clay loam about 9 inches thick. The subsurface layer also is black, calcareous

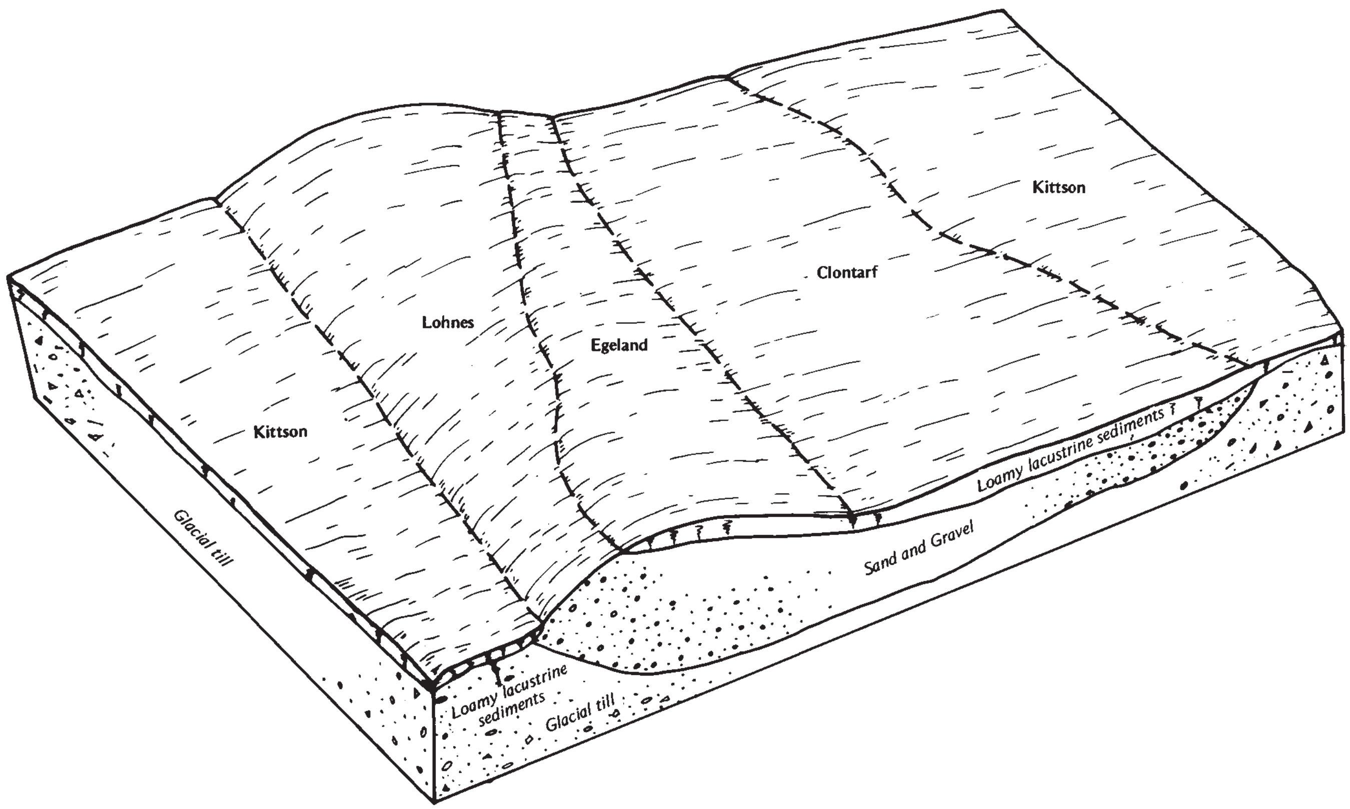


Figure 2.—Pattern of soils and parent material in the Lohnes-Egeland-Clontarf association.

silty clay loam. It is about 15 inches thick. The next layer is olive gray, mottled, calcareous silty clay loam about 25 inches thick. Below this is a buried surface layer of very dark gray, calcareous silty clay loam about 6 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous silty clay loam.

The Ludden soils are in broad areas on flood plains. They are poorly drained and level. Typically, the surface layer is black, calcareous silty clay loam about 10 inches thick. The subsurface layer is very dark gray, calcareous silty clay about 23 inches thick. The underlying material to a depth of about 60 inches is dark gray, calcareous silty clay loam.

The Rauville soils are in low areas adjacent to rivers and lakes. They are very poorly drained and level. Typically, the surface layer is black, calcareous silt loam about 5 inches thick. The subsurface layer is black, calcareous silty clay loam about 28 inches thick. The upper part of the underlying material is dark gray and olive gray, mottled, calcareous silty clay loam. The lower part to a depth of about 60 inches is olive gray, calcareous silt loam.

Of minor extent in this association are the somewhat poorly drained Bearden soils, the poorly drained Colvin soils, and the somewhat poorly drained Doran soils. Bearden soils are on flats, slightly convex rises, and gentle slopes. Colvin soils are on low flats and in shallow swales. Doran soils are on low-gradient slopes and flats.

Most of the acreage of the Lamoure and Ludden soils in this association is farmed, whereas most of the acreage of the Rauville soils is idle land. Wheat, barley, soybeans, and corn are the chief crops. Lamoure soils are well suited to cultivated crops, Ludden soils are fairly suited, and Rauville soils are generally unsuited. Wetness and flooding are the principal limitations. Controlling soil blowing and maintaining fertility are additional management concerns.

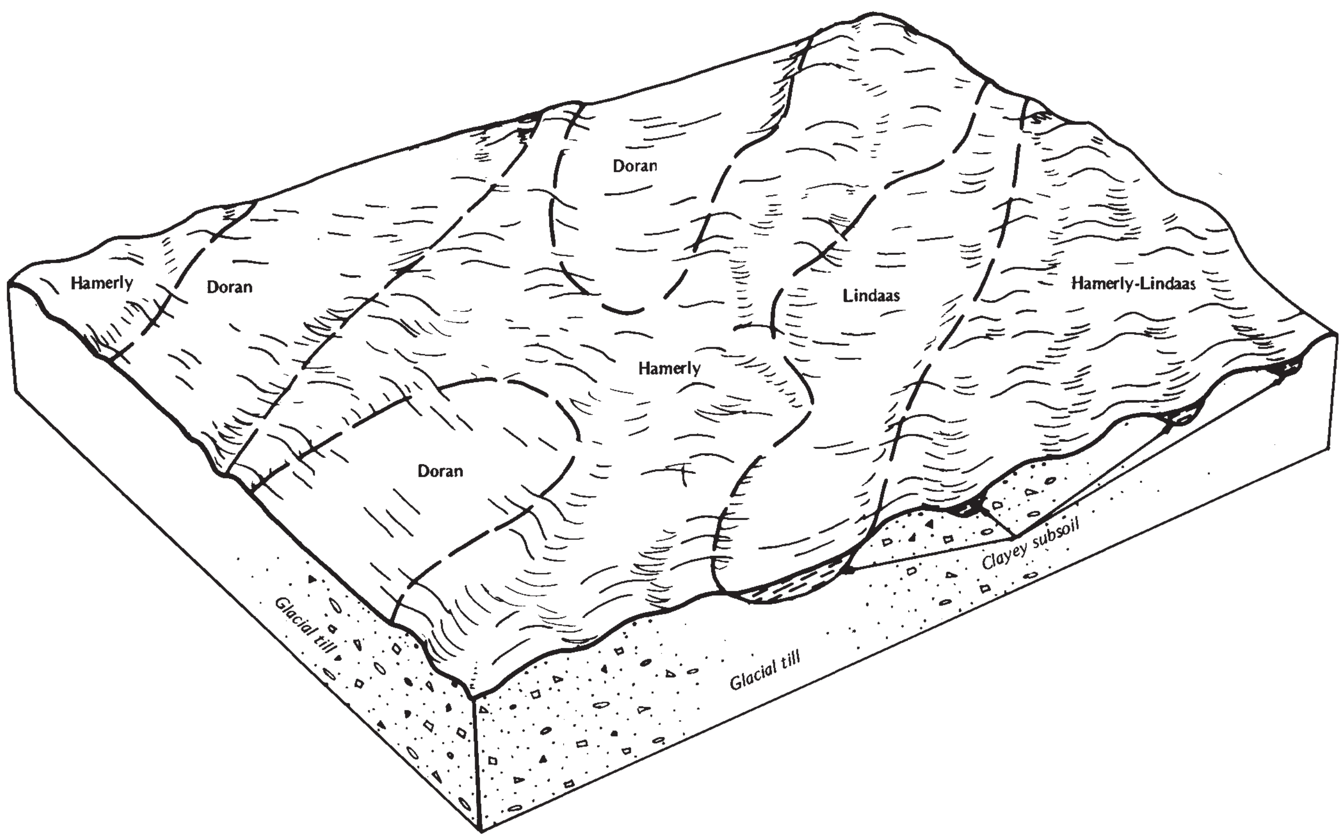


Figure 3.—Pattern of soils and parent material in the Hamerly-Doran-Lindaas association.

6. Hamerly-Doran-Lindaas Association

Level and nearly level, moderately well drained to poorly drained soils that formed in loamy glacial till and in loamy, silty, and clayey lacustrine sediments; on lake plains and till plains

This association is on flats, low-gradient slopes, and low rises and in shallow depressions. Local relief is slight. Slopes range from 0 to 3 percent.

This association makes up about 42 percent of the county. It is about 30 percent Hamerly soils, 30 percent Doran soils, 20 percent Lindaas soils, and 20 percent soils of minor extent (fig. 3).

The Hamerly soils are on flats and low, convex rises. They are nearly level and somewhat poorly drained and moderately well drained. Typically, the surface layer is black, calcareous clay loam about 9 inches thick. The subsoil is grayish brown and light olive brown, mottled, calcareous clay loam about 23 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam.

The Doran soils are on low-gradient slopes and flats. They are nearly level and somewhat poorly drained. Typically, the surface layer is black clay loam about 10 inches thick. The subsoil is about 18 inches thick. It is dark grayish brown clay in the upper part and light olive gray, mottled, calcareous clay loam in the lower part. The underlying material to a depth of about 60 inches is olive and light olive brown, mottled, calcareous clay loam.

The Lindaas soils are on low flats and in shallow depressions. They are level and poorly drained. Typically, the surface layer is black clay loam about 11 inches thick. The subsoil is very dark gray and dark grayish brown, mottled clay about 21 inches thick. The underlying material to a depth of about 60 inches is light olive gray and light olive brown, mottled, very strongly calcareous silty clay loam and clay loam.

Of minor extent in this association are the moderately well drained Aazdahl soils, the somewhat poorly drained and moderately well drained Kittson soils, and the poorly drained Roliss soils. Aazdahl and Kittson

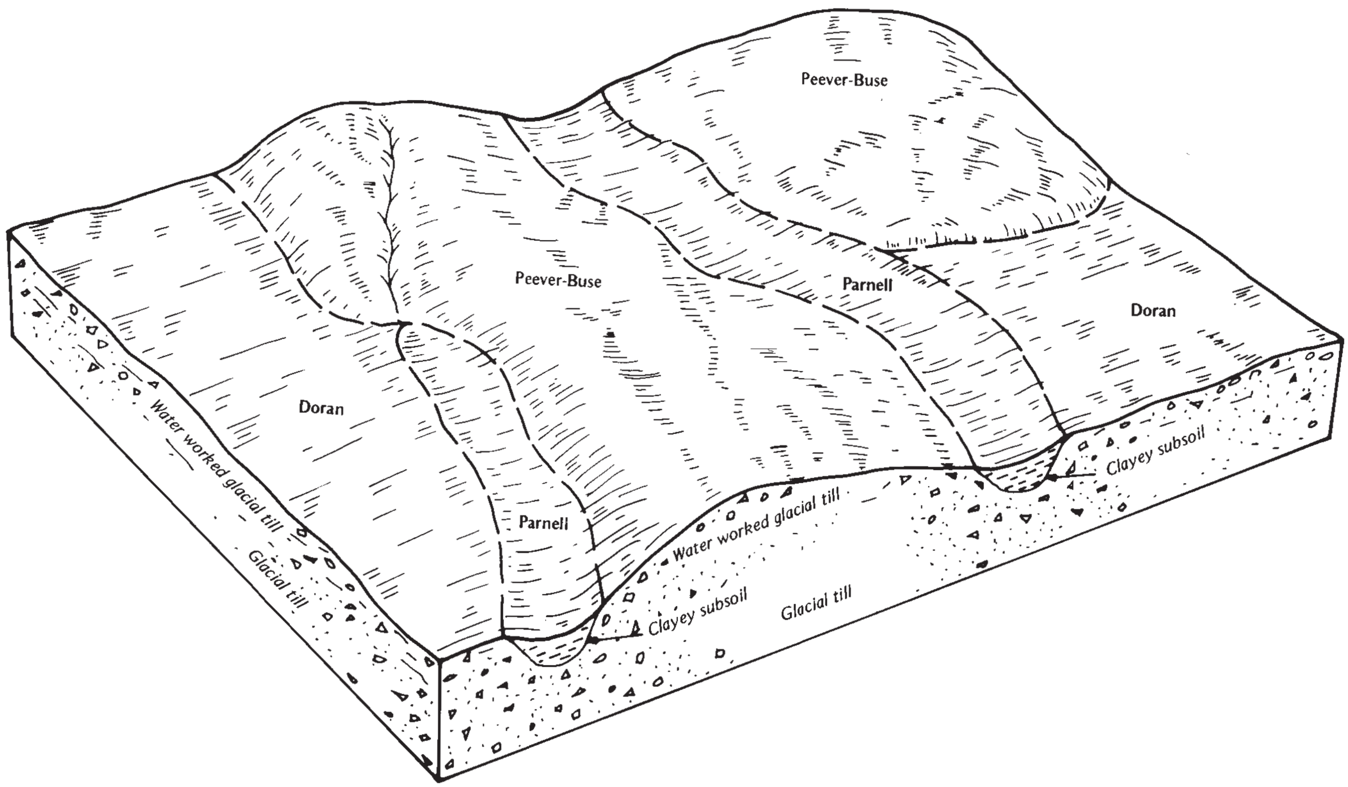


Figure 4.—Pattern of soils and parent material in the Peever-Doran-Parnell association.

soils are on low-gradient slopes. Roliss soils are on low flats and in shallow swales.

Most of the acreage in this association is farmed. Wheat, barley, soybeans, and corn are the chief crops. The major soils are well suited to cultivated crops. Soil blowing is the principal hazard. Wetness is a limitation in the lower areas.

7. Peever-Doran-Parnell Association

Level to gently sloping, well drained, somewhat poorly drained, and very poorly drained soils that formed in loamy and clayey glacial till or lacustrine sediments and in silty and clayey alluvium; on uplands and lake plains

This association is on gentle or low-gradient slopes, on flats, and in depressions. Slopes range from 0 to 6 percent.

This association makes up about 2 percent of the county. It is about 30 percent Peever soils, 25 percent Doran soils, 20 percent Parnell soils, and 25 percent soils of minor extent (fig. 4).

The Peever soils are in gently sloping areas. They are well drained. Typically, the surface layer is black clay about 10 inches thick. The subsoil is clay about 26 inches thick. It is dark grayish brown and dark brown in the upper part and light olive brown and calcareous in the lower part. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous clay.

The Doran soils are on low-gradient slopes and flats. They are nearly level and somewhat poorly drained. Typically, the surface layer is black clay loam about 10 inches thick. The subsoil is about 18 inches thick. It is dark grayish brown clay in the upper part and light olive gray, mottled, calcareous clay loam in the lower part. The underlying material to a depth of about 60 inches is olive and light olive brown, mottled, calcareous clay loam.

The Parnell soils are in depressions. They are level and very poorly drained. Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is black silt loam about 6 inches thick. The subsoil to a depth of 60 inches or more is clay. It is black in the upper part and very dark gray and

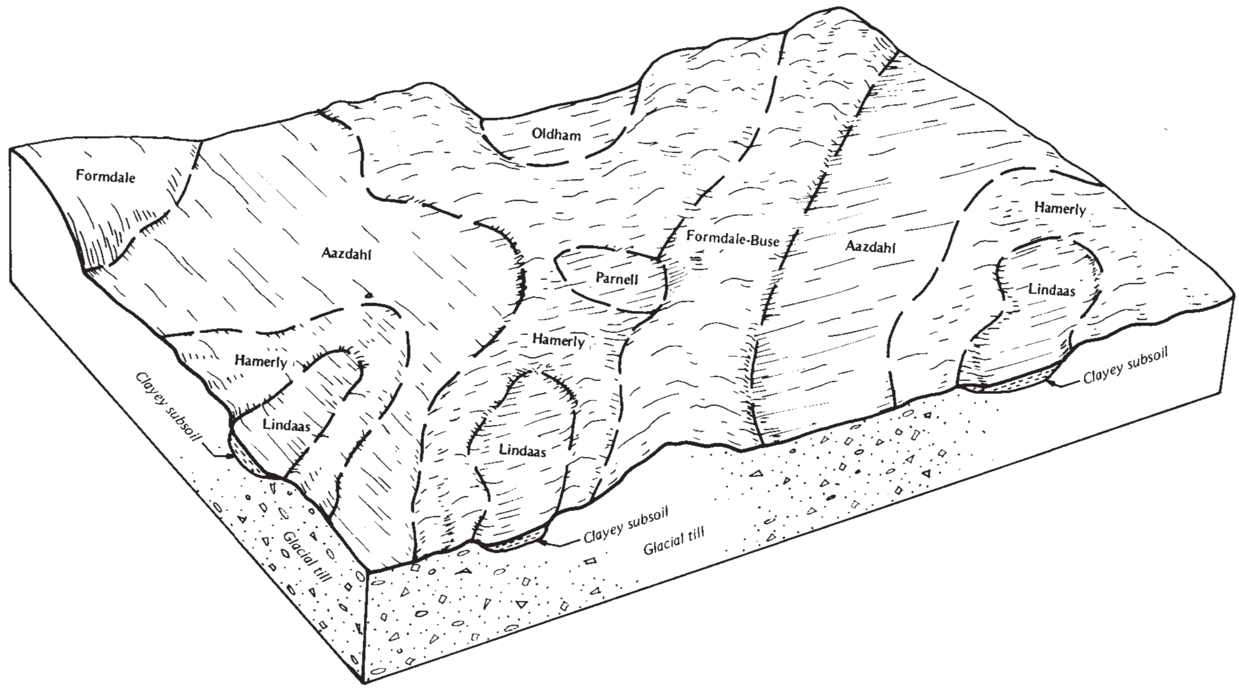


Figure 5.—Pattern of soils and parent material in the Aazdahl-Hamerly-Lindaas association.

calcareous in the lower part.

Of minor extent in this association are the well drained Buse soils, the somewhat poorly drained and moderately well drained Hamerly soils, the moderately well drained Aazdahl soils, and the poorly drained Lindaas soils. Aazdahl soils are on low-gradient slopes. Buse soils are on the tops of knobs and on slope breaks. Hamerly soils are on flats and low rises. Lindaas soils are on low flats and in shallow depressions.

Most of the acreage in this association is farmed. Wheat, barley, soybeans, and corn are the chief crops. The major soils are well suited to cultivated crops. Soil blowing and water erosion are the principal hazards. Wetness is a limitation in the lower areas.

8. Aazdahl-Hamerly-Lindaas Association

Level and nearly level, moderately well drained to poorly drained soils that formed in loamy glacial till; on uplands and till plains

This association is on low-gradient slopes, on flats, and in shallow depressions. Slopes are 0 to 2 percent.

This association makes up about 24 percent of the county. It is about 25 percent Aazdahl soils, 25 percent Hamerly soils, 15 percent Lindaas soils, and 35 percent soils of minor extent (fig. 5).

The Aazdahl soils are on low-gradient slopes. They are nearly level and moderately well drained. Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer also is black clay loam. It is about 7 inches thick. The subsoil is brown clay loam about 5 inches thick. It is calcareous in the lower part. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam.

The Hamerly soils are on flats and low, convex rises. They are nearly level and are somewhat poorly drained and moderately well drained. Typically, the surface layer is black, calcareous clay loam about 11 inches thick. The subsoil is light olive brown, calcareous clay loam about 16 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam.

The Lindaas soils are on low flats and in shallow depressions. They are level and poorly drained. Typically, the surface layer is black silty clay loam about 9 inches thick. The subsoil is about 27 inches thick. It is very dark gray silty clay loam and silty clay in the upper part and light brownish gray, mottled, calcareous silty clay loam in the lower part. The underlying material to a depth of about 60 inches is light olive gray, mottled, calcareous clay loam.

Of minor extent in this association are the well drained Formdale, Buse, and Darnen soils and the very poorly drained Parnell, Quam, and Oldham soils. Formdale soils are on side slopes. Buse soils are on the tops of knobs and on slope breaks. Darnen soils are on the toe slopes of breaks. Parnell soils are in depressions. Quam and Oldham soils are in large, deep basins and sloughs.

Most of the acreage in this association is farmed. Wheat, barley, soybeans, and corn are the chief crops. The major soils are well suited to cultivated crops. Soil blowing and water erosion are the principal hazards. Maintaining fertility is an additional management concern. Wetness is a limitation in the lower areas.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. The management practices are intended to increase crop production, conserve the soil resource, and protect the environment. Over a period of time, these practices may or may not be in accordance with federal, state, and local laws. More information on each map unit, or soil, is given under "Use and Management of the Soils."

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

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

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

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

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

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

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

The names of some map units on the detailed soil maps do not fully agree with those in the published surveys of adjacent Grant and Stevens Counties, Minnesota, and Roberts County, South Dakota. Differences result from variations in the scale of mapping or new soil concepts.

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

Soil Descriptions

26—Aazdahl clay loam. This nearly level soil is moderately well drained. It is on low-gradient slopes on uplands and till plains. Individual areas are irregular in shape and range from 3 to 1,050 acres in size.

Typically, the surface layer is black clay loam about 10 inches thick. The subsoil is mottled clay loam about 20 inches thick. The upper part is brown, and the lower part is light olive brown and calcareous. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam. In some places the dark surface soil is more than 16 inches thick. In other places the soil has more sand and less silt throughout. In some areas the calcareous subsoil is less than 16 inches from the surface. In other areas the soil has a thin, clayey subsoil.

Included with this soil in mapping are small areas of Formdale, Hamerly, and Lindaas soils. The well drained Formdale soils are on the steeper slopes. The somewhat poorly drained and moderately well drained Hamerly soils are on flats and low rises. They are calcareous throughout. The poorly drained Lindaas soils are on low flats and in shallow depressions. Included soils make up about 15 percent of the map unit.

Permeability is moderately slow in the Aazdahl soil. Available water capacity is high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 3 to 6 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are alfalfa, smooth bromegrass, and orchardgrass. No major limitations or hazards affect cropping. Soil blowing, however, is a management concern. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is well suited to windbreaks. A wide variety of trees and shrubs can be grown as windbreaks or environmental plantings.

The land capability classification is I.

34—Parnell silty clay loam. This level soil is very poorly drained. It is in closed depressions and sloughs on uplands, till plains, and lake plains. It is subject to ponding. Individual areas are circular and range from 3 to 30 acres in size.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is black silt loam about 6 inches thick. The subsoil to a depth of 60 inches or more is clay. It is black in the upper part and very dark gray and calcareous in the lower part. In some places the surface layer has more clay. In other places as much as 15 inches of recently deposited calcareous material is on top of the surface layer. In some areas the calcareous underlying material is less than 35 inches from the surface.

Included with this soil in mapping are small areas of the poorly drained Vallers soils on the slightly higher rims of the depressions. These soils are calcareous throughout. They make up about 5 percent of the map unit.

Permeability is slow in the Parnell soil. Available water capacity is high. Surface runoff is very slow or ponded. Organic matter content is high. Natural fertility also is high. The seasonal high water table is 2 feet above to 2 feet below the surface.

Most areas are cropped. This soil is fairly well suited to cropland and well suited to pasture. The best suited hay and pasture plants are birdsfoot trefoil, red clover, reed canarygrass, and creeping foxtail. Wetness is the principal limitation in cropped areas. Ponding and soil blowing are additional management concerns. The ponding usually delays spring tillage. Surface drains can reduce the wetness, but draining the closed depressions commonly is difficult. Crop damage often occurs during periods when precipitation is above normal. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is poorly suited to windbreaks because of excessive wetness. Seedling mortality is severe. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of wetness.

The land capability classification is IIIw in drained areas, Vw in undrained areas.

46—Borup loam. This nearly level soil is poorly drained. It is on low flats and in shallow swales on lake plains. Individual areas are irregular in shape and range from 3 to 25 acres in size.

Typically, the surface layer is black, calcareous loam about 10 inches thick. The subsoil is about 15 inches of dark gray, mottled loam and light olive gray, mottled, calcareous very fine sandy loam. The underlying material to a depth of about 60 inches is light olive gray, mottled, calcareous loamy very fine sand and very fine sand. In some places the soil has more sand or more clay throughout. In other places clayey material is at a depth of 20 to 40 inches.

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

Permeability is moderately rapid in the Borup soil. Available water capacity is high. Surface runoff is very slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 1.0 to 2.5 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are birdsfoot trefoil, red clover, reed canarygrass, and creeping foxtail. Wetness is the principal limitation in cropped areas. It can delay fieldwork. Surface drains are needed. The content of calcium carbonates and soil blowing are additional management concerns. The content of calcium carbonates can cause moisture stress. Measures that maintain carefully balanced fertility levels and the selection of crops and crop varieties that are tolerant of calcium carbonates minimize this problem. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is fairly well suited to windbreaks. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of excess calcium carbonates and excess moisture. Seedling mortality is moderate because of the wetness. Spring planting may be delayed.

The land capability classification is IIw.

47—Colvin silty clay loam. This level soil is poorly drained. It is on low flats and in shallow swales on lake plains. Individual areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface layer is black, calcareous silty clay loam about 10 inches thick. The subsurface layer is very dark gray, calcareous silty clay loam about 8 inches thick. The subsoil is dark gray, calcareous silty clay loam about 8 inches thick. The upper part of the underlying material is dark gray and dark grayish brown, mottled, calcareous silty clay loam. The lower part to a depth of about 60 inches is light yellowish brown, calcareous loam. In some places the soil has more sand and less silt throughout. In other places it has less clay throughout.

Included with this soil in mapping are small areas of Bearden and Perella soils. The somewhat poorly drained Bearden soils are on the slightly higher rises. The poorly drained Perella soils are in landscape positions similar to those of the Colvin soil. They are not calcareous within 16 inches of the surface. Included soils make up about 10 percent of the map unit.

Permeability is moderately slow in the Colvin soil. Available water capacity is high. Surface runoff is very slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 1 to 2 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are birdsfoot trefoil, ladino clover, reed canarygrass, and creeping foxtail. Wetness is the principal limitation in cropped areas. It can delay fieldwork. Surface drains are needed. The content of calcium carbonates and soil blowing are additional management concerns. The content of calcium carbonates can cause moisture stress. Measures that maintain carefully balanced fertility levels and the selection of crops and crop varieties that are tolerant of calcium carbonates minimize this problem. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is fairly well suited to windbreaks. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of excess calcium carbonates and excess moisture. Seedling mortality is moderate because of the wetness. Spring planting may be delayed.

The land capability classification is IIw.

51—La Prairie silt loam. This nearly level soil is moderately well drained. It is on stream terraces and is occasionally flooded. Individual areas are elongated and range from 3 to 10 acres in size.

Typically, the surface layer is black silt loam about 6 inches thick. The subsurface layer also is black silt loam. It is about 24 inches thick. It is calcareous in the lower part. The subsoil is very dark gray, calcareous silty clay loam about 13 inches thick. The underlying material to a depth of about 60 inches is dark grayish brown, mottled, calcareous silt loam. In places the dark surface soil is less than 24 inches thick.

Included with this soil in mapping are small areas of Hamerly and Lamoure soils. The somewhat poorly drained and moderately well drained Hamerly soils are on slightly higher rises and are not subject to flooding. The poorly drained Lamoure soils are in the lower landscape positions. They contain less sand throughout than the La Prairie soil. Included soils make up about 10 percent of the map unit.

Permeability is moderate in the La Prairie soil. Available water capacity is high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 3.5 to 6.0 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass. Wetness is the principal limitation in cropped areas. It can delay fieldwork. Occasional flooding and soil blowing are additional management concerns. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is well suited to windbreaks. A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings.

The land capability classification is IIw.

56—Fargo silty clay loam. This nearly level soil is poorly drained. It is on low flats on lake plains. It is subject to rare flooding. Individual areas are irregular in shape and range from 12 to 425 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsoil is olive gray, mottled silty clay about 8 inches thick. The underlying material to a depth of about 60 inches is gray and olive gray, mottled, calcareous silty clay. In some places it contains less clay. In other places the soil is calcareous at or near the surface and has coarse fragments throughout. In some areas the surface layer contains more clay.

Included with this soil in mapping are small areas of Croke, Doran, and Lindaas soils. The moderately well drained Croke and somewhat poorly drained Doran soils are in the slightly higher areas. Croke soils have less clay in the upper part than the Fargo soil, and Doran soils have less clay in the underlying material. The poorly drained Lindaas soils are in shallow depressions. They have less clay in the subsoil than the Fargo soil. Included soils make up about 15 percent of the map unit.

Permeability is slow in the Fargo soil. Available water capacity is high. Surface runoff is very slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is within a depth of 3 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are birdsfoot trefoil, ladino clover, reed canarygrass, and creeping foxtail. Wetness is the principal limitation in cropped areas. Soil blowing also is a management concern. Surface drains are needed. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is fairly well suited to windbreaks. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of wetness. Seedling mortality is moderate because of the wetness.

The land capability classification is IIw.

57—Fargo silty clay. This nearly level soil is poorly drained. It is on low flats on lake plains. It is subject to rare flooding. Individual areas are irregular in shape and range from 6 to 260 acres in size.

Typically, the surface layer is black silty clay about 7 inches thick. The subsoil is silty clay about 16 inches thick. The upper part is very dark gray, and the lower part is very dark grayish brown and calcareous. The underlying material to a depth of about 60 inches is gray and olive gray, mottled, calcareous silty clay. In some places it contains less clay. In other places the soil is calcareous at or near the surface and has coarse fragments throughout. In some areas the surface layer contains less clay. In other areas the content of soluble salts is high enough to restrict the growth of most crops.

Included with this soil in mapping are small areas of Croke, Doran, and Lindaas soils. The moderately well drained Croke and somewhat poorly drained Doran soils are in the slightly higher areas. Croke soils have less clay in the upper part than the Fargo soil, and Doran and Lindaas soils have less clay in the underlying material. The poorly drained Lindaas soils are in shallow depressions. Included soils make up about 15 percent of the map unit.

Permeability is slow in the Fargo soil. Available water capacity is high. Surface runoff is very slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is within a depth of 3 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are birdsfoot trefoil, ladino clover, reed canarygrass, and creeping foxtail. Wetness is the principal limitation in cropped areas. Surface drains are needed. The high content of clay and soil blowing are additional management concerns. Working the soil when it is wet damages soil structure and makes seedbed preparation difficult because of the high content of clay in the surface layer. Delaying cultivation during wet periods minimizes the damage to soil structure and results in a more desirable seedbed. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is fairly well suited to windbreaks. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of wetness. Seedling mortality is moderate because of the wetness.

The land capability classification is IIw.

58—Kittson loam. This nearly level soil is somewhat poorly drained and moderately well drained. It is on low-gradient slopes on old beach ridges and till plains. Individual areas are irregular in shape and range from 4 to 600 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsoil is about 24 inches thick. The upper part is brown fine sandy loam. The next part is dark grayish brown, calcareous clay loam. The lower part is grayish brown, calcareous clay loam. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam. In places the soil has less sand and more silt throughout.

Included with this soil in mapping are small areas of Doran, Hamerly, and Lindaas soils. The somewhat poorly drained Doran and somewhat poorly drained and moderately well drained Hamerly soils are in landscape positions similar to those of the Kittson soil. Doran soils have more clay in the subsoil than the Kittson soil. Hamerly soils are calcareous at or near the surface. The poorly drained Lindaas soils are in shallow depressions. Included soils make up about 15 percent of the map unit.

Permeability is moderate or moderately slow in the Kittson soil. Available water capacity is high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 2.5 to 6.0 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are alfalfa, smooth bromegrass, and orchardgrass. No major limitations or hazards affect cropping. Soil blowing, however, is a management concern. A system of conservation tillage that leaves protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is well suited to windbreaks. A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings.

The land capability classification is I.

60—Glyndon loam. This nearly level soil is somewhat poorly drained and moderately well drained. It is on flats and low rises on lake plains. Individual areas are irregular in shape and range from 9 to 2,600 acres in size.

Typically, the surface layer is black, calcareous loam about 10 inches thick. The subsoil is about 15 inches thick. It is dark grayish brown, calcareous loam in the upper part and grayish brown, calcareous very fine sandy loam in the lower part. The underlying material to a depth of about 60 inches is light olive brown and light brownish gray, mottled, calcareous very fine sandy loam and loamy very fine sand. In some places clayey material is within a depth of 40 inches. In other places the soil has more clay throughout.

Included with this soil in mapping are small areas of Borup and Croke soils. The poorly drained Borup soils are on the lower flats and in shallow swales. The moderately well drained Croke soils are in landscape positions similar to those of the Glyndon soil. They are not calcareous in the surface layer or subsoil. Included soils make up about 15 percent of the map unit.

Permeability is moderate or moderately rapid in the upper part of the Glyndon soil and moderately rapid in the lower part. Available water capacity is high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 2.5 to 6.0 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are alfalfa, crownvetch, smooth bromegrass, big bluestem, little bluestem, indiangrass, and switchgrass. The content of calcium carbonates is the principal limitation in cropped areas. It can cause moisture stress. Measures that maintain carefully balanced fertility levels and the selection of crops and crop varieties that are tolerant of calcium carbonates minimize this problem. Soil blowing is an additional management concern. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is fairly well suited to windbreaks. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of excess calcium carbonates.

The land capability classification is IIs.

67A—Bearden silt loam, 0 to 2 percent slopes. This nearly level soil is somewhat poorly drained. It is on flats and low rises on lake plains. Individual areas are irregular in shape and range from 6 to 500 acres in size.

Typically, the surface layer is black, calcareous silt loam about 11 inches thick. The subsoil is dark grayish brown and grayish brown, calcareous silt loam about 18 inches thick. It is mottled in the lower part. The underlying material to a depth of about 60 inches is light olive brown, mottled calcareous silt loam. In some places the soil has less clay throughout. In other places it has more sand at a depth of 24 to 40 inches.

Included with this soil in mapping are small areas of the poorly drained Colvin and Lindaas soils. Colvin soils are on the lower flats or in shallow swales. Lindaas soils do not have calcium carbonates in the surface layer or subsoil. They are in shallow depressions. Included soils make up about 15 percent of the map unit.

Permeability is moderately slow in the Bearden soil. Available water capacity is high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 2 to 4 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are alfalfa, smooth bromegrass, and orchardgrass. The content of calcium carbonates is the principal limitation in cropped areas. It can cause moisture stress. Measures that maintain carefully balanced fertility levels and the selection of crops and crop varieties that are tolerant of calcium carbonates minimize this problem. Soil blowing is an additional management concern. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is fairly well suited to windbreaks. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of excess calcium carbonates.

The land capability classification is IIs.

67B—Bearden silty clay loam, 2 to 6 percent slopes. This gently sloping soil is somewhat poorly drained. It is on side slopes on lake plains. It is adjacent to bottom land. Individual areas are elongated and range from 4 to 110 acres in size.

Typically, the surface layer is black, calcareous silty clay loam about 7 inches thick. The subsoil is brown and light olive brown, calcareous silty clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous silty clay loam. In some places the soil has more clay throughout. In other places it has less clay throughout. In some areas it has coarse fragments and less silt throughout.

Included with this soil in mapping are small areas of Croke, Lamoure, and Wheatville soils. The moderately well drained Croke soils are on flats. They do not have calcium carbonates in the surface layer or subsoil. They are more clayey at a depth of 20 to 40 inches than the Bearden soil. The poorly drained Lamoure soils are on low terraces and narrow bottom land. They have a dark surface soil more than 24 inches thick. The somewhat poorly drained and moderately well drained Wheatville soils are on flats and low rises. They have less clay in the surface layer and subsoil than the Bearden soil and have more clay in the underlying material. Included soils make up about 15 percent of the map unit.

Permeability is moderately slow in the Bearden soil. Available water capacity is high. Surface runoff is medium. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 2 to 4 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are alfalfa, smooth bromegrass, and orchardgrass. Soil blowing and water erosion are the principal hazards in cropped areas. The content of calcium carbonates is an additional management concern. It can cause moisture stress. Measures that maintain carefully balanced fertility levels and the selection of crops and crop varieties that are tolerant of calcium carbonates minimize this problem. Soil blowing can be controlled by planting field windbreaks. Leaving protective amounts of crop residue on the surface and seeding cover crops help to control both soil blowing and water erosion. Grassed waterways help to prevent the formation of gullies.

This soil is fairly well suited to windbreaks. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of excess calcium carbonates.

The land capability classification is IIe.

108—McIntosh silt loam. This nearly level soil is somewhat poorly drained. It is on flats and low rises on lake plains and till plains. Individual areas are irregular in shape and range from 12 to 400 acres in size.

Typically, the surface layer is black, calcareous silt loam about 8 inches thick. The subsurface layer is very dark gray, calcareous silt loam about 6 inches thick. The subsoil is grayish brown, calcareous silt loam about 13 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous loam and clay loam. In some places the silty mantle is less than 24 inches thick. In other places it is more than 40 inches thick. In some areas the surface layer has no calcium carbonates.

Included with this soil in mapping are small areas of Colvin and Lindaas soils. The poorly drained Colvin soils are on the lower flats and in shallow swales. They have a silty mantle more than 40 inches thick. The poorly drained Lindaas soils are in shallow depressions. They do not have calcium carbonates in the surface layer or subsoil. Included soils make up about 15 percent of the map unit.

Permeability is moderate or moderately slow in the McIntosh soil. Available water capacity is high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 3 to 6 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are alfalfa, crownvetch, smooth bromegrass, big bluestem, little bluestem, indiangrass, and switchgrass. The content of calcium carbonates is the principal limitation in cropped areas. It can cause moisture stress. Measures that maintain carefully balanced fertility levels and the selection of crops and crop varieties that are tolerant of calcium carbonates minimize this problem. Soil blowing is an additional management concern. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is fairly well suited to windbreaks. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of excess calcium carbonates.

The land capability classification is IIs.

141—Egeland loam. This nearly level soil is well drained. It is on low-lying old beach ridges and terraces. Individual areas are elongated and range from 5 to 100 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer also is black loam. It is about 4 inches thick. The subsoil is dark brown sandy loam about 5 inches thick. The upper part of the underlying material is yellowish brown and light gray, calcareous loamy sand and very fine sandy loam. The lower part to a depth of about 60 inches is yellowish brown and brown, calcareous sandy loam and loam. In some places the soil has more sand or gravel throughout. In other places it is moderately well drained.

Included with this soil in mapping are small areas of Bearden, Hamerly, and Kittson soils. The somewhat poorly drained, nearly level Bearden soils and the somewhat poorly drained and moderately well drained, nearly level Hamerly soils are in the lower areas. They are calcareous throughout. The somewhat poorly drained and moderately well drained Kittson soils are on low-gradient slopes. They have more clay in the underlying material than the Egeland soil. Included soils make up about 15 percent of the map unit.

Permeability is moderately rapid in the upper part of the Egeland soil and moderate in the lower part. Available water capacity is moderate. Surface runoff is slow or medium. Organic matter content is moderately low. Natural fertility is medium.

Most areas are cropped. This soil is fairly well suited to cropland and pasture. The best suited hay and pasture plants are alfalfa, crownvetch, smooth bromegrass, big bluestem, and indiangrass. The moderate available water capacity is the principal limitation in cropped areas. Soil blowing is an additional management concern. The soil is droughty during periods when precipitation is less than normal or is poorly distributed. Drought-tolerant crops should be selected for planting. If left on the surface throughout winter, protective amounts of crop residue help to hold snow on the field and thus increase the moisture supply. The crop residue helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is fairly well suited to windbreaks. A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings. Because of the limited available water capacity, measures that control weeds, such as cultivation and applications of herbicide, are especially important.

The land capability classification is IIs.

171B—Formdale clay loam, 1 to 6 percent slopes. This gently sloping soil is well drained. It is on uplands. Individual areas are irregular in shape and range from 3 to 200 acres in size.

Typically, the surface layer is black clay loam about 8 inches thick. The subsoil is clay loam about 34 inches thick. It is dark brown and brown in the upper part and light olive brown and calcareous in the lower part. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam. In some places the dark surface soil is more than 16 inches thick. In other places the soil has more clay throughout. In some areas it has more sand and less silt throughout. In other areas it does not have a dark surface layer or subsoil and is calcareous throughout.

Included with this soil in mapping are small areas of Aazdahl, Buse, and Lindaas soils. The moderately well drained Aazdahl soils are on low-gradient slopes. The well drained Buse soils are on the steeper, more convex slopes. They are calcareous throughout. The poorly drained Lindaas soils are in shallow depressions. They have a clayey subsurface layer. Included soils make up about 15 percent of the map unit.

Permeability is moderately slow in the Formdale soil. Available water capacity is high. Surface runoff is medium. Organic matter content is high. Natural fertility also is high.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are alfalfa, smooth bromegrass, and orchardgrass. Soil blowing and water erosion are the principal hazards in cropped areas. Soil blowing can be controlled by planting field windbreaks. Seeding cover crops and leaving protective amounts of crop residue on the surface help to control soil blowing and water erosion. Unless the surface is protected, runoff removes soil material and forms rills and small gullies. Grassed waterways help to prevent the formation of gullies. Terraces and contour farming help to prevent the formation of both rills and gullies.

This soil is well suited to windbreaks. A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings.

The land capability classification is IIe.

184—Hamerly clay loam. This nearly level soil is somewhat poorly drained and moderately well drained. It is on flats and low rises on uplands, till plains, and lake plains. Individual areas are irregular in shape and range from 3 to 330 acres in size.

Typically, the surface layer is black, calcareous clay loam about 9 inches thick. The subsoil is grayish brown and light olive brown, mottled, calcareous clay loam about 23 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam. In some places the soil has more silt and less sand throughout. In other places it has more sand and less clay throughout. In some areas many cobbles are on the surface.

Included with this soil in mapping are small areas of Aazdahl, Doran, Lindaas, and Parnell soils. These soils do not have calcium carbonates in the surface layer or subsoil. The moderately well drained Aazdahl and somewhat poorly drained Doran soils are on plane slopes. The poorly drained Lindaas soils are in shallow depressions. The very poorly drained Parnell soils are in depressions and sloughs. Included soils make up about 15 percent of the map unit.

Permeability is moderately slow in the Hamerly soil. Available water capacity is high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 2 to 4 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are alfalfa, crownvetch, smooth bromegrass, big bluestem, little bluestem, indiangrass, and switchgrass. The content of calcium carbonates is the principal limitation in cropped areas. It can cause moisture stress. Measures that maintain carefully balanced fertility levels and the selection of crops and crop varieties that are tolerant of calcium carbonates minimize this problem. Soil blowing is an additional management concern. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops. In places the soil has a concentration of cobbles in the surface layer. Picking and removing the cobbles or burying them below the frost line facilitates tillage.

This soil is fairly well suited to windbreaks. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of excess calcium carbonates.

The land capability classification is IIs.

236—Vallers clay loam. This nearly level soil is poorly drained. It is on low flats, in shallow swales, and on the rims of depressions on uplands and till plains. It is subject to rare flooding. Individual areas are irregular in shape and range from 3 to 125 acres in size.

Typically, the surface layer is black, calcareous clay loam about 10 inches thick. The subsoil is about 14 inches of light olive gray and olive gray, mottled, calcareous clay loam. The underlying material to a depth of about 60 inches is gray, mottled, calcareous clay loam. In some places the soil has less sand and more silt throughout. In other places the surface soil is not calcareous.

Included with this soil in mapping are small areas of Hamerly, Parnell, and Quam soils. The somewhat poorly drained and moderately well drained Hamerly soils are on the slightly higher rises. The very poorly drained Parnell soils are in depressions and sloughs. They do not have calcium carbonates within a depth of 35 inches. The very poorly drained Quam soils are in large, deep basins. They have a dark surface soil more than 24 inches thick. Included soils make up about 15 percent of the map unit.

Permeability is moderately slow in the Vallers soil. Available water capacity is high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 1.0 to 2.5 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are birdsfoot trefoil, ladino clover, reed canarygrass, and creeping foxtail. Wetness is the principal limitation in cropped areas. It can delay fieldwork. Surface drains are needed. The content of calcium carbonates and soil blowing are additional management concerns. The calcium carbonates can cause moisture stress. Measures that maintain carefully balanced fertility levels and the selection of crops and crop varieties that are tolerant of calcium carbonates minimize this problem. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is fairly well suited to windbreaks. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of excess calcium carbonates and excess moisture. Seedling mortality is moderate because of the wetness. Spring planting may be delayed.

The land capability classification is IIw.

245B—Lohnes sandy loam, 1 to 6 percent slopes. This gently sloping soil is well drained. It is on the crests and upper side slopes of old beach ridges. Individual areas are elongated and range from 3 to 15 acres in size.

Typically, the surface layer is black sandy loam about 9 inches thick. The subsurface layer is very dark grayish brown sandy loam about 5 inches thick. The underlying material to a depth of about 60 inches is brown and yellowish brown, calcareous sand. In some places the soil has less sand or finer sand throughout. In other places the underlying material does not have calcium carbonates. In some areas the content of gravel in the underlying material is more than 35 percent. In some areas the soil is moderately well drained. In places clay loam glacial till is within a depth of 40 inches.

Included with this soil in mapping are small areas of Clontarf and Kittson soils. The moderately well drained Clontarf soils are on low-gradient slopes. They have less sand in the upper part than the Lohnes soil. The somewhat poorly drained and moderately well drained Kittson soils are on low-gradient slopes and low ridges. They have more clay and less sand throughout than the Lohnes soil. Included soils make up about 15 percent of the map unit.

Permeability is rapid in the Lohnes soil. Available water capacity is low. Surface runoff is very slow. Organic matter content is moderate. Natural fertility is medium.

Most areas are cropped. This soil is poorly suited to cropland and pasture. The best suited hay and pasture plants are alfalfa, smooth bromegrass, little bluestem, and sideoats grama. The low available water capacity is the principal limitation in cropped areas. The soil is droughty even during periods when precipitation is normal. Drought-tolerant crops should be selected for planting. Soil blowing and water erosion are additional management concerns. Leaving protective amounts of crop residue on the surface throughout winter and planting field windbreaks help to hold snow on the field, increase the moisture supply, and help to prevent excessive soil blowing and water erosion. Seeding cover crops also helps to control both soil blowing and water erosion.

This soil is fairly well suited to windbreaks. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the droughtiness. Leaving some vegetation on the soil or mulching during the early years of establishment helps to prevent excessive soil loss and conserves moisture.

The land capability classification is IVs.

276—Oldham silty clay loam. This nearly level soil is very poorly drained. It is in large, deep basins and sloughs on uplands. This soil is subject to ponding. Individual areas are circular and range from 3 to 75 acres in size.

Typically, the surface layer is black, mottled, calcareous silty clay loam about 10 inches thick. The subsoil is mottled, calcareous silty clay loam about 34 inches thick. It is black in the upper part and very dark gray in the lower part. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous silty clay loam. In some places the soil does not have calcium carbonates in the upper part. In other places it has less clay throughout.

Included with this soil in mapping are small areas of Hamerly and Vallers soils. The somewhat poorly drained and moderately well drained Hamerly soils are on the slightly higher rises. The poorly drained Vallers soils are on low flats, in shallow swales, and on the slightly higher rims of depressions. Included soils make up about 10 percent of the map unit.

Permeability is slow in the Oldham soil. Available water capacity is high. Surface runoff is very slow or ponded. Organic matter content is high. Natural fertility also is high. The seasonal high water table is 2 feet above to 1 foot below the surface.

Most areas are cropped. This soil is fairly well suited to cropland and pasture. The best suited hay and pasture crops are birdsfoot trefoil, ladino clover, reed canarygrass, and creeping foxtail. Wetness is the principal limitation in cropped areas. Ponding, excess calcium carbonates, and soil blowing are additional management concerns. The ponding usually delays spring tillage. Surface drains can help to reduce the wetness, but draining the closed depressions commonly is difficult. Crop damage often occurs during periods when precipitation is above normal. The content of calcium carbonates may cause moisture stress. Measures that maintain carefully balanced fertility levels and the selection of crops and crop varieties that are tolerant of calcium carbonates minimize this problem. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is poorly suited to windbreaks. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of wetness. Because of the wetness, seedling mortality is severe.

The land capability classification is IIIw in drained areas, VIw in undrained areas.

293—Swenoda loam. This nearly level soil is moderately well drained. It is on low-gradient slopes on uplands. Individual areas are irregular in shape and range from 6 to 250 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is very dark grayish brown loam about 13 inches thick. The subsoil is about 18 inches thick. It is yellowish brown sandy loam in the upper part and brownish yellow, mottled, calcareous silt loam in the lower part. The underlying material to a depth of about 60 inches is light yellowish brown, mottled, calcareous silt loam. In some places the dark surface soil is less than 16 inches thick. In other places the underlying material has more sand and less silt and clay.

Included with this soil in mapping are small areas of Aazdahl and Doran soils. These soils are in landscape positions similar to those of the Swenoda soil. The moderately well drained Aazdahl soils have less sand and more clay throughout than the Swenoda soil, and the somewhat poorly drained Doran soils have more clay in the subsoil. Included soils make up about 15 percent of the map unit.

Permeability is moderately rapid in the upper part of the Swenoda soil and moderately slow in the underlying material. Available water capacity is high. Surface runoff is slow. Organic matter content is moderate. Natural fertility is high. The seasonal high water table is at a depth of 2.5 to 4.0 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are alfalfa, smooth bromegrass, and orchardgrass. No major hazards or limitations affect cropping. Soil blowing, however, is a management concern. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is well suited to windbreaks. A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings.

The land capability classification is I.

343—Wheatville silt loam. This nearly level soil is somewhat poorly drained and moderately well drained. It is on flats and low rises on lake plains. Individual areas are irregular in shape and range from 6 to 1,300 acres in size.

Typically, the surface layer is black, calcareous silt loam about 8 inches thick. The subsoil is about 17 inches thick. It is grayish brown, calcareous silt loam in the upper part and light brownish gray, calcareous very fine sandy loam in the lower part. The upper part of the underlying material is light olive brown, mottled, calcareous loamy very fine sand. The lower part to a depth of about 60 inches is olive, mottled, calcareous silty clay. In some places the content of sand in the upper soil layers is more than 15 percent. In other places the surface layer has more clay. In some areas the clayey underlying material is below a depth of 40 inches.

Included with this soil in mapping are small areas of Borup and Croke soils. The poorly drained Borup soils are in the lower landscape positions. The moderately well drained Croke soils are in landscape positions similar to those of the Wheatville soil. They are not calcareous in the surface layer or subsoil. Included soils make up about 15 percent of the map unit.

Permeability is moderately rapid in the upper part of the Wheatville soil and slow in the lower part. Available water capacity is high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 2.5 to 6.0 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are alfalfa, crownvetch, smooth bromegrass, big bluestem, little bluestem, indiangrass, and switchgrass. The content of calcium carbonates is the principal limitation in cropped areas. It can cause moisture stress. Measures that maintain carefully balanced fertility levels and the selection of crops and crop varieties that are tolerant of calcium carbonates minimize this problem. Soil blowing is an additional management concern. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is fairly well suited to windbreaks. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of excess calcium carbonates.

The land capability classification is IIs.

344—Quam silt loam. This level soil is very poorly drained. It is in large, deep basins and sloughs on lake plains, till plains, and uplands. It is subject to ponding. Individual areas are circular and range from 3 to 55 acres in size.

Typically, the surface layer is black silt loam about 14 inches thick. The subsurface layer is calcareous silty clay loam about 23 inches thick. It is black in the upper part and very dark gray in the lower part. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous silty clay loam. In some places the soil has more clay and is calcareous throughout. In other places it has a clayey subsoil.

Included with this soil in mapping are small areas of Hamerly and Vallers soils. The somewhat poorly drained and moderately well drained Hamerly soils are on the slightly higher rises. The poorly drained Vallers soils are on the slightly higher rims around depressions. Included soils make up about 10 percent of the map unit.

Permeability is moderately slow in the Quam soil. Available water capacity is high. Surface runoff is very slow or ponded. Organic matter content is very high. Natural fertility is high. The seasonal high water table is 2 feet above to 1 foot below the surface.

Most areas are cropped. This soil is fairly well suited to cropland and is well suited to pasture. The best suited hay and pasture plants are birdsfoot trefoil, ladino clover, reed canarygrass, and creeping foxtail. Wetness is the principal limitation in cropped areas. Ponding and soil blowing are additional management concerns. The ponding usually delays spring tillage. Surface drains help to reduce the wetness, but draining the closed depressions commonly is difficult. Crop damage often occurs during periods when precipitation is above normal. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is poorly suited to windbreaks because of excessive wetness. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of wetness. Seedling mortality is severe because of the wetness.

The land capability classification is IIIw.

371—Clontarf sandy loam. This nearly level soil is moderately well drained. It is on low-gradient slopes and low ridges on lake plains and outwash plains. Individual areas are irregular in shape and range from 3 to 100 acres in size.

Typically, the surface layer is black sandy loam about 8 inches thick. The subsurface layer is very dark brown sandy loam about 12 inches thick. The subsoil is dark brown sandy loam about 9 inches thick. The upper part of the underlying material is light olive brown, mottled sand. The lower part to a depth of about 60 inches is light brownish gray, mottled loamy fine sand. In some places the dark surface soil is less than 16 inches thick. In other places the underlying material has more clay. In some areas the soil has less sand and more silt throughout.

Included with this soil in mapping are small areas of Kittson and Lohnes soils. The somewhat poorly drained and moderately well drained Kittson soils are in landscape positions similar to those of the Clontarf soil. They have more clay throughout than the Clontarf soil. The well drained Lohnes soils are on the higher ridges. They have more sand and gravel throughout than the Clontarf soil. Included soils make up about 15 percent of the map unit.

Permeability is rapid in the Clontarf soil. Available water capacity is moderate. Surface runoff is slow. Organic matter content is high. Natural fertility is medium. The seasonal high water table is at a depth of 3 to 5 feet.

Most areas are cropped. This soil is fairly well suited to cropland and pasture. The best suited hay and pasture plants are alfalfa, crownvetch, smooth bromegrass, big bluestem, and indiangrass. The moderate available water capacity is the principal limitation in cropped areas. The soil is droughty during periods when precipitation is less than normal or is poorly distributed. Drought-tolerant crops should be selected for planting. Soil blowing is an additional management concern. Leaving protective amounts of crop residue on the surface throughout winter and planting field windbreaks help to hold snow on the field, increase the moisture supply, and prevent excessive soil loss. Soil blowing also can be controlled by seeding cover crops.

This soil is fairly well suited to windbreaks. A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings. Because of the limited available water capacity, measures that control weeds, such as cultivation and applications of herbicide, are especially important.

The land capability classification is IIIs.

418—Lamoure silty clay loam. This nearly level soil is poorly drained. It is on flood plains and is occasionally flooded (fig. 6). Individual areas are elongated and range from 3 to 310 acres in size.

Typically, the surface layer is black, calcareous silty clay loam about 9 inches thick. The subsurface layer is black, calcareous silty clay loam about 15 inches thick. The next layer is olive gray, mottled, calcareous silty clay loam about 25 inches thick. Below this is a buried surface layer of very dark gray, calcareous silty clay loam about 6 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous silty clay loam. In some places the soil is very poorly drained. In other places it has more clay throughout. In some areas it has more sand throughout. In other areas the surface soil has no calcium carbonates.

Included with this soil in mapping are small areas of the poorly drained Colvin soils in the slightly higher landscape positions. These soils have a dark surface soil less than 16 inches thick. They make up about 10 percent of the map unit.

Permeability is moderate or moderately slow in the Lamoure soil. Available water capacity is high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is within a depth of 2 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are birdsfoot trefoil, ladino clover, reed canarygrass, and creeping foxtail. Wetness is the principal limitation in cropped areas. It can delay fieldwork. Flooding, excess calcium carbonates, and soil blowing are additional management concerns. The soil is seasonally flooded by meltwater during spring runoff. Also, flooding after periods of heavy rainfall damages crops in places. The excess calcium carbonates can cause moisture stress. Carefully balanced fertility levels and the selection of crops and crop varieties that are tolerant of calcium carbonates minimize this problem. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is fairly well suited to windbreaks. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of excess calcium carbonates and excess moisture. Seedling mortality is moderate because of the wetness. Spring planting may be delayed.

The land capability classification is IIw.

434—Perella silty clay loam. This level soil is poorly drained. It is on low flats and in shallow swales on lake plains. It is subject to ponding. Individual areas are irregular in shape and range from 3 to 30 acres in size.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer also is black silty clay loam. It is about 8 inches thick. The subsoil is silty clay loam about 11 inches thick. It is black in the upper part and olive gray, mottled, and calcareous in the lower part. The upper part of the underlying material is olive gray, mottled, calcareous silty clay loam. The lower part to a depth of about 60 inches is light olive gray, mottled, calcareous clay loam. In places the soil has calcium carbonates in the surface soil and has less sand and more silt throughout.

Included with this soil in mapping are small areas of Bearden, Colvin, Lindaas, and McIntosh soils. The somewhat poorly drained Bearden and McIntosh soils are on the slightly higher rises. They have calcium carbonates in the surface layer. The poorly drained Colvin soils are in landscape positions similar to those of the Perella soil. They have a calcareous subsoil layer within a depth of 16 inches. The poorly drained Lindaas soils are in shallow depressions. They have a clayey subsoil. Included soils make up about 15 percent of the map unit.

Permeability is moderately slow in the Perella soil. Available water capacity is high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is 1 foot above to 1 foot below the surface.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are birdsfoot trefoil, ladino clover, reed canarygrass, and creeping foxtail. Wetness is the principal limitation in cropped areas. Ponding and soil blowing are additional management concerns. Surface drains are needed. The ponding usually delays spring tillage. Even if the soil is drained, crop damage or loss occurs in some areas during periods when precipitation is above normal. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is fairly well suited to windbreaks. The trees and shrubs grown as windbreaks and environmental

Figure 6.—A flooded playground in an area of Lamoure silty clay loam.

plantings should be those that are tolerant of wetness. Seedling mortality is moderate because of the wetness.

The land capability classification is IIw.

437E—Buse clay loam, 18 to 35 percent slopes. This steep and very steep soil is well drained. It is on the convex upper parts of breaks in the uplands. Individual areas are elongated and range from 3 to 200 acres in size.

Typically, the surface layer is black, calcareous clay loam about 5 inches thick. The underlying material to a depth of about 60 inches is calcareous clay loam. It is yellowish brown in the upper part and light olive brown and mottled in the lower part. In some places the soil does not have a dark surface layer. In other places the slope is less than 18 percent.

Included with this soil in mapping are small areas of Darnen, Formdale, and Lamoure soils. The well drained

Figure 7.—Marsh vegetation in an area of Rauville silt loam.

Darnen soils are on the lower slopes. They have a dark surface soil more than 16 inches thick. The well drained Formdale soils are in the less sloping areas. They do not have calcium carbonates in the surface layer or subsoil. The poorly drained Lamoure soils are on narrow bottom land. They have a dark surface soil more than 24 inches thick. Included soils make up about 15 percent of the map unit.

Permeability is moderately slow in the Buse soil. Available water capacity is high. Surface runoff is very rapid. Organic matter content is moderate. Natural fertility is medium.

Most areas are used for pasture or are left idle. Some support native trees. This soil is generally unsuited to crops and windbreaks. The best suited pasture plants are alfalfa, smooth bromegrass, little bluestem, and sideoats grama. The areas of grassland are fairly well suited to pasture and are well suited to wildlife habitat. The wooded areas are poorly suited to pasture and are well suited to woodland wildlife habitat.

Water erosion is the principal hazard affecting the use of this soil as pasture. The slope is an additional management concern. The hazard of erosion is very severe. Overgrazing can increase this hazard and can result in the formation of large gullies. Because of the slope, pasture renovation is dangerous and difficult.

Proper management can improve wildlife habitat in areas of this soil. Planting fruit-bearing trees and shrubs provides additional food for wildlife. Constructing dams across ravines attracts wetland wildlife.

The land capability classification is VIIe.

450—Rauville silt loam. This level soil is very poorly drained. It is on low flood plains adjacent to rivers and lakes. It is frequently flooded. Individual areas are irregular in shape and range from 3 to 1,500 acres in size.

Typically, the surface layer is black, calcareous silt loam about 5 inches thick. The subsurface layer is black, calcareous silty clay loam about 28 inches thick. The upper part of the underlying material is dark gray and olive gray, mottled, calcareous silty clay loam. The lower part to a depth of about 60 inches is olive gray, calcareous silt loam. In some places the dark surface soil is less than 24 inches thick. In other places the soil has more sand throughout. In some areas it is poorly drained.

Included with this soil in mapping are small areas of the poorly drained Colvin soils in the slightly higher landscape positions. These soils have a calcareous subsoil layer within a depth of 16 inches. They make up about 10 percent of the map unit.

Permeability is moderate or moderately slow in the Rauville soil. Available water capacity is high. Surface runoff is very slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is 1 foot above to 2 feet below the surface.

Most of the acreage is idle land. This soil supports marsh vegetation (fig. 7). It is generally unsuited to crops and windbreaks. It is well suited to wetland wildlife habitat. It provides nesting and escape areas for waterfowl and cover for furbearers and upland game. The habitat can be improved by management measures, including fencing to limit access by livestock. Leaving small areas of crops or planting trees and shrubs on nearby soils provides additional food and cover for wildlife.

The land capability classification is VIw.

494B—Darnen loam, 1 to 6 percent slopes. This gently sloping soil is well drained. It is on toe slopes of breaks in the uplands. Individual areas are elongated and range from 3 to 100 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer also is black loam. It is about 14 inches thick. The subsoil is very dark grayish brown loam about 4 inches thick. The underlying material to a depth of about 60 inches is brown and dark yellowish brown, calcareous loam. In some places the dark surface soil is less than 20 inches thick. In other places the slope is more than 6 percent.

Included with this soil in mapping are small areas of Bearden and Buse soils. The somewhat poorly drained Bearden soils are in lower lying, nearly level areas. They have calcium carbonates in the surface layer. The well drained Buse soils are on the steeper slopes. They have a thin, calcareous surface layer. Included soils make up about 15 percent of the map unit.

Permeability is moderate in the Darnen soil. Available water capacity is high. Surface runoff is medium. Organic matter content is high. Natural fertility also is high.

Most areas are cropped (fig. 8). This soil is well suited to cropland and pasture. The best suited hay and pasture plants are alfalfa, smooth bromegrass, and orchardgrass. Water erosion is the principal hazard in cropped areas. Runoff from areas upslope results in the formation of rills. Leaving protective amounts of crop residue on the surface, seeding cover crops, and establishing grassed waterways help to control water erosion.

This soil is well suited to windbreaks. A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings.

The land capability classification is IIe.

582—Roliss clay loam. This level soil is poorly drained. It is on low flats and in shallow swales on till plains. It is subject to rare flooding. Individual areas are irregular in shape and range from 3 to 55 acres in size.

Typically, the surface layer is black, calcareous clay loam about 10 inches thick. The subsoil is calcareous clay loam about 12 inches thick. It is dark gray and mottled in the upper part and grayish brown in the lower part. The underlying material to a depth of about 60 inches is dark grayish brown and dark gray, mottled, calcareous clay loam. In some places the soil has less sand and more silt throughout. In other places the surface layer and subsoil have no calcium carbonates.

Included with this soil in mapping are small areas of Doran, Hamerly, Kittson, and Lindaas soils. The somewhat poorly drained Doran soils are on the slightly higher, nearly level slopes and on flats. They have a clayey subsoil. The somewhat poorly drained and

Figure 8.—Swathed wheat in an area of Darnen loam, 1 to 6 percent slopes.

moderately well drained Hamerly and Kittson soils are in the slightly higher areas. The poorly drained Lindaas soils are in shallow depressions. They have a clayey subsoil. Included soils make up about 15 percent of the map unit.

Permeability is moderate or moderately slow in the Roliss soil. Available water capacity is high. Surface runoff is very slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are birdsfoot trefoil, ladino clover, reed canarygrass, and creeping foxtail. Wetness is the principal limitation in cropped areas. It can delay fieldwork. Surface drains are needed. The content of calcium carbonates and soil blowing are additional management concerns. Excess calcium carbonates can cause moisture stress. Measures that maintain carefully balanced fertility levels and the selection of crops and crop varieties that are tolerant of calcium carbonates minimize this problem. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is fairly well suited to windbreaks. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of excess moisture and excess calcium carbonates. Seedling mortality is moderate because of the wetness. Spring planting may be delayed.

The land capability classification is IIw.

642—Clearwater silty clay loam. This nearly level soil is poorly drained. It is on low flats and in shallow swales on lake plains. It is subject to rare flooding. Individual areas are irregular in shape and range from 15 to 115 acres in size.

Typically, the surface layer is black silty clay loam about 7 inches thick. The subsoil is very dark gray, calcareous silty clay about 10 inches thick. The upper part of the underlying material is olive gray, mottled, calcareous silty clay. The lower part to a depth of about 60 inches is light olive gray, mottled, calcareous silty clay loam. In some places the calcium carbonates are at a depth of more than 11 inches. In other places the soil does not have coarse fragments.

Included with this soil in mapping are small areas of Doran, Hamerly, and Kittson soils. The somewhat poorly drained Doran soils are on the slightly higher, nearly level slopes and on flats. They do not have calcium carbonates in the subsoil. The somewhat poorly drained and moderately well drained Hamerly soils are on slightly higher rises. The somewhat poorly drained and moderately well drained Kittson soils are on the slightly higher, nearly level slopes. They are not calcareous in the subsoil. Included soils make up about 15 percent of the map unit.

Permeability is slow in the Clearwater soil. Available water capacity is high. Surface runoff is very slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are birdsfoot trefoil, ladino clover, reed canarygrass, and creeping foxtail. Wetness is the principal limitation in cropped areas. It can delay fieldwork. Surface drains are needed. The content of calcium carbonates and soil blowing are additional management concerns. Excess calcium carbonates can cause moisture stress. Measures that maintain carefully balanced fertility levels and the selection of crops and crop varieties that are tolerant of calcium carbonates minimize this problem. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is fairly well suited to windbreaks. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of excess moisture and excess calcium carbonates. Seedling mortality is moderate because of the wetness. Spring planting may be delayed.

The land capability classification is IIw.

646B—Peever clay, 2 to 6 percent slopes. This gently sloping soil is well drained. It is on uplands. Individual areas are irregular in shape and range from 3 to 300 acres in size.

Typically, the surface layer is black clay about 10 inches thick. The subsoil is clay about 26 inches thick. It is dark grayish brown and dark brown in the upper part and light olive brown and calcareous in the lower part. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous clay. In places the soil has less clay throughout.

Included with this soil in mapping are small areas of Buse, Doran, and Parnell soils. The well drained Buse soils are on the tops of knobs and slope breaks. They have a thin, calcareous surface layer. The somewhat poorly drained Doran soils are on the lower, nearly level slopes and on flats. The very poorly drained Parnell soils are in depressions and sloughs. They do not have calcium carbonates within a depth of 35 inches. Included soils make up about 15 percent of the map unit.

Permeability is slow or moderately slow in the Peever soil. Available water capacity is high. Surface runoff is medium. Organic matter content is high. Natural fertility also is high.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass. Soil blowing and water erosion are the principal hazards in cropped areas. Soil blowing can be controlled by planting field windbreaks. Leaving protective amounts of crop residue on the surface and seeding cover crops help to prevent soil blowing and water erosion. Unless the surface is protected, runoff removes soil material and forms rills and small gullies. If row crops are planted up and down the slope, runoff is channeled and the amount of soil moved by water action is increased. Grassed waterways help to prevent the formation of gullies. Terraces and contour farming help to prevent the formation of both rills and gullies. The high content of clay is a management concern. Working the soil when it is wet damages soil structure and makes seedbed preparation difficult. Delaying cultivation during wet periods minimizes the damage to soil structure and results in a more desirable seedbed.

This soil is well suited to windbreaks. A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings.

The land capability classification is IIIe.

698—Doran clay loam. This nearly level soil is somewhat poorly drained. It is on low-gradient slopes and flats on lake plains and till plains. Individual areas are irregular in shape and range from 5 to 700 acres in size.

Typically, the surface layer is black clay loam about 10 inches thick. The subsoil is about 18 inches thick. It is dark grayish brown clay in the upper part and light olive gray, mottled, calcareous clay loam in the lower part. The underlying material to a depth of about 60 inches is olive and light olive brown, mottled, calcareous clay loam. In some places it has a higher content of very fine sand. In other places the subsoil has less clay. In some areas the clayey subsoil is less than 4 inches thick. In other areas many cobbles are on the surface.

Included with this soil in mapping are small areas of Hamerly, Lindaas, and Roliss soils. The somewhat poorly drained and moderately well drained Hamerly soils are on slightly convex rises. They are calcareous throughout. The poorly drained Lindaas soils are in shallow depressions. The poorly drained Roliss soils are on the lower flats and in shallow swales. They do not have a clayey subsoil. Included soils make up about 15 percent of the map unit.

Permeability is slow in the Doran soil. Available water capacity is high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 3 to 5 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass. Wetness is the principal limitation in cropped areas. Surface drains are needed. Soil blowing is an additional management concern. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is well suited to windbreaks. A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings.

The land capability classification is IIw.

814—Hamerly-Lindaas clay loams. These nearly level soils are on till plains and lake plains. The somewhat poorly drained and moderately well drained Hamerly soil is on low rises. The poorly drained Lindaas soil is in shallow depressions and is subject to ponding. Differences in elevation are mainly less than 2 feet. Individual areas are irregular in shape and range from 3 to 1,500 acres in size. They are about 55 percent Hamerly soil and about 30 percent Lindaas soil.

Typically, the Hamerly soil has a surface layer of black, calcareous clay loam about 9 inches thick. The subsoil is grayish brown and light olive brown, mottled, calcareous clay loam about 23 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam. In some places the soil has more silt and less sand throughout. In other places it has more sand and less clay throughout. In some areas many cobbles are on the surface.

Typically, the Lindaas soil has a surface layer of black clay loam about 11 inches thick. The subsoil is very dark gray and dark grayish brown, mottled clay about 21 inches thick. The underlying material to a depth of about 60 inches is light olive gray and light olive brown, mottled, calcareous silty clay loam and clay loam. In some places the subsoil has less clay. In other places the soil is dark to a depth of less than 16 inches. In some areas the soil does not have calcium carbonates within a depth of 35 inches.

Included with these soils in mapping are small areas of Aazdahl, Doran, and Roliss soils. Aazdahl and Doran soils are not calcareous in the surface layer or subsoil. The moderately well drained Aazdahl soils are on low-gradient slopes. The somewhat poorly drained Doran soils are on low-gradient slopes and flats. The poorly drained Roliss soils are on low flats and in shallow swales. They are calcareous at or near the surface. Included soils make up about 15 percent of the map unit.

Permeability is moderately slow in the Hamerly soil. Available water capacity is high. Surface runoff is medium or slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 2 to 4 feet.

Permeability is slow in the Lindaas soil. Available water capacity is high. Surface runoff is very slow or ponded. Organic matter content is high. Natural fertility also is high. The seasonal high water table is 1 foot above to 2 feet below the surface.

Most areas are cropped. These soils are well suited to cropland and pasture. The best suited hay and pasture plants are birdsfoot trefoil, creeping foxtail, ladino clover, and reed canarygrass on the Hamerly soil and alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass on the Lindaas soil. The content of calcium carbonates is the principal limitation in cropped areas of the Hamerly soil. It can cause moisture stress. Measures that maintain carefully balanced fertility levels and the selection of crops and crop varieties that are tolerant of calcium carbonates minimize this problem. Soil blowing is an additional management concern. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops. In places cobbles are concentrated in the surface layer. Picking and removing the cobbles or burying them below the frost line facilitates tillage.

Wetness is the principal limitation in cropped areas of the Lindaas soil. Ponding and soil blowing are additional management concerns. The ponding usually delays spring tillage. Surface drains are needed. Even if the soil is drained, however, crop damage or loss occurs in some areas during periods when precipitation is above normal. Replanting drowned out areas is not always feasible. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

These soils are fairly well suited to windbreaks. The trees grown as windbreaks and environmental plantings on the Hamerly soil should be those that are tolerant of excess calcium carbonates. Those grown on the Lindaas soil should be those that are tolerant of wetness. Because of the wetness, seedling mortality is moderate and spring planting may be delayed.

The land capability classification of the Hamerly soil is IIs, and that of the Lindass soil is IIw.

816—Fargo clay, saline. This nearly level soil is poorly drained. It is on low flats with closely spaced shallow swales and on low rises on lake plains. It is subject to rare flooding. It has variable concentrations of salts. Generally, the areas with the highest concentrations are in the shallow swales and commonly are 50 to 200 feet wide. The concentrations tend to change from year to year, depending on the amount of rainfall and other climatic conditions. Individual areas are irregular in shape and range from 5 to 770 acres in size.

Typically, the surface layer is black clay about 10 inches thick. The subsoil is very dark gray, calcareous clay about 5 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous clay. In some places the surface layer has less clay. In other places it is calcareous. In some areas the soil has a light colored subsurface layer.

Included with this soil in mapping are small areas of the somewhat poorly drained Doran soils on low-gradient slopes and flats. These soils make up about 10 percent of the map unit.

Permeability is slow in the Fargo soil. Available water capacity is high. Surface runoff is very slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is within a depth of 3 feet.

Most areas are cropped. This soil is fairly well suited to cropland and pasture. The best suited hay and pasture plants are birdsfoot trefoil, ladino clover, reed canarygrass, and creeping foxtail. Salinity is the principal limitation in cropped areas. It commonly inhibits crop growth. Severely saline areas support no plants, except for scattered salt-tolerant weeds. Salt-tolerant crops should be selected for planting. Since the saline and nonsaline areas are so intermixed, it is not possible to farm only the nonsaline areas. Wetness, a high content of clay, and soil blowing are additional management concerns. Surface drains are needed. Because of the high content of clay in the surface layer, working the soil when it is wet damages soil structure and makes seedbed preparation difficult. Delaying cultivation during wet periods minimizes the damage to soil structure and results in a more desirable seedbed. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is poorly suited to windbreaks. The concentration of salts severely limits tree growth. Seedling mortality is severe because of the salinity and the wetness. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of excess salinity and wetness.

The land capability classification is IIIs.

821—Doran-Lindaas silty clay loams. These nearly level soils are on lake plains and till plains. The somewhat poorly drained Doran soil is on low, flat-topped rises. The poorly drained Lindaas soil is in shallow depressions and is subject to ponding (fig. 9). Differences in elevation are mainly less than 1 foot. Individual areas are irregular in shape and range from 18 to 4,500 acres in size. They are about 50 percent Doran soil and 35 percent Lindaas soil.

Typically, the Doran soil has a surface layer of black silty clay loam about 10 inches thick. The subsoil is about 19 inches thick. It is dark grayish brown clay in the upper part and grayish brown, calcareous silty clay loam in the lower part. The underlying material to a

Figure 9.—Ponding on the Lindaas soil in an area of Doran-Lindaas silty clay loams.

depth of about 60 inches is grayish brown and light olive brown, mottled, calcareous clay loam. In some places the subsoil has less clay. In other places the clayey subsoil is less than 4 inches thick. In some areas many cobbles are on the surface.

Typically, the Lindaas soil has a surface layer of black silty clay loam about 10 inches thick. The subsoil is about 24 inches thick. It is black and dark grayish brown, mottled clay in the upper part and light brownish gray, mottled, calcareous silty clay loam in the lower part. The underlying material to a depth of about 60 inches is grayish brown and light olive brown, mottled, calcareous clay loam. In some places the soil is dark to a depth of less than 16 inches. In some areas the soil is not calcareous within a depth of 35 inches.

Included with these soils in mapping are small areas of Hamerly and Roliss soils. The somewhat poorly drained and moderately well drained Hamerly soils are on low rises. They have a calcareous surface layer. The poorly drained Roliss soils are on low flats and in shallow swales. They do not have a clayey subsoil. Included soils make up about 15 percent of the map unit.

Permeability is slow in the Doran soil. Available water capacity is high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 3 to 5 feet.

Permeability is slow in the Lindaas soil. Available water capacity is high. Surface runoff is very slow or ponded. Organic matter content is high. Natural fertility also is high. The seasonal high water table is 1 foot above to 2 feet below the surface.

Most areas are cropped. These soils are well suited to cropland and pasture. The best suited hay and pasture plants are birdsfoot trefoil, creeping foxtail, red clover, and reed canarygrass. Wetness is the principal limitation in cropped areas. Surface drains are needed. Ponding is an additional management concern on the Lindaas soil. It usually delays spring tillage. Even if a drainage system is installed, crop damage or loss occurs in some areas during periods when precipitation is above normal. Replanting drowned out areas is not always feasible. Soil blowing is a management concern on these soils. Leaving protective amounts of residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops. In some areas of the Doran soil cobbles are concentrated in the surface layer. Picking and removing the cobbles or burying them below the frost line facilitates tillage.

The Doran soil is well suited to windbreaks, and the Lindaas soil is fairly well suited. A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on the Doran soil.

The trees and shrubs grown on the Lindaas soil should be those that are tolerant of wetness. Seedling mortality is moderate because of the wetness. Spring planting may be delayed.

The land capability classification is IIw.

822B—Peever-Buse complex, 2 to 6 percent slopes. These well drained, gently undulating soils are on uplands. The Peever soil is on gentle slopes. The Buse soil is on knobs and crests. Individual areas are irregular in shape and range from 5 to 365 acres in size. They are about 55 percent Peever soil and 30 percent Buse soil.

Typically, the Peever soil has a surface layer of black clay about 10 inches thick. The subsoil is clay about 26 inches thick. It is dark grayish brown and brown in the upper part and light olive brown and calcareous in the lower part. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous clay. In places the soil has less clay throughout.

Typically the Buse soil has a surface layer of very dark grayish brown clay loam about 7 inches thick. The subsoil is light olive brown, calcareous clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is olive brown, calcareous clay loam. It is mottled in the lower part. In some places the soil has more clay throughout. In other places it does not have a dark surface layer.

Included with these soils in mapping are small areas of Doran and Parnell soils. The somewhat poorly drained Doran soils are on low-gradient slopes and flats. The very poorly drained Parnell soils are in depressions. Included soils make up about 15 percent of the map unit.

Permeability is slow or moderately slow in the Peever soil. Available water capacity is high. Surface runoff is medium. Organic matter content is high. Natural fertility also is high.

Permeability is moderately slow in the Buse soil. Available water capacity is high. Surface runoff is rapid. Organic matter content is moderate. Natural fertility is medium.

Most areas are cropped. The Peever soil is well suited to cropland and pasture, and the Buse soil is fairly well suited to cropland and well suited to pasture. The best suited hay and pasture plants are alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass. Soil blowing and water erosion are the principal hazards in cropped areas. Leaving protective amounts of crop residue on the surface and seeding cover crops help to control both soil blowing and water erosion. Soil blowing also can be controlled by planting field windbreaks. Unless the surface is protected, runoff removes soil material and forms rills and small gullies. If row crops are planted up and down the slope, runoff is channeled and the amount of soil moved by water erosion is increased. Grassed waterways help to prevent the formation of gullies. Terraces and contour farming help to prevent the formation of rills and gullies. The high content of clay is an additional management concern. Working the soil when it is wet can damage soil structure and make seedbed preparation difficult. Delaying cultivation during wet periods minimizes the damage to soil structure and results in a more desirable seedbed.

These soils are well suited to windbreaks. A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings.

The land capability classification is IIIe.

900—Hamerly-Aazdahl-Lindaas complex. These nearly level soils are on uplands. The somewhat poorly drained and moderately well drained Hamerly soil is on low rises. The moderately well drained Aazdahl soil is on low, flat-topped rises. The poorly drained Lindaas soil is in shallow depressions and is subject to ponding. Differences in elevation are mainly less than 2 feet. Individual areas are irregular in shape and range from 3 to 2,600 acres in size. They are about 40 percent Hamerly soil, 30 percent Aazdahl soil, and 30 percent Lindaas soil.

Typically, the Hamerly soil has a surface layer of black, calcareous clay loam about 11 inches thick. The subsoil is light olive brown, calcareous clay loam about

16 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam. In some places the soil has more silt and less sand throughout. In other places it has more sand and less clay throughout.

Typically, the Aazdahl soil has a surface layer of black clay loam about 8 inches thick. The subsurface layer also is black clay loam. It is about 7 inches thick. The subsoil is brown clay loam about 5 inches thick. It is calcareous in the lower part. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam. In some places the dark surface soil is more than 16 inches thick. In other places the soil has a calcareous subsoil less than 16 inches from the surface. In some areas it has a thin, clayey subsoil. In other areas it has less silt and more sand throughout.

Typically, the Lindaas soil has a surface layer of black silty clay loam about 9 inches thick. The subsoil is about 27 inches thick. It is very dark gray, mottled silty clay loam and silty clay in the upper part and light brownish gray, mottled, calcareous silty clay loam in the lower part. The underlying material to a depth of about 60 inches is grayish brown and light brownish gray, mottled, calcareous silty clay loam and clay loam. In some places the subsoil has less clay. In other places the soil is not calcareous within a depth of 35 inches. In some areas it is dark to a depth of less than 16 inches. In other areas it has a light colored subsurface layer.

Permeability is moderately slow in the Hamerly soil. Available water capacity is high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 2 to 4 feet.

Permeability is moderately slow in the Aazdahl soil. Available water capacity is high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 3 to 6 feet.

Permeability is slow in the Lindaas soil. Available water capacity is high. Surface runoff is very slow or ponded. Organic matter content is high. Natural fertility also is high. The seasonal high water table is 1 foot above to 2 feet below the surface.

Most areas are cropped. These soils are well suited to cropland and pasture. The best suited hay and pasture plants are birdsfoot trefoil, creeping foxtail, ladino clover, and reed canarygrass.

An excess of calcium carbonates is the principal limitation in cropped areas of the Hamerly soil. It can cause moisture stress. Measures that maintain carefully balanced fertility levels and the selection of crops and crop varieties that are tolerant of calcium carbonates minimize this problem. Soil blowing is a hazard on the Hamerly and Aazdahl soils. It can be controlled by leaving protective amounts of crop residue on the surface, planting field windbreaks, and seeding cover crops. The wetness of the Lindaas soil is a limitation. Ponding is an additional management concern. It usually delays spring tillage. Surface drains are needed. Even if the soil is drained, however, crop damage or loss occurs in some areas during periods when precipitation is above normal. Replanting drowned out areas is not always feasible.

The Aazdahl soil is well suited to windbreaks, and the Hamerly and Lindaas soils are fairly well suited. A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on the Aazdahl soil. The ones grown on the Hamerly soil should be those that are tolerant of excess calcium carbonates. The ones grown on the Lindaas soil should be those that are tolerant of wetness. Seedling mortality is moderate because of the wetness. Spring planting may be delayed.

The land capability classification of the Hamerly soil is IIs, that of the Aazdahl soil is I, and that of the Lindaas soil is IIw.

915B—Formdale-Buse clay loams, 2 to 6 percent slopes. These well drained, gently undulating soils are on uplands. The Formdale soil is on gentle slopes. The Buse soil is on knobs and crests. Individual areas are irregular in shape and range from 3 to 205 acres in size. They are about 50 percent Formdale soil and 40 percent Buse soil.

Typically, the Formdale soil has a surface layer of black clay loam about 10 inches thick. The subsoil is brown clay loam about 7 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous clay loam. In some places the soil has more sand and less silt throughout. In other places the dark surface soil is more than 16 inches thick.

Typically, the Buse soil has a surface layer of very dark grayish brown, calcareous clay loam about 10 inches thick. The subsoil is light olive brown, calcareous clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam. In places the soil does not have a dark surface layer.

Included with these soils in mapping are small areas of Aazdahl, Hamerly, and Lindaas soils. The moderately well drained Aazdahl soils are on low-gradient slopes. The somewhat poorly drained and moderately well drained Hamerly soils are on low rises. They have a calcareous subsoil layer within a depth of 16 inches. The poorly drained Lindaas soils are in shallow depressions. They have more clay in the subsoil than the Formdale and Buse soils. Included soils make up about 10 percent of the map unit.

Permeability is moderately slow in the Formdale soil. Available water capacity is high. Surface runoff is medium. Organic matter content is high. Natural fertility also is high.

Permeability is moderately slow in the Buse soil. Available water capacity is high. Surface runoff is rapid. Organic matter content is low to moderate. Natural fertility is medium.

Most areas are cropped. The Formdale soil is well suited to cropland and pasture, and Buse soil is fairly well suited to cropland and well suited to pasture. The best suited hay and pasture plants are alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass. Soil blowing and water erosion are the principal hazards in cropped areas. Leaving protective amounts of crop residue on the surface and seeding cover crops help to prevent both soil blowing and water erosion. Soil blowing also can be controlled by planting field windbreaks. Unless the surface is protected, runoff removes soil material and forms rills and small gullies. If row crops are planted up and down the slope, runoff is channeled and the amount of soil moved by water erosion is increased. Grassed waterways help to prevent the formation of gullies. Terraces and contour farming help to prevent the formation of rills and gullies.

These soils are well suited to windbreaks. A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings.

The land capability classification is IIe.

915C2—Buse-Formdale clay loams, 6 to 14 percent slopes, eroded. These well drained, rolling soils are on uplands. The Buse soil is on knobs and crests (fig. 10). The Formdale soil is in the less sloping areas. Individual areas are irregular in shape and range from 3 to 205 acres in size. They are about 45 percent Buse soil and 40 percent Formdale soil. In places the surface layer of these soils has a grayish cast because part of it has been removed by erosion. During cultivation the subsoil has been mixed into the remaining surface layer. The underlying material is exposed in some areas.

Typically, the Buse soil has a surface layer of very dark grayish brown, calcareous clay loam about 9 inches thick. The subsoil is light olive brown, calcareous clay loam about 16 inches thick. The upper part of the underlying material is light olive brown, calcareous clay loam. The lower part to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In some places the soil has more clay throughout. In other places it does not have a dark surface layer.

Typically, the Formdale soil has a surface layer of very dark gray clay loam about 8 inches thick. The subsoil is clay loam about 17 inches thick. It is brown in the upper part and yellowish brown and calcareous in the lower part. The underlying material to a depth of about 60 inches is light olive brown, calcareous clay loam. In some places the soil has more clay throughout. In other places it has more sand and less silt throughout. In areas where sediments transported by erosion have accumulated, the dark surface soil is more than 16 inches thick and may be calcareous.

Included with these soils in mapping are small areas of Hamerly and Lindaas soils. The somewhat poorly drained and moderately well drained Hamerly soils are on low rises. They have a calcareous subsoil layer within a depth of 16 inches. The poorly drained Lindaas soils are in shallow depressions. They have more clay in the subsoil than the Buse and Formdale soils. Included soils make up about 15 percent of the map unit.

Permeability is moderately slow in the Buse soil. Available water capacity is high. Surface runoff is rapid. Organic matter content is moderate. Natural fertility is medium.

Permeability is moderately slow in the Formdale soil. Available water capacity is high. Surface runoff is medium. Organic matter content is high. Natural fertility also is high.

Most areas are cropped. These soils are fairly well suited to cropland and well suited to pasture. The best suited hay and pasture plants are alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass. Water erosion is a severe hazard in cropped areas. Unless the surface is protected, runoff removes soil material and forms rills and small gullies. If row crops are planted up and down the slope, runoff is channeled and the amount of soil moved by water action is increased. Grassed waterways help to prevent the formation of gullies. Leaving protective amounts of crop residue on the surface, constructing terraces, and farming on the contour help to control water erosion.

These soils are well suited to windbreaks. A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings.

The land capability classification is IIIe.

922—Hamerly-Parnell complex. These nearly level soils are on uplands. The somewhat poorly drained and

Figure 10.—An area of Buse-Formdale clay loams, 6 to 14 percent slopes. The Buse soil is in the lighter colored areas.

moderately well drained Hamerly soil is on rises. The very poorly drained Parnell soil is in closed depressions and is subject to ponding (fig. 11). Differences in elevation are mainly less than 4 feet. Individual areas are irregular in shape and range from 25 to 4,500 acres in size. They are about 65 percent Hamerly soil and 25 percent Parnell soil.

Typically, the Hamerly soil has a surface layer of very dark gray, calcareous clay loam about 8 inches thick. The subsoil is brownish gray and light brownish gray, calcareous clay loam about 20 inches thick. The underlying material to a depth of about 60 inches is light olive brown and grayish brown, mottled, calcareous clay loam. In some places the soil has more silt and less sand throughout. In other places it has more sand and less clay throughout.

Typically, the Parnell soil has a surface layer of black silty clay loam about 9 inches thick. The subsurface layer is very dark grayish brown silt loam about 9 inches thick. The subsoil is very dark gray and olive gray, mottled clay and silty clay loam. It is about 21 inches thick. The underlying material to a depth of about 60 inches is olive gray and gray, mottled, calcareous clay loam. In places the soil is calcareous within a depth of 35 inches.

Included with these soils in mapping are small areas of the moderately well drained Aazdahl and somewhat poorly drained Doran soils on low-gradient slopes. These included soils are not calcareous in the surface layer or subsoil. They make up about 10 percent of the map unit.

Permeability is moderately slow in the Hamerly soil. Available water capacity is high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 2 to 4 feet.

Permeability is slow in the Parnell soil. Available water capacity is high. Surface runoff is very slow or ponded. Organic matter content is high. Natural fertility also is high. The seasonal high water table is 2 feet above to 2 feet below the surface.

Most areas are cropped. The Hamerly soil is well suited to cropland and pasture, and the Parnell soil is fairly well suited to cropland and well suited to pasture. The best suited hay and pasture plants are birdsfoot trefoil, creeping foxtail, ladino clover, and reed canarygrass. An excess of calcium carbonates is the principal limitation in cropped areas of the Hamerly soil. It can cause moisture stress. Measures that maintain carefully balanced fertility levels and the selection of

Figure 11.—An area of the Hamerly-Parnell complex. The Parnell soil is in closed depressions.

crops and crop varieties that are tolerant of calcium carbonates minimize this problem. Soil blowing is an additional management concern. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops. Wetness is the principal limitation in cropped areas of the Parnell soil. Ponding is an additional management concern. It usually delays spring tillage. Surface drains are needed. Draining these closed depressions commonly is difficult. Crop damage or loss may result during periods when precipitation is above normal. Replanting drowned out areas is not always feasible.

The Hamerly soil is fairly well suited to windbreaks. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of excess calcium carbonates. The Parnell soil is poorly suited to windbreaks because of excessive wetness. The species selected for planting should be those that are tolerant of excess moisture. Seedling mortality is severe because of the wetness. Spring planting may be delayed.

The land capability classification of the Hamerly soil is IIs, and that of the Parnell soil is IIIw.

948—McIntosh-Lindaas complex. These nearly level soils are on lake plains and till plains. The somewhat poorly drained McIntosh soil is on low rises. The poorly drained Lindaas soil is in shallow depressions and is subject to ponding. Differences in elevation are mainly less than 2 feet. Individual areas are irregular in shape and range from 40 to 3,840 acres in size. They are about 65 percent McIntosh soil and 25 percent Lindaas soil.

Typically, the McIntosh soil has a surface layer of black, calcareous silt loam about 8 inches thick. The subsurface layer is very dark gray, calcareous silt loam about 6 inches thick. The subsoil is grayish brown and light yellowish brown, calcareous silt loam about 13 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous loam and clay loam. In places the silty mantle is less than 24 or more than 40 inches thick. In some areas the surface layer is not calcareous.

Typically, the Lindaas soil has a surface layer of black silty clay loam about 16 inches thick. The subsoil is about 24 inches thick. It is very dark gray and dark grayish brown silty clay in the upper part and gray, mottled, calcareous silty clay loam in the lower part. The underlying material to a depth of about 60 inches is gray, mottled, calcareous silt loam. In some places the subsoil has less clay. In other places the soil is not calcareous within a depth of 35 inches. In some areas it is dark to a depth of less than 16 inches. In other areas a calcareous subsoil layer is within a depth of 16 inches.

Included with these soils in mapping are small areas of Aazdahl and Doran soils. These included soils are on low-gradient slopes. The moderately well drained Aazdahl soils do not have calcium carbonates in the surface layer or subsoil. The somewhat poorly drained Doran soils have more clay in the subsoil than the McIntosh soil. Included soils make up about 10 percent of the map unit.

Permeability is moderate or moderately slow in the McIntosh soil. Available water capacity is high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 3 to 6 feet.

Permeability is slow in the Lindaas soil. Available water capacity is high. Surface runoff is very slow or ponded. Organic matter content is high. Natural fertility also is high. The seasonal high water table is 1 foot above to 2 feet below the surface.

Most areas are cropped. These soils are well suited to cropland and pasture. The best suited hay and pasture plants are birdsfoot trefoil, creeping foxtail, ladino clover, and reed canarygrass. An excess of calcium carbonates is the principal limitation in cropped areas of the McIntosh soil. It can cause moisture stress. Carefully balanced fertility levels and the selection of crops and crop varieties that are tolerant of calcium carbonates minimize this problem. Soil blowing is another management concern. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops. Wetness is the principal limitation in cropped areas of the Lindaas soil. Ponding is an additional management concern. It usually delays tillage. Surface drains are needed. Even if the soil is drained, however, crop damage or loss occurs in some areas during periods when precipitation is above normal. Replanting drowned out areas is not always feasible.

These soils are fairly well suited to windbreaks. The species selected for planting on the McIntosh soil should be those that are tolerant of excess calcium carbonates. The ones grown on the Lindaas soil should be those that are tolerant of wetness. Seedling mortality is moderate because of the wetness. Spring planting may be delayed.

The land capability classification of the McIntosh soil is IIs, and that of the Lindaas soil is IIw.

1020—Udorthents, sloping. These soils are on spoil banks along the Mustinka and Bois de Sioux Rivers. The textures and colors of the soil material vary. The material commonly is glacial till or clayey alluvium. Individual areas are elongated. They are as much as 300 feet wide and as much as 10 miles long.

Typically, the surface layer is olive brown, mottled, calcareous clay loam. The underlying material to a depth of about 60 inches also is olive brown, mottled, calcareous clay loam. Threads or pockets of dark, calcareous material generally are mixed throughout the upper 60 inches.

Permeability and surface runoff vary. Available water capacity is high. Organic matter content is low. Natural fertility also is low.

Most of the acreage is idle land. Some areas have been smoothed and are used as cropland. This soil is poorly suited to cropland and pasture and is generally unsuited to windbreaks, building site development, and most sanitary facilities. The best suited hay and pasture plants are birdsfoot trefoil, orchardgrass, and smooth bromegrass.

The cost of reclamation is the principal limitation in cropped areas. This cost is considerable. Erosion and low fertility levels are additional management concerns. Maintaining a cover of grasses on the side slopes adjacent to the rivers reduces the hazards of erosion and siltation. Incorporating organic matter into the soils and applying fertilizer improve fertility.

The idle areas of these soils can provide wildlife habitat. Planting trees and shrubs or leaving a narrow strip of crops on the soils adjacent to the spoil banks provides additional cover and food for wildlife.

The land capability classification is IVe.

1030—Udorthents-Pits complex. This map unit is in areas where gravelly material has been mined (fig. 12). The pits are generally adjacent to areas of Lohnes soils. They are around old beach ridges or in areas of coarse textured outwash. Commonly, the surface layer has been stripped from these soils and deposited around the edges of the gravel pits. The size and shape of the pits are influenced largely by the quantity and quality of gravel at each site. Many pits have been abandoned because the supply of suitable gravel has been exhausted. Some of the deeper abandoned pits are filled with water.

Included in this unit in mapping are a few areas where soil material other than gravel and sand has been removed. This material is sand to clay and has been used primarily for building roads and railroad grades.

Introduced and native grasses grow in and around the abandoned pits. A few scattered trees also grow in these areas. Limited grazing is available on the spoil of these pits, and water for livestock is available in the deeper ones. Many abandoned pits provide cover and water for wildlife. Planting shrubs and trees and leaving small areas of crops on nearby soils provide additional food and cover for wildlife.

In some areas the pits have been leveled and reclaimed, but their suitability for cropland and other uses varies considerably. Onsite investigation is necessary to determine the suitability of specific areas for desired uses.

No land capability classification has been assigned.

1916—Lindaas clay loam. This level soil is poorly drained. It is on low flats, in drainageways, and in shallow depressions on lake plains, till plains, and uplands. It is subject to ponding. Individual areas are irregular in shape and range from 3 to 120 acres in size.

Typically, the surface layer is black clay loam about 9 inches thick. The subsoil is about 16 inches thick. It is very dark grayish brown and olive gray clay in the upper part and olive gray, mottled, calcareous clay loam in the lower part. The underlying material to a depth of about 60 inches is light olive gray, mottled, calcareous clay loam. In some places the subsoil has less clay. In other places the soil is not calcareous within a depth of 35 inches. In some areas it is dark to a depth of less than 16 inches. In other areas it has a light colored subsurface layer.

Included with this soil in mapping are small areas of Doran and Hamerly soils. The somewhat poorly drained Doran soils are in the slightly higher, nearly level areas. The somewhat poorly drained and moderately well drained Hamerly soils are on slightly higher rises. They have calcium carbonates in the surface layer. Included soils make up about 15 percent of the map unit.

Permeability is slow in the Lindaas soil. Available water capacity is high. Surface runoff is very slow or ponded. Organic matter content is high. Natural fertility also is high. The seasonal high water table is 1 foot above to 2 feet below the surface.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are birdsfoot trefoil, ladino clover, reed canarygrass, and creeping foxtail. Wetness is the principal limitation in cropped areas. Ponding and soil blowing are additional management concerns. The ponding usually delays tillage. Surface drains are needed. Even if the soil is drained, however, crop

Figure 12.—A gravel pit in an area of the Udorthents-Pits complex.

damage or loss occurs in some areas during periods when precipitation is above normal. Leaving a protective amount of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is fairly well suited to windbreaks. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of wetness. Seedling mortality is moderate because of the wetness. Spring planting may be delayed.

The land capability classification is IIw.

1918—Croke loam. This nearly level soil is moderately well drained. It is on low-gradient slopes on lake plains. Individual areas are irregular in shape and range from 8 to 1,620 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsoil is dark grayish brown very fine sandy loam about 10 inches thick. The upper part of the underlying material is light olive brown very fine sandy loam. The lower part to a depth of about 60 inches is olive gray and gray, mottled, calcareous silty clay. In some places the content of fine sand or coarser sand in the upper soil layers is more than 15 percent. In other places the clayey part of the underlying material is at a depth of more than 40 inches.

Included with this soil in mapping are small areas of

Fargo, Glyndon, and Wheatville soils. The poorly drained Fargo soils are on the slightly lower flats. They have more clay than the Croke soils. The somewhat poorly drained and moderately well drained Glyndon and Wheatville soils are in landscape positions similar to those of the Croke soils. They have a calcareous subsoil layer within a depth of 16 inches. Included soils make up about 15 percent of the map unit.

Permeability is moderately rapid in the upper part of the Croke soil and slow in the lower part. Available water capacity is moderate. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 2.5 to 6.0 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are alfalfa, smooth bromegrass, and orchardgrass. No major limitations or hazards affect cropping. Soil blowing, however, is a management concern. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is well suited to windbreaks. A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings.

The land capability classification is I.

1933—Bearden-Lindaas complex. These nearly level soils are on lake plains. The somewhat poorly drained Bearden soil is on low rises. The poorly drained Lindaas soil is in shallow depressions and is subject to ponding. Differences in elevation are mainly less than 2 feet. Individual areas are irregular in shape and range from 35 to 780 acres in size. They are about 55 percent Bearden soil and 30 percent Lindaas soil.

Typically, the Bearden soil has a surface layer of black, calcareous silt loam about 10 inches thick. The subsoil is grayish brown, calcareous silt loam about 8 inches thick. The upper part of the underlying material is light olive brown, calcareous silt loam. The lower part to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam. In some places it has less clay throughout. In other places it has loamy material at a depth of 24 to 40 inches.

Typically, the Lindaas soil has a surface layer of black silty clay loam about 10 inches thick. The subsoil is very dark gray and dark grayish brown silty clay about 16 inches thick. The upper part of the underlying material is light brownish gray, mottled, calcareous silt loam. The lower part to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam. In some places the subsoil has less clay. In other places the soil is not calcareous within a depth of 35 inches. In some areas it is dark to a depth of less than 16 inches. In other places the underlying material has a higher content of very fine sand.

Included with these soils in mapping are small areas of Colvin and Doran soils. The poorly drained Colvin soils are on low flats and in shallow swales. They are calcareous in the surface soil. The somewhat poorly drained Doran soils are on low-gradient slopes and flats. They are not calcareous in the surface layer or subsoil. Included soils make up about 15 percent of the map unit.

Permeability is moderately slow in the Bearden soil. Available water capacity is high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 2 to 4 feet.

Permeability is slow in the Lindaas soil. Available water capacity is high. Surface runoff is very slow or ponded. Organic matter content is high. Natural fertility also is high. The seasonal high water table is 1 foot above to 2 feet below the surface.

Most areas are cropped. These soils are well suited to cropland and pasture. The best suited hay and pasture plants are birdsfoot trefoil, creeping foxtail, ladino clover, and reed canarygrass. An excess of calcium carbonates is the principal limitation in cropped areas of the Bearden soil. It can cause moisture stress. Measures that maintain carefully balanced fertility levels and the selection of crops and crop varieties that are tolerant of calcium carbonates minimize this problem. Soil blowing is an additional management concern. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops. Wetness is the principal limitation in cropped areas of the Lindaas soil. Ponding is an additional management concern. It usually delays tillage. Surface drains are needed. Even if the soil is drained, however, crop damage or loss occurs in some areas during periods when precipitation is above normal. Replanting drowned out areas is not always feasible.

These soils are fairly well suited to windbreaks and environmental plantings. The species selected for planting on the Bearden soil should be those that are tolerant of excess calcium carbonates. The ones grown on the Lindaas soil should be those that are tolerant of wetness. Seedling mortality is moderate because of the wetness. Spring planting may be delayed.

The land capability classification of the Bearden soil is IIs, and that of the Lindaas soil is IIw.

1940—Quam silty clay loam, ponded. This level soil is very poorly drained. It is in large, deep basins on lake plains, till plains, and uplands. These marshy areas are covered by about 2 feet of water during most of the growing season. Commonly, areas of open water are near the center of the basins. The vegetation is cattails, reeds, and sedges. Individual areas are circular and range from 3 to 220 acres in size.

Typically, the surface layer is black silty clay loam about 20 inches thick. The subsurface layer is black, calcareous silty clay loam about 10 inches thick. The upper part of the underlying material is gray, calcareous silty clay loam. The lower part to a depth of about 60 inches is gray, mottled, calcareous clay loam. In some places the surface layer is mucky or calcareous. In other places the dark surface soil is less than 24 inches thick. In some areas the soil has a clayey, noncalcareous subsoil.

Included with this soil in mapping are small areas of Hamerly and Vallers soils. These soils have a calcareous subsoil layer within 16 inches of the surface. The somewhat poorly drained and moderately well drained Hamerly soils are on the higher rises. The poorly drained Vallers soils are on the rims surrounding the deep basins. Included soils make up about 5 percent of the map unit.

Permeability is moderately slow in the Quam soil. Available water capacity is high. Surface runoff is ponded. Organic matter content is very high. The seasonal high water table is 2 feet above to 1 foot below the surface.

Most of the acreage is idle land. This soil is generally unsuited to crops and windbreaks. It is well suited to wetland wildlife habitat. The habitat provides nesting and escape areas for waterfowl and cover for furbearers and upland game. It can be improved by management measures, including controlling the water level and fencing to limit access by livestock. Planting trees and shrubs or leaving small areas of unharvested crops on nearby soils provides additional food and cover for wildlife.

The land capability classification is VIIIw.

1947—Doran silty clay loam, loamy substratum. This nearly level soil is somewhat poorly drained. It is on low-gradient slopes and flats on lake plains and till plains. Individual areas are irregular in shape and range from 3 to 320 acres in size.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsoil is silty clay about 20 inches thick. It is black in the upper part and grayish brown, mottled, and calcareous in the lower part. The upper part of the underlying material is grayish brown, mottled, calcareous silty clay loam. The lower part to a depth of about 60 inches is light olive brown, mottled, calcareous very fine sandy loam. In some places the underlying material has a lower content of very fine sand. In other places the subsoil has less clay. In some areas it is less than 4 inches thick.

Included with this soil in mapping are small areas of Bearden and Lindaas soils. The somewhat poorly drained Bearden soils are on the slightly higher rises. They are calcareous throughout. The poorly drained Lindaas soils are in shallow depressions. Included soils make up about 15 percent of the map unit.

Permeability is slow in the upper part of the Doran soil and moderately rapid below a depth of 40 inches. Available water capacity is high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 3 to 5 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass. Wetness is the principal limitation in cropped areas. Surface drains are needed. Soil blowing is an additional management concern. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is well suited to windbreaks. A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings.

The land capability classification is IIw.

1948—Fargo-Lindaas silty clay loams. These nearly level, poorly drained soils are on lake plains. The Fargo soil is on low, flat-topped rises. The Lindaas soil is in shallow depressions. Both soils are subject to rare flooding. Differences in elevation are mainly less than 1 foot. Individual areas are irregular in shape and range from 80 to 670 acres in size. They are about 50 percent Fargo soil and 35 percent Lindaas soil.

Typically, the Fargo soil has a surface layer of black silty clay loam about 11 inches thick. The subsurface layer is dark olive gray silty clay about 5 inches thick. The upper part of the underlying material is light olive brown, mottled, calcareous silty clay. The lower part to a depth of about 60 inches is light brownish gray, mottled, calcareous silty clay loam. In some places the soil is calcareous at or near the surface. In other places it has no coarse fragments. In some areas the surface layer has less clay and more silt.

Typically, the Lindaas soil has a surface layer of black silty clay loam about 8 inches thick. The subsoil is very dark grayish brown and dark olive gray clay about 23 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous silty clay. In places the soil is not calcareous within a depth of 35 inches. In some areas it has a light colored subsurface layer. In other areas it is dark to a depth of less than 16 inches.

Included with these soils in mapping are small areas of Bearden and Doran soils. The somewhat poorly drained, silty Bearden soils are on the slightly higher rises. They have a calcareous surface layer. The somewhat poorly drained Doran soils are on the slightly higher, low-gradient slopes. They have less clay in the underlying material than the Fargo and Lindaas soils. Included soils make up about 15 percent of the map unit.

Permeability is slow in the Fargo soil. Available water capacity is high. Surface runoff is very slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is within a depth of 3 feet.

Permeability is slow in the Lindaas soil. Available water capacity is high. Surface runoff is very slow or ponded. Organic matter content is high. Natural fertility also is high. The seasonal high water table is 1 foot above to 2 feet below the surface.

Most areas are cropped. These soils are well suited to cropland and pasture. The best suited hay and pasture plants are birdsfoot trefoil, ladino clover, reed canarygrass, and creeping foxtail. Wetness is the principal limitation in cropped areas. Surface drains are needed. Soil blowing is an additional management concern. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops. Ponding is an additional hazard on the Lindaas soil. It usually delays tillage. Even if the soil is drained, crop damage or loss occurs in some areas during periods when precipitation is above normal. Replanting drowned out areas is not always feasible.

These soils are fairly well suited to windbreaks. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of wetness. Seedling mortality is moderate because of the wetness.

The land capability classification is IIw.

1949—Gardena loam. This nearly level soil is moderately well drained. It is on low-gradient slopes on lake plains. Individual areas are irregular in shape and range from 5 to 65 acres in size.

Typically, the surface layer is very dark gray loam about 9 inches thick. The subsurface layer also is very dark gray loam. It is about 8 inches thick. The subsoil is dark grayish brown very fine sandy loam about 13 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous very fine sandy loam. In some places the dark surface soil is less than 16 inches thick. In other places the content of fine sand or coarser sand is higher in the upper part of the profile. In some areas the underlying material has more sand or more clay.

Included with this soil in mapping are small areas of the somewhat poorly drained and moderately well drained Glyndon soils on the slightly higher rises. These soils have a calcareous surface layer. They make up about 10 percent of the map unit.

Permeability is moderate in the Gardena soil. Available water capacity is very high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is at a depth of 4 to 6 feet.

Most areas are cropped. This soil is well suited to cropland and pasture. The best suited hay and pasture plants are alfalfa, smooth bromegrass, and orchardgrass. No major limitations or hazards affect cropping. Soil blowing however, is a management concern. It can be controlled by leaving protective amounts of crop residue on the surface, planting field windbreaks, and seeding cover crops.

This soil is well suited to windbreaks. A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings.

The land capability classification is I.

1950—Ludden silty clay loam. This level soil is poorly drained. It is in broad areas on flood plains. It is frequently flooded. Individual areas are elongated and range from 3 to 1,250 acres in size.

Typically, the surface layer is black, calcareous silty clay loam about 10 inches thick. The subsurface layer is very dark gray, calcareous silty clay about 23 inches thick. The underlying material to a depth of about 60 inches is dark gray, calcareous silty clay loam. Some areas in abandoned stream channels are flooded more often and are wetter. In places the surface soil is not calcareous. In some areas the dark surface soil is less than 24 inches thick. In other areas the soil has less clay throughout.

Included with this soil in mapping are small areas of the somewhat poorly drained, silty Bearden soils on the slightly higher rises. These soils make up about 10 percent of the map unit.

Permeability is slow in the Ludden soil. Available water capacity is high. Surface runoff is slow. Organic matter content is high. Natural fertility also is high. The seasonal high water table is within a depth of 2 feet.

Most areas are cropped. This soil is fairly suited to cropland and pasture. The best suited hay and pasture plants are birdsfoot trefoil, ladino clover, reed canarygrass, and creeping foxtail. Wetness is the principal limitation in cropped areas. Flooding, excess calcium carbonates, and soil blowing are additional management concerns. Surface drains are needed. The soil is seasonally flooded by meltwater during spring runoff. Also, flooding after periods of heavy rainfall damages crops in places. The calcium carbonate can cause moisture stress. Measures that maintain carefully balanced fertility levels and the selection of crops and crop varieties that are tolerant of calcium carbonates minimize this problem. Leaving protective amounts of crop residue on the surface helps to prevent excessive soil loss. Soil blowing also can be controlled by planting field windbreaks and seeding cover crops.

This soil is fairly well suited to windbreaks. The trees and shrubs grown as windbreaks and environmental plantings should be those that are tolerant of wetness. Seedling mortality is moderate because of the wetness. Spring planting may be delayed.

The land capability classification is IIIw.

Prime Farmland

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

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

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

About 310,000 acres in the survey area, or more than 85 percent of the total acreage, meets the soil requirements for prime farmland. This land is throughout the county. The crops grown on this land, mainly wheat, corn, and soybeans, account for most of the county's total agricultural income each year.

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

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

Use and Management of the Soils

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

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

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

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

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

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

Crops and Pasture

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

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

In 1982, Traverse County had approximately 323,500 acres of cropland and 16,500 acres of pasture. In 1981, about 138,000 acres was used for corn, soybeans, and other row crops, including dry beans, sunflowers, and sugar beets; 167,200 acres was used for small grain, including wheat, barley, oats, and rye; and 10,400 acres was used for hay and pasture *(9)*.

The paragraphs that follow describe the main management needs on the cropland and pasture in the county. These needs are measures that control soil blowing and water erosion, reduce wetness, maintain fertility and tilth, and help to overcome salinity.

Soil blowing and water erosion reduce soil productivity by removing nutrients and organic matter from the surface layer. As the thickness of the topsoil is reduced through erosion, part of the less fertile subsoil is incorporated into the plow layer. Erosion can be especially damaging to soils having a surface layer of sandy loam and a low or moderate available water capacity. Examples are Clontarf and Lohnes soils. Conservation practices that help to control runoff and erosion also increase the rate of water infiltration and the amount of moisture available to crops.

Soil blowing and water erosion result in sedimentation of ditches, streams, and lakes. The sediments carry nutrients and pesticides. Those deposited in ditches interfere with drainage systems. Removing these sediments is costly. Measures that control erosion and minimize the pollution of streams and lakes improve the quality of water for commercial use, for recreation, and for fish and wildlife.

Soil blowing is a hazard on about three-fourths of the cropland in Traverse County. The susceptible areas consist of nearly level soils in closely spaced, shallow depressions and on low rises. Factors that influence the susceptibility to soil blowing are texture of the surface layer, free calcium carbonates at the surface, surface roughness, field size, and vegetative cover.

The soils in Traverse County that are most susceptible to soil blowing include Bearden, Clontarf, Glyndon, Hamerly, Lohnes, Roliss, and Vallers soils. These soils either have a surface layer of sandy loam or have free calcium carbonates at the surface. The carbonates reduce the stability of soil aggregates and thus increase the hazard of soil blowing. Management methods can have little effect on soil texture or the content of free calcium carbonates. Thus, farmers should consider the factors of roughness, field size, and vegetative cover when designing methods of controlling soil blowing.

Surface roughness can be increased by certain kinds of tillage. Fields that are plowed by moldboards in the fall are rough and cloddy until these conditions are destroyed by freezing or thawing. Using a chisel plow instead of a moldboard plow creates a more stable, better defined pattern of ridges and valleys and mixes crop residue with the soil or leaves it on the surface. Properly managing surface roughness on ridges that are established perpendicular to the wind can reduce soil blowing by as much as 50 percent.

Wide, open fields allow soil blowing to reach maximum levels. Establishing stable vegetative borders around the fields reduces the field size. Also, field windbreaks or other vegetative barriers and wind stripcropping can reduce field width and thus help to control soil blowing.

Managing residue from the previous crop is one of the most cost-effective methods of controlling soil blowing. Tillage practices that leave all or part of the crop residue on the surface are very effective during periods when the soil is highly susceptible to soil blowing. Using chisel plows, disks, or field cultivators to perform primary tillage incorporates some of the residue into the soil and leaves the surface rough. This practice allows some exposed soil to warm up and dry out in the spring and thus permits timely secondary tillage and planting.

Conservation tillage systems leave at least 30 percent of the surface covered with crop residue after planting. These systems not only help to control soil blowing but also save time, reduce fuel consumption and equipment costs, conserve moisture, and improve wildlife habitat. Forms of conservation tillage include mulch-till, strip-till, ridge-till, and no-till. Soil texture, drainage class, slope, and type of crop to be grown should be considered when a conservation tillage system is selected. Tillage practices that leave small amounts of crop residue on the surface and ridge-till planting in row cropped areas are effective on somewhat poorly drained soils and on wetter soils. In contrast, tillage systems that leave large amounts of crop residue on the surface, including strip-till and no-till, are effective on moderately well drained to excessively drained soils.

The Soil Conservation Service, the Minnesota Cooperative Extension Service, and the Traverse County Soil and Water Conservation District can provide assistance in designing methods of controlling soil blowing.

Water erosion is a problem on approximately one-third of the cropland in Traverse County. It is a hazard on the gently sloping or steeper areas of Bearden, Buse, Darnen, Formdale, and Peever soils. It is a very severe hazard on the steeper Buse soils. Contour farming, terraces, diversions, and crop rotations that include grasses and legumes are effective in controlling sheet and rill erosion. On much of the acreage in the southwestern part of the county, the application of these measures is difficult because of short, irregular slopes. In these areas conservation tillage systems help to control sheet and rill erosion and grassed waterways or water- and sediment-control basins help to control the erosion caused by a concentrated flow.

Even the nearly level soils on the Glacial Lake Agassiz lake plain are subject to the erosion caused by concentrated flow. This erosion occurs where field drainage systems enter county road ditches and drainage mains. Erosion-control structures and surface water inlets are needed in these areas.

Wetness is the major limitation on approximately one-fourth of the cropland in the county. It is a limitation in the poorly drained and very poorly drained Borup, Clearwater, Colvin, Fargo, Lamoure, Lindaas, Roliss, and Vallers soils and the very poorly drained Oldman, Parnell, Quam, and Rauville soils. These soils are naturally so wet that crop production is unlikely or impossible unless a drainage system is installed. Draining the ponded areas of Quam and Rauville soils commonly is difficult because outlets are not readily available.

Open field ditches are commonly used to drain excess surface water. The main ditches also can provide outlets for subsurface tile lines. The spacing of subsurface drainage lines depends on the soil type and the depth at which the drains can be installed.

Soil tilth refers to the physical condition of the soil. Soils with good tilth are granular and porous. Soils with poor tilth have large clods, which interfere with seedbed preparation, seed germination and emergence, the uptake of nutrients by plants, and the available water capacity. Cultivating moderately fine textured and fine textured soils an excessive number of times or when they are wet results in deterioration of tilth and compaction of the surface layer and subsurface layer. Soils that have a surface layer of clay or silty clay, such as Buse, Fargo, and Peever soils, can be easily damaged if they are worked when wet. Tilth can be improved by returning crop residue to the soil, applying livestock manure or other organic material, growing green manure crops, and minimizing the number of times that the field is tilled.

Natural fertility is high in most of the soils in the county. It is medium, however, in Buse, Clontarf, Egeland, and Lohnes soils. On most of the soils, crops respond well to applications of fertilizer. They respond less well on soils that are excessively wet, are droughty, or have a nutrient imbalance. This imbalance is characteristic of some soils that have an excessive content of calcium carbonates. The amount of fertilizer needed depends on the soil type, past and present management, the degree of erosion, and the crop to be planted. Soil tests can provide guidelines for the kind and amount of fertilizer to be applied.

Many soils in the county have free calcium carbonates in the surface layer. Examples are Bearden, Borup, Buse, Colvin, Glyndon, Hamerly, McIntosh, Roliss, and Vallers soils. Excess calcium carbonates in cool, wet soils can cause moisture stress because of an imbalance with other nutrients, such as iron, zinc, phosphorus, and potassium. This imbalance is less of a problem in warm, well drained soils, such as Buse. Other soils, such as Aazdahl, Croke, Fargo, Formdale, Parnell, and Peever, do not have free calcium carbonates in the surface layer.

Areas of the saline Fargo soil cannot be easily managed. If crops are grown on this soil, bare spots are common. These spots are surrounded by areas of stunted plants. Crops with a low tolerance to saline conditions, such as alfalfa, corn, flax, and soybeans, should not be grown. Crops with a moderate tolerance to saline conditions are oats, sunflowers, and wheat. Crops with a high tolerance are barley and sugar beets. Sugar beets, however, are quite sensitive during the germination stage and require special treatment to ensure sprouting.

In addition to the saline Fargo soil, scattered small areas of other saline soils are throughout the county. These areas were generally too small to be shown on the detailed soil maps. Typically, they are adjacent to drainage or road ditches and have a white crust at the surface during dry periods. Plants do not grow in these areas or are stunted.

Although droughtiness is a limitation in many areas, the county had no irrigation systems as of 1986. Most of the soils are too fine textured for irrigation. Also, obtaining sufficient quantities of suitable irrigation water is difficult in many areas. Some irrigation test wells indicate high levels of soluble salts, which could make the soil saline if the water were applied as irrigation water. Irrigating coarse textured soils best suited to irrigation, such as Clontarf and Lohnes soils, commonly is not practical because the areas of these soils are too small.

Permanent pastures generally are established on soils that are too wet, too steep, or too droughty for use as cropland. Existing pastures can be improved by pasture rotation, applications of fertilizer, weed control, and deferred grazing during periods before the grasses reach the proper height and during wet periods. In some areas pastures could be renovated by reseeding the more productive species. Species selection should be based on the soil type, drainage conditions, and planned grazing period.

Well drained to somewhat poorly drained soils, such as Aazdahl, Formdale, and Hamerly soils, are suited to the widest range of forage species. These include alfalfa, crownvetch, smooth bromegrass, timothy, and reed canarygrass. Also, warm-season grasses, such as big bluestem and switchgrass, grow well on these soils during the summer. These cool- and warm-season species also grow well on somewhat poorly drained and poorly drained soils, such as Bearden, Doran, and Lindaas soils.

Poorly drained and very poorly drained soils, such as Borup, Ludden, and Quam, are suited only to those species that can withstand wet conditions. These species include reed canarygrass, creeping foxtail, redtop, birdsfoot trefoil, alsike clover, and ladino clover. If drained, these soils also are suitable for timothy, smooth bromegrass, Kentucky bluegrass, and red clover.

Moderately well drained and well drained soils, such as Clontarf, Egeland, and Lohnes soils, usually produce forage in the spring and early summer and again in the fall, when the amount of precipitation is adequate. During the summer droughty conditions limit production. Alfalfa, birdsfoot trefoil, smooth bromegrass, timothy, Kentucky bluegrass, and intermediate wheatgrass grow well when an adequate supply of moisture is available. Warm-season grasses, such as big bluestem, little bluestem, switchgrass, and sideoats grama, also grow well on these soils. If the pasture is properly managed, these species provide good forage during the summer. A combination of warm- and cool-season species can provide a full season of forage.

Current information on species adaptation and variety selection can be obtained from local offices of the Soil Conservation Service and the Minnesota Cooperative Extension 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 6 *(3)*. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

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

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

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

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

Land Capability Classification

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

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

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

Class I soils have few limitations that restrict their use.

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

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

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

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

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

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

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

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

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

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

Woodland

Approximately 2,600 acres in Traverse County is native woodland. Most of the woodland is on the valley slopes or breaks above Lake Traverse. The other wooded tracts are mainly along rivers and streams and along marshy areas of Mud Lake and Traverse Lake. Bur oak, green ash, basswood, elm, and boxelder are common in the sloping areas of Buse, Darnen, and Formdale soils above Lake Traverse. Cottonwood, willow, and boxelder are common on Bearden, Colvin, and Lamoure soils along streams and marshes.

The early settlers used trees as a source of building material, fenceposts, and fuel. Trees and shrubs currently are valued because they enhance wildlife habitat and recreational areas and protect watersheds and livestock.

Windbreaks and Environmental Plantings

Windbreaks have been planted since the days of the early settlers to protect farmsteads and livestock. In the 1930's, they were planted to control soil blowing. In recent years field windbreaks have been planted to trap snow and thus increase the moisture supply. The maximum growth and survival rates for trees and shrubs can be obtained if weeds are controlled by cultivation or by applications of herbicide.

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

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

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

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

Recreation

The major public recreational areas in Traverse County are parks, lakes and streams, and state and federal hunting areas. The county park along Lake Traverse is the largest park in the county. It is about 16 acres in size. It provides facilities for primitive camping, picnic tables, a shelter house, grills, and boat launches. The U.S. Army Corps of Engineers maintains two small parks, one at the Lake Traverse outlet and the other at the Mud Lake outlet. These parks have sanitary facilities, picnic tables, grills, and playground equipment.

Hunting and fishing are the primary recreational activities in the county. A total of 2,984 acres is managed by the Minnesota Department of Natural Resources or the U.S. Fish and Wildlife Service for public hunting. Mud Lake is a popular hunting area during the waterfowl migration in the fall. Lake Traverse and the Mustinka River are the primary fishing areas in the county.

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

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

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

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

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry.

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

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

Wildlife Habitat

The soils in Traverse County can provide good habitat for various wildlife species. Changes in land use patterns have reduced the population of most wildlife species. More intensive farming and artificial drainage of wetlands have greatly reduced the number of ducks, geese, and pheasants. The wooded valley along Lake Traverse has a good deer population, and some deer are in other areas throughout the county. Abandoned gravel pits and abandoned farmsteads commonly are frequented by deer herds.

Walleye, northern pike, largemouth bass, crappie, sunfish, perch, white bass, and bullheads are the principal fish sought by anglers. Shore fishing is popular at the dam between Lake Traverse and Mud Lake and at the bridges on the Mustinka River, southwest of Wheaton. Lake Traverse is a large, shallow, fertile lake with fast-growing fish. Walleyes weighing more than 10 pounds have been caught in Lake Traverse. In 1985, a northern pike weighing more than 27 pounds was caught in the lake. During winter rough fish are harvested by commercial fisherman on the lake.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Engineering

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

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

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

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

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

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

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

Building Site Development

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

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

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

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

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

Sanitary Facilities

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

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

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

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

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

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

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

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

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

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

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

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

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

Construction Materials

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Water Management

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

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

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

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

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

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

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

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

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

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

Soil Properties

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

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

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

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

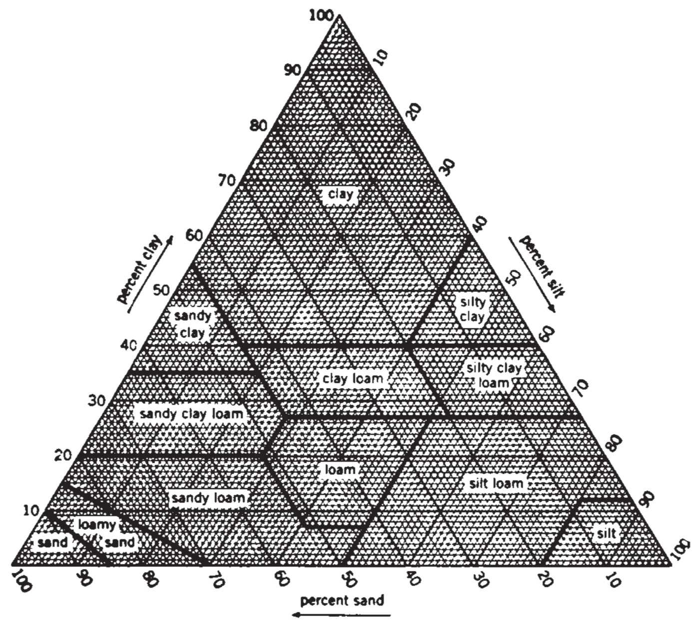


Figure 13.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

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

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

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 13). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

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

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

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

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

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

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

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

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

Physical and Chemical Properties

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

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

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

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

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

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

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

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

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

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

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

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

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

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

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

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

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous, loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

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

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

8. Stony or gravelly soils and other soils not subject to soil blowing.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 15, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

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

Soil and Water Features

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

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

The four hydrologic soil groups are:

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

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

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

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

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

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

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

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

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

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

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

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

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

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

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

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Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(8)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 17 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

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

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

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

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

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

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

Soil Series and Their Morphology

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

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual (7)*. Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (8)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Aazdahl Series

The Aazdahl series consists of moderately well drained soils that are moderately slowly permeable. These soils formed in loamy glacial till on uplands and till plains. Slopes are 0 to 2 percent.

Typical pedon of Aazdahl clay loam, 200 feet north and 1,500 feet west of the southeast corner of sec. 4, T. 126 N., R. 47 W.

Ap—0 to 10 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate medium granular structure; friable; common very fine roots; about 2 percent coarse fragments 2 to 20 millimeters in size; neutral; abrupt smooth boundary.

Bw—10 to 18 inches; brown (10YR 4/3) clay loam; few fine faint dark grayish brown (10YR 4/2) mottles; moderate medium subangular blocky structure; friable; common very fine roots; about 2 percent coarse fragments 2 to 20 millimeters in size; neutral; clear wavy boundary.

Bk—18 to 30 inches; light olive brown (2.5Y 5/4) clay loam; few medium faint grayish brown (2.5Y 5/2) mottles; weak fine subangular blocky structure; friable; few very fine roots; about 3 percent coarse fragments 2 to 20 millimeters in size; common very fine accumulations of calcium carbonate; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—30 to 40 inches; light olive brown (2.5Y 5/4) clay loam; common medium distinct gray (10YR 6/1) and few fine prominent yellowish red (5YR 5/6) mottles; massive; firm; few very fine roots; about 4 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; mildly alkaline; gradual wavy boundary.

C2—40 to 60 inches; light olive brown (2.5Y 5/4) clay loam; many medium distinct gray (10YR 6/1) and few fine prominent yellowish red (5YR 5/6) mottles; massive; firm; about 4 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; mildly alkaline.

The depth to free calcium carbonates ranges from 14 to 27 inches. The thickness of the mollic epipedon ranges from 10 to 16 inches. The content of coarse fragments ranges from 2 to 7 percent throughout the profile.

The A horizon has value of 2 or 3 (3 or 4 dry). It is typically clay loam, but silty clay loam and loam are within the range. The B horizon has hue of 2.5Y or 10YR and value of 3 or 4. It is clay loam or silty clay loam. The Bk horizon has value of 5 or 6 and chroma of 2 to 4. It is typically clay loam or silty clay loam, but silt loam and loam are within the range. The calcium carbonate equivalent ranges from 15 to 30 percent in this horizon. The C horizon has value of 5 or 6 and chroma of 2 to 6. It is typically clay loam or silty clay loam, but silt loam and loam are within the range.

Bearden Series

The Bearden series consists of somewhat poorly drained soils that are moderately slowly permeable. These soils formed in calcareous, silty lacustrine sediments on lake plains. Slopes range from 0 to 6 percent.

Typical pedon of Bearden silt loam, 0 to 2 percent slopes, 1,550 feet north and 100 feet east of the southwest corner of sec. 1, T. 125 N., R. 45 W.

Ap—0 to 11 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak very fine granular structure; friable; many very fine roots; strong effervescence; moderately alkaline; abrupt smooth boundary.

Bk1—11 to 22 inches; dark grayish brown (10YR 4/2) silt loam; weak medium subangular blocky structure; friable; few very fine roots; calcium carbonates disseminated throughout; violent effervescence; moderately alkaline; gradual smooth boundary.

Bk2—22 to 29 inches; grayish brown (2.5Y 5/2) silt loam; few fine prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; calcium carbonates disseminated throughout; violent effervescence; moderately alkaline; clear smooth boundary.

C1—29 to 45 inches; light olive brown (2.5Y 5/4) silt loam; few fine distinct light brownish gray (2.5Y 6/2) and few fine prominent yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; slight effervescence; moderately alkaline; gradual smooth boundary.

C2—45 to 60 inches; light olive brown (2.5Y 5/4) silt loam; common fine and medium distinct light brownish gray (2.5Y 6/2) and common fine and medium prominent yellowish brown (10YR 5/6) mottles; weak medium platy structure; very friable; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 20 inches. The Ap or A horizon has hue of 10YR, 2.5Y, or N, value of 2 or 3 (3 to 5 dry), and chroma of less than 2. It is typically silt loam or silty clay loam, but loam and clay loam are within the range. Some pedons have an ABk horizon. The Bk and C horizons are silt loam or silty clay loam. The Bk horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 5, and chroma of 1 to 4. The content of calcium carbonates in this horizon is 15 to more than 30 percent. The C horizon has value of 4 to 6 and chroma of 2 to 4.

Borup Series

The Borup series consists of poorly drained soils that are moderately rapidly permeable. These soils formed in calcareous, loamy lacustrine sediments on lake plains. Slopes are 0 to 2 percent.

Typical pedon of Borup loam, 2,400 feet west and 200 feet south of the northeast corner of sec. 1, T. 129 N., R. 45 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; common very fine roots; slight effervescence; moderately alkaline; abrupt smooth boundary.

Bkg1—10 to 19 inches; dark gray (5Y 4/1) loam; few fine prominent dark yellowish brown (10YR 4/6) mottles; weak medium subangular blocky structure; very friable; few very fine roots; calcium carbonates disseminated throughout; violent effervescence; moderately alkaline; clear smooth boundary.

Bkg2—19 to 25 inches; light olive gray (5Y 6/2) very fine sandy loam; few fine prominent dark yellowish brown (10YR 4/6) mottles; weak medium subangular blocky structure; very friable; few very fine roots; calcium carbonates disseminated throughout; violent effervescence; moderately alkaline; clear smooth boundary.

Cg1—25 to 38 inches; light olive gray (5Y 6/2) loamy very fine sand; common fine prominent dark yellowish brown (10YR 4/6) mottles; massive; very friable; few very fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

Cg2—38 to 60 inches; light olive gray (5Y 6/2) very fine sand; many medium prominent yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) mottles; massive; very friable; slight effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 20 inches. The upper boundary of the calcic horizon is within a depth of 16 inches.

The A horizon has hue of 10YR, 2.5Y, 5Y, or N, value of 2 or 3, and chroma of 1 or less. It is typically loam, but very fine sandy loam, silt loam, silty clay loam, and sandy clay loam are within the range. The Bkg horizon has hue of 2.5Y or 5Y. It is loam, loamy very fine sand, very fine sandy loam, or silt loam. The Cg horizon has colors similar to those of the Bkg horizon, but it typically has few to many, distinct or prominent mottles. It is loamy very fine sand or very fine sand. Some pedons have a 2C horizon.

Buse Series

The Buse series consists of well drained soils that are moderately slowly permeable. These soils formed in calcareous, loamy glacial till on uplands. Slopes range from 2 to 35 percent.

The Buse soils in Traverse County have a browner surface layer than is defined as the range for the series. This difference, however, does not alter the usefulness or behavior of the soils.

Typical pedon of Buse clay loam, in an area of Buse-Formdale clay loams, 6 to 14 percent slopes, eroded; 2,460 feet north and 790 feet east of the southwest corner of sec. 15, T. 125 N., R. 49 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; few fine roots; about 2 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; mildly alkaline; clear wavy boundary.

Bk—9 to 25 inches; light olive brown (2.5Y 5/4) clay loam; weak fine subangular blocky structure; friable; few coarse fragments 2 to 20 millimeters in size; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—25 to 46 inches; light olive brown (2.5Y 5/4) clay loam; weak fine subangular blocky structure; friable; about 2 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—46 to 60 inches; light olive brown (2.5Y 5/4) loam; few medium prominent dark gray (2.5Y 4/0) and few fine prominent yellowish red (5YR 5/8) relict mottles; weak fine subangular blocky structure; friable; few very fine roots; about 2 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; moderately alkaline.

The texture is clay loam or loam throughout the profile. The content of coarse fragments typically ranges from 2 to 10 percent.

The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2. The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 4. Some pedons do not have a Bk horizon. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6, and chroma of 2 to 5. The calcium carbonate equivalent ranges from 15 to 35 percent in this horizon.

Clearwater Series

The Clearwater series consists of poorly drained soils that are slowly permeable. These soils formed in clayey glacial till or lacustrine sediments on lake plains. Slopes are 0 to 2 percent.

Typical pedon of Clearwater silty clay loam, 1,950 feet west and 2,600 feet south of the northeast corner of sec. 2, T. 128 N., R. 45 W.

Ap—0 to 7 inches; black (2.5Y 2/0) silty clay loam, very dark gray (2.5Y 3/0) dry; weak very fine angular blocky structure; friable, sticky; common very fine roots; neutral; abrupt smooth boundary.

Bg1—7 to 17 inches; very dark gray (5Y 3/1) silty clay, dark gray (5Y 4/1) dry; moderate medium prismatic structure parting to moderate fine angular blocky; firm, sticky; common very fine roots; about 2 percent coarse fragments 2 to 20 millimeters in size; slight effervescence; mildly alkaline; clear smooth boundary.

Bg2—17 to 36 inches; olive gray (5Y 4/2) silty clay; few fine prominent dark yellowish brown (10YR 4/6) mottles; moderate fine angular blocky structure; firm, sticky; few very fine roots; about 2 percent coarse fragments 2 to 20 millimeters in size; slight effervescence; mildly alkaline; clear smooth boundary.

Bg3—36 to 50 inches; olive gray (5Y 5/2) silty clay; few fine prominent dark yellowish brown (10YR 4/6) and light brownish gray (10YR 6/2) mottles; moderate medium subangular blocky structure; firm; about 2 percent coarse fragments 2 to 20 millimeters in size; slight effervescence; mildly alkaline; clear smooth boundary.

Cg3—50 to 60 inches; light olive gray (5Y 6/2) silty clay loam; common fine prominent dark yellowish brown (10YR 4/6) and common fine distinct gray (2.5Y 5/1) mottles; massive; firm, sticky; about 3 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 12 to 24 inches. Typically, the content of coarse fragments in the solum ranges from 2 to 8 percent. In the control section, the content of clay ranges from 35 to 60 percent and the content of fine sand or coarser sand is less than 20 percent.

The A horizon has hue of 2.5Y or N, value of 2 or 3, and chroma of 2 or less. Typically, it is silty clay loam, but clay, silty clay, clay loam, and loam are within the range.

The Bg horizon has hue of 2.5Y or 5Y, value of 3 or 4, and chroma of 1 or 2. Typically, it is silty clay or clay, but silty clay loam is within the range.

The Cg horizon has hue of 2.5Y or 5Y and chroma of 1 or 2. It has few to many, distinct or prominent mottles. It is silty clay, clay, or silty clay loam.

Clontarf Series

The Clontarf series consists of moderately well drained soils that are rapidly permeable. These soils formed in loamy lacustrine sediments over sandy lacustrine sediments. They are on lake plains and outwash plains. Slopes range from 0 to 3 percent.

Typical pedon of Clontarf sandy loam, 100 feet south and 2,600 feet east of the northwest corner of sec. 11, T. 128 N., R. 47 W.

Ap—0 to 8 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; neutral; abrupt smooth boundary.

A1—8 to 15 inches; very dark brown (10YR 2/2) sandy loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; very friable; neutral; clear smooth boundary.

A2—15 to 20 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; very friable; neutral; clear smooth boundary.

Bw—20 to 29 inches; dark brown (10YR 3/3) sandy loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure parting to weak fine subangular blocky; very friable; neutral; clear smooth boundary.

2C1—29 to 45 inches; light olive brown (2.5Y 5/4) sand; few fine distinct yellowish brown (10YR 5/6) and few fine faint grayish brown (2.5Y 5/2) mottles; single grain; loose; neutral; clear smooth boundary.

2C2—45 to 60 inches; light brownish gray (2.5Y 6/2) loamy fine sand; common fine and medium prominent yellowish brown (10YR 5/6) mottles; massive; very friable; neutral.

The thickness of the solum ranges from 20 to 36 inches. The depth to free calcium carbonates ranges from 40 to more than 60 inches. The thickness of the mollic epipedon ranges from 16 to 34 inches.

The A horizon has value of 2 or 3. It is typically sandy loam, but fine sandy loam and loam are within in the range. The B horizon has hue of 2.5Y or 10YR, value of 3 or 4, and chroma of 2 or 3. It is sandy loam, fine sandy loam, or loam. The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 6. It is sand, loamy fine sand, fine sand, or loamy sand.

Colvin Series

The Colvin series consists of poorly drained soils that are moderately slowly permeable. These soils formed in calcareous, silty lacustrine sediments on lake plains. Slopes are 0 to 1 percent.

Typical pedon of Colvin silty clay loam, 500 feet west and 1,250 feet north of the southeast corner of sec. 21, T. 126 N., R. 48 W.

Ap—0 to 10 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; common very fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

Ak—10 to 18 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; common very fine roots; few fine pores; calcium carbonates disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary.

Bkg—18 to 26 inches; dark gray (5Y 4/1) silty clay loam; massive; friable; few fine roots; few fine pores; many very fine white (10YR 8/1) accumulations of calcium carbonate; violent effervescence; moderately alkaline; clear wavy boundary.

Cg—26 to 46 inches; dark gray (5Y 4/1) silty clay loam; few fine distinct olive brown (2.5Y 4/4) mottles; massive; friable; few very fine roots; common medium white (10YR 8/1) accumulations of calcium carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

2C—46 to 60 inches; light yellowish brown (2.5Y 6/4) loam; massive; friable; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 24 inches. The upper boundary of the calcic horizon is within a depth of 16 inches.

The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 or 3 (3 or 4 dry), and chroma of 1 or less. It is typically silty clay loam, but silt loam is within the range. Some pedons do not have an Ak horizon. The Bkg horizon has a calcium carbonate equivalent of 20 to 40 percent. It has hue of 2.5Y, 5Y, or N, value of 3 to 6, and chroma of 0 to 2. The C horizon has hue of 2.5Y or 5Y, value of 3 to 6, and chroma of 1 to 3. The 2C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 2 to 4. It is loam, clay loam, or very fine sand. Some pedons do not have a 2C horizon.

Croke Series

The Croke series consists of moderately well drained soils that are moderately rapidly permeable in the upper part and slowly permeable in the underlying material. These soils formed in loamy lacustrine sediments over clayey lacustrine sediments. They are on lake plains. Slopes are 0 to 2 percent.

Typical pedon of Croke loam, 200 feet south and 250 feet east of the northwest corner of sec. 22, T. 126 N., R. 45 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very friable; common very fine roots; neutral; abrupt smooth boundary.

Bw—9 to 19 inches; dark grayish brown (2.5Y 4/2) very fine sandy loam; weak medium subangular blocky structure; very friable; common very fine roots; common medium black (10YR 2/1) concentrations of manganese oxide; neutral; clear smooth boundary.

C—19 to 25 inches; light olive brown (2.5Y 5/4) very fine sandy loam; weak medium subangular blocky structure; very friable; common very fine roots; common fine prominent black (10YR 2/1) concentrations of manganese oxide; neutral; abrupt smooth boundary.

2C1—25 to 38 inches; olive gray (5Y 5/2) silty clay; few fine prominent yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; strong effervescence; moderately alkaline; gradual smooth boundary.

2C2—38 to 60 inches; gray (5Y 5/1) silty clay; common fine and medium prominent yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure parting to moderate very fine angular blocky; firm; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 12 to 24 inches. The depth to free calcium carbonates ranges from 14 to 30 inches. The thickness of the loamy lacustrine sediments ranges from 20 to 40 inches. The mollic epipedon is 7 to 16 inches thick.

The A horizon has value of 2 or 3 (3 to 5 dry). It is typically loam, but silt loam and very fine sandy loam are within the range. The B and C horizons are very fine sandy loam, loam, silt loam, or loamy very fine sand. The B horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 to 4. The C horizon has hue of 5Y, 2.5Y, or 10YR, value of 4 to 6, and chroma of 2 to 4. The 2C horizon has hue of 2.5Y or 5Y and value of 4 to 6. It is silty clay, clay, or silty clay loam.

Darnen Series

The Darnen series consists of well drained soils that are moderately permeable. These soils formed in loamy colluvium on uplands. Slopes range from 1 to 6 percent.

Typical pedon of Darnen loam, 1 to 6 percent slopes, 1,060 feet west and 1,280 feet south of the northeast corner of sec. 6, T. 126 N., R. 47 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium granular structure; very friable; common very fine roots; neutral; abrupt smooth boundary.

A—10 to 24 inches; black (10YR 2/1) loam, dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to medium fine subangular blocky; very friable; common very fine roots; neutral; clear wavy boundary.

Bw—24 to 28 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; very friable; common very fine roots; neutral; clear wavy boundary.

BC—28 to 37 inches; brown (10YR 4/3) loam; weak medium subangular blocky structure; friable; few very fine roots; common fine accumulations of calcium carbonate; strong effervescence; mildly alkaline; gradual wavy boundary.

C—37 to 60 inches; olive brown (2.5Y 4/4) loam; massive; friable; common fine accumulations of calcium carbonate; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 30 to 50 inches. The mollic epipedon ranges from 20 to 48 inches in thickness. The depth to free calcium carbonates is 20 to 50 inches. The content of coarse fragments ranges from 0 to 5 percent. Generally, these fragments are in the lower part of the B horizon and in the C horizon.

The A horizon has value of 2 or 3 (2 to 4 dry) and chroma of 1 or 2. It is typically loam, but silt loam, sandy loam, and clay loam are within in the range. The B and C horizons are loam or clay loam. The B horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 4. The C horizon has value of 4 to 6 and chroma of 2 to 6.

Doran Series

The Doran series consists of somewhat poorly drained soils that are slowly permeable. These soils formed in loamy and clayey lacustrine and water-worked till sediments over loamy glacial till. They are on lake plains and till plains. Slopes range from 0 to 3 percent.

Typical pedon of Doran clay loam, 2,280 feet south and 300 feet east of the northwest corner of sec. 25, T. 127 N., R. 47 W.

Ap—0 to 10 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to moderate very fine subangular blocky; friable; neutral; abrupt smooth boundary.

Bt—10 to 16 inches; dark grayish brown (2.5Y 4/2) clay; moderate medium prismatic structure parting to strong fine subangular blocky; very firm; many moderately thick very dark gray (10YR 3/1) clay films on faces of peds; neutral; clear wavy boundary.

Bk—16 to 28 inches; light brownish gray (2.5Y 6/2) clay loam; common fine faint light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; calcium carbonates disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary.

C1—28 to 40 inches; olive (5Y 5/3) clay loam; common fine faint grayish brown (2.5Y 5/2) and common medium faint light olive brown (2.5Y 5/4) mottles; massive; friable; about 3 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—40 to 60 inches; light olive brown (2.5Y 5/4) clay loam; common medium distinct light brownish gray (2.5Y 6/2) mottles; massive; firm; about 3 percent coarse fragments; strong effervescence; mildly alkaline.

The depth to free calcium carbonates ranges from 12 to 24 inches. The thickness of the mollic epipedon ranges from 7 to 16 inches.

The A horizon has value of 2 or 3 (2 to 4 dry). It is typically clay loam or silty clay loam, but sandy clay loam and loam are within the range. The Bt horizon has hue of 10YR or 2.5Y, value of 2 to 4, and chroma of 1 to 3. It is clay, clay loam, or silty clay loam. The content of clay in this horizon ranges from 35 to 50 percent. The Bk horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 to 3. The calcium carbonate equivalent in this horizon ranges from 15 to 35 percent. The C horizon has value of 4 to 6 and chroma of 1 to 4.

Egeland Series

The Egeland series consists of well drained soils that formed in outwash and lacustrine sediments on beach ridges and terraces. Permeability is moderately rapid in the upper part of the profile and moderate in the lower part. Slopes range from 0 to 3 percent.

Typical pedon of Egeland loam, 200 feet west and 1,800 feet north of the southeast corner of sec. 10, T. 125 N., R. 46 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; common very fine roots; about 2 percent coarse fragments 2 to 20 millimeters in size; neutral; abrupt smooth boundary.

A—10 to 14 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; common very fine roots; about 2 percent coarse fragments 2 to 20 millimeters in size; neutral; clear wavy boundary.

Bw—14 to 19 inches; dark brown (10YR 4/3) sandy loam; weak medium subangular blocky structure; very friable; few very fine roots; common thin organic coatings on faces of peds; about 6 percent coarse fragments 2 to 20 millimeters in size; neutral; clear wavy boundary.

C1—19 to 28 inches; yellowish brown (10YR 5/4) loamy sand; loose; single grain; few fine roots; about 12 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; mildly alkaline; abrupt wavy boundary.

C2—28 to 31 inches; light brownish gray (2.5Y 6/2) very fine sandy loam; massive; friable; calcium carbonates disseminated throughout; about 8 percent coarse fragments 2 to 20 millimeters in size; violent effervescence; moderately alkaline; abrupt wavy boundary.

C3—31 to 41 inches; yellowish brown (10YR 5/4) sandy loam; massive; friable; about 4 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; moderately alkaline; clear wavy boundary.

2C4—41 to 60 inches; brown (10YR 5/3) loam; massive; friable; about 4 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; mildly alkaline.

The depth to free calcium carbonates ranges from 15 to 35 inches. The mollic epipedon ranges from 8 to 16 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1.5 or less. It is typically loam, but sandy loam and fine sandy loam are within the range.

The Bw horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 to 4. It is sandy loam or fine sandy loam.

The C horizon has value of 4 to 6. It typically is loamy sand or very fine sandy loam, but some pedons have layers of sandy loam.

Fargo Series

The Fargo series consists of poorly drained soils that are slowly permeable. These soils formed in clayey lacustrine sediments on lake plains. Slopes are 0 to 2 percent.

Typical pedon of Fargo silty clay, 300 feet south and 1,450 feet east of the northwest corner of sec. 17, T. 126 N., R. 46 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate fine and very fine granular structure; firm; neutral; abrupt smooth boundary.

BA—7 to 16 inches; very dark gray (10YR 3/1) silty clay, dark gray (10Y 4/1) dry; weak medium prismatic structure; firm; shiny surfaces on peds; neutral; clear wavy boundary.

Bg—16 to 23 inches; very dark grayish brown (2.5Y 3/2) silty clay, dark gray (5Y 4/1) dry; weak medium prismatic structure; firm; cracks filled with material from the A horizon extend into this horizon; slight effervescence in the lower part; mildly alkaline; clear wavy boundary.

Cg1—23 to 36 inches; gray (5Y 5/1) silty clay; few fine faint light olive gray (5Y 6/2) mottles; weak medium angular blocky structure; firm; few dark gray (5Y 4/1) patches throughout the upper part; strong effervescence; mildly alkaline; gradual wavy boundary.

Cg2—36 to 60 inches; olive gray (5Y 5/2) silty clay; few fine prominent yellowish brown (10YR 5/6) mottles; weak fine angular blocky structure; firm; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 16 to 36 inches. The depth to free calcium carbonates ranges from 11 to 25 inches. The mollic epipedon ranges from 8 to 24 inches in thickness. The clay content of the 10- to 40-inch control section ranges from 45 and 60 percent.

The A horizon has hue of 10YR, 2.5Y, 5Y, or N and value of 1 or 2 (3 or 4 dry). It is silty clay, silty clay loam, or clay. Cracks filled with material from the A horizon extend through the B horizon and into the C horizon. The Bg and Cg horizons are silty clay or clay. The Bg horizon has hue of 2.5Y or 5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 or 2. The Cg horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 to 3. Some pedons have a Bkg horizon.

Formdale Series

The Formdale series consists of well drained soils that are moderately slowly permeable. These soils formed in loamy glacial till on uplands. Slopes range from 1 to 14 percent.

Typical pedon of Formdale clay loam, 1 to 6 percent slopes, 1,150 feet south and 450 feet east of the northwest corner of sec. 36, T. 125 N., R. 48 W.

Ap—0 to 8 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; common very fine roots; about 1 percent coarse fragments 2 to 20 millimeters in size; neutral; abrupt smooth boundary.

Bw1—8 to 13 inches; dark brown (10YR 3/3) clay loam, brown (10YR 4/3) dry; moderate coarse subangular blocky structure parting to moderate fine subangular blocky; friable; common very fine roots; common black (10YR 2/1) organic coatings on faces of peds; about 1 percent coarse fragments 2 to 20 millimeters in size; neutral; clear wavy boundary.

Bw2—13 to 18 inches; brown (10YR 4/3) clay loam; moderate medium and fine subangular blocky structure; friable; common very fine roots; few dark brown (10YR 3/3) organic coatings on faces of peds; about 2 percent coarse fragments 2 to 20 millimeters in size; neutral; clear wavy boundary.

Bk—18 to 42 inches; light olive brown (2.5Y 5/4) clay loam; weak fine subangular blocky structure; friable; few very fine roots; calcium carbonates disseminated throughout; about 3 percent coarse fragments 2 to 20 millimeters in size; violent effervescence; moderately alkaline; clear wavy boundary.

C—42 to 60 inches; light olive brown (2.5Y 5/4) clay loam; few fine distinct light brownish gray (10YR 6/2) mottles; massive; firm; few fine prominent yellowish red (5YR 4/6) accumulations; about 5 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; moderately alkaline.

The depth to free calcium carbonates ranges from 8 to 20 inches. The thickness of the mollic epipedon ranges from 8 to 14 inches. The content of coarse fragments ranges from 1 to 8 percent throughout the profile.

The A horizon has value of 2 or 3. It has chroma of 1 in the upper part and 1 or 2 in the lower part. It is typically clay loam, but silty clay loam and loam are within the range.

The Bw horizon has value of 3 to 5 and chroma of 3 or 4. It is typically clay loam or loam. The calcium carbonate equivalent ranges from 20 to 30 percent in the Bk horizon. Some pedons do not have a Bk horizon.

The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 3 to 5. It is typically clay loam, but loam, silt loam, and silty clay loam are within the range.

Gardena Series

The Gardena series consists of moderately well drained soils that are moderately permeable. These soils formed in loamy lacustrine sediments on lake plains. Slopes are 0 to 2 percent.

Typical pedon of Gardena loam, 1,820 feet west and 100 feet south of the northeast corner of sec. 35, T. 127 N., R. 47 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure parting to moderate medium granular; very friable; common very fine roots; neutral; abrupt smooth boundary.

AB—9 to 17 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate coarse subangular blocky structure; very friable; common very fine roots; neutral; clear wavy boundary.

Bw—17 to 30 inches; dark grayish brown (2.5Y 4/2) very fine sandy loam; moderate coarse subangular blocky structure; friable; common very fine roots; neutral; clear wavy boundary.

C1—30 to 45 inches; light olive brown (2.5Y 5/4) very fine sandy loam; few fine faint grayish brown (2.5Y 5/2) mottles; weak medium subangular blocky structure; friable; few very fine roots; slight effervescence; mildly alkaline; clear wavy boundary.

C2—45 to 60 inches; light olive brown (2.5Y 5/4) very fine sandy loam; common fine prominent light gray (10YR 6/1) and few fine prominent yellowish brown (10YR 5/8) mottles; massive; friable; strong effervescence; moderately alkaline.

The depth to free calcium carbonates ranges from 14 to 35 inches. The mollic epipedon is 16 to 20 inches thick. It includes part of the B horizon in some pedons.

The A horizon has value of 2 or 3 (3 or 4 dry). It is typically loam, but silt loam and very fine sandy loam are within the range. The B and C horizons are very fine sandy loam, loam, or silt loam. The B horizon has hue of 10YR or 2.5Y, value of 2 to 4, and chroma of 1 to 3. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6, and chroma of 2 to 4.

Glyndon Series

The Glyndon series consists of somewhat poorly drained and moderately well drained soils that formed in calcareous lacustrine sediments on lake plains. Permeability is moderate or moderately rapid in the upper part of the profile and moderately rapid in the lower part. Slopes are 0 to 2 percent.

Typical pedon of Glyndon loam, 100 feet north and 75 feet west of the southeast corner of sec. 21, T. 126 N., R. 45 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very friable; common very fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

Bk1—10 to 15 inches; dark grayish brown (10YR 4/2) loam; weak medium subangular blocky structure; very friable; common very fine roots; calcium carbonates disseminated throughout; strong effervescence; moderately alkaline; clear smooth boundary.

Bk2—15 to 25 inches; grayish brown (2.5Y 5/2) very fine sandy loam; weak medium subangular blocky structure; very friable; few very fine roots; calcium carbonates disseminated throughout; violent effervescence; moderately alkaline; clear smooth boundary.

C1—25 to 34 inches; light olive brown (2.5Y 5/4) very fine sandy loam; few fine distinct dark yellowish brown (10YR 4/6) mottles; weak medium subangular blocky structure; very friable; strong effervescence; moderately alkaline; clear smooth boundary.

C2—34 to 60 inches; light brownish gray (2.5Y 6/2) loamy very fine sand; common fine prominent dark yellowish brown (10YR 4/6) mottles; massive; very friable; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The calcic horizon is within a depth of 16 inches. In the 10- to 40-inch control section, the content of noncarbonate clay is less than 18 percent and the content of fine sand or coarser sand averages less than 15 percent.

The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2, moist or dry. It is typically loam, but very fine sandy loam, silt loam, and silty clay loam are within the range.

The Bk horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6, and chroma of 2 or 3. It is loam, silt loam, loamy very fine sand, and very fine sandy loam.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6, and chroma of 2 to 4. It is very fine sandy loam, loamy very fine sand, or very fine sand.

Hamerly Series

The Hamerly series consists of somewhat poorly drained and moderately well drained soils that are moderately slowly permeable. These soils formed in calcareous, loamy glacial till on uplands, till plains, and lake plains. Slopes range from 0 to 3 percent.

Typical pedon of Hamerly clay loam, in an area of Hamerly-Lindaas clay loams, 530 feet north and 2,590 feet east of the southwest corner of sec. 8, T. 129 N., R. 46 W.

Ap—0 to 9 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; common very fine roots; about 2 percent coarse fragments 2 to 20 millimeters in size; slight effervescence; mildly alkaline; abrupt smooth boundary.

Bk1—9 to 17 inches; grayish brown (2.5Y 5/2) clay loam; common fine faint light olive brown (2.5Y 5/4) mottles; weak medium subangular blocky structure; friable; few very fine roots; calcium carbonates disseminated throughout; about 2 percent coarse fragments 2 to 20 millimeters in size; violent effervescence; moderately alkaline; clear wavy boundary.

Bk2—17 to 32 inches; light olive brown (2.5Y 5/4) clay loam; common medium distinct grayish brown (2.5Y 5/2) mottles; weak medium subangular blocky structure; friable; few very fine roots; calcium carbonates disseminated throughout; about 2 percent coarse fragments 2 to 20 millimeters in size; violent effervescence; moderately alkaline; clear wavy boundary.

C1—32 to 36 inches; light olive brown (2.5Y 5/4) clay loam; common medium distinct grayish brown (2.5Y 5/2) mottles; massive; firm; about 4 percent coarse fragments 2 to 20 millimeters in size; many gypsum nests; strong effervescence; moderately alkaline; clear wavy boundary.

C2—36 to 60 inches; light olive brown (2.5Y 5/4) clay loam; common medium distinct grayish brown (2.5Y 5/2) and prominent yellowish red (5YR 5/8) mottles; massive; firm; about 4 percent coarse fragments 2 to 20 millimeters in size; many gypsum nests; slight effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The upper boundary of the calcic horizon is within a depth of 16 inches.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. It is typically clay loam, but loam and silt loam are within the range. Some pedons have an Ak horizon. The Bk and C horizons are clay loam or loam. The Bk horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5, and chroma of 1 to 4. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6, and chroma of 2 to 4.

Kittson Series

The Kittson series consists of somewhat poorly drained and moderately well drained soils that are moderately permeable or moderately slowly permeable. These soils formed in a mantle of loamy lacustrine sediments and in the underlying loamy glacial till. They are on beach ridges and till plains. Slopes range from 0 to 3 percent.

Typical pedon of Kittson loam, 170 feet west and 1,550 feet south of the northeast corner of sec. 4, T. 128 N., R. 46 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium granular structure; friable; common very fine roots; about 1 percent coarse fragments 2 to 20 millimeters in size; neutral; abrupt smooth boundary.

Bw1—10 to 16 inches; brown (10YR 4/3) fine sandy loam; weak medium subangular blocky structure; friable; common very fine roots; about 3 percent coarse fragments 2 to 20 millimeters in size; neutral; clear wavy boundary.

2Bw2—16 to 24 inches; dark grayish brown (2.5Y 4/2) clay loam; weak medium subangular blocky structure; friable; few very fine roots; about 3 percent coarse fragments 2 to 20 millimeters in size; slight effervescence; mildly alkaline; clear wavy boundary.

2Bk—24 to 34 inches; grayish brown (2.5Y 5/2) clay loam; weak fine subangular blocky structure; friable; few very fine roots; calcium carbonates disseminated throughout; about 3 percent coarse fragments 2 to 20 millimeters in size; violent effervescence; moderately alkaline; clear wavy boundary.

2C—34 to 60 inches; light olive brown (2.5Y 5/4) clay loam; common medium distinct grayish brown (10YR 5/2) mottles; massive; firm; about 3 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; mildly alkaline.

The depth to free calcium carbonates ranges from 14 to 30 inches. The thickness of the mollic epipedon ranges from 9 to 16 inches. The thickness of the lacustrine mantle ranges from 0 to 30 inches. The content of coarse fragments in the glacial till ranges from 2 to 10 percent.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is typically loam, but fine sandy loam, very fine sandy loam, sandy loam, and sandy clay loam are within the range.

The B horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 or 3. It is fine sandy loam, sandy loam, very fine sandy loam, sandy clay loam, or loam.

The 2Bw2 horizon, has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 or 3. It is clay loam or loam. Some pedons do not have a 2Bw2 horizon.

The 2Bk horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. It is clay loam, loam, or sandy loam. Some pedons do not have a 2Bk horizon.

The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 4. It is clay loam or loam.

La Prairie Series

The La Prairie series consists of moderately well drained soils that are moderately permeable. These soils formed in silty alluvium on stream terraces. Slopes are 0 to 2 percent.

Typical pedon of La Prairie silt loam, 1,300 feet west and 300 feet south of the northeast corner of sec. 19, T. 127 N., R. 45 W.

Ap—0 to 6 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; strong fine subangular blocky structure; friable; many very fine roots; neutral; abrupt smooth boundary.

A2—6 to 11 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; many fine roots; neutral; clear wavy boundary.

A3—11 to 18 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure; friable; many fine roots; neutral; clear wavy boundary.

A4—18 to 30 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; many fine roots; strong effervescence; moderately alkaline; clear wavy boundary.

Bw—30 to 43 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; weak fine subangular blocky structure; common fine roots; strong effervescence; moderately alkaline; clear wavy boundary.

C—43 to 60 inches; dark grayish brown (10YR 4/2) silt loam; few fine distinct light olive brown (2.5Y 5/4) mottles; massive; strong effervescence; moderately alkaline.

The depth to free calcium carbonates ranges from 0 to 40 inches. The thickness of mollic epipedon ranges from 16 to more than 40 inches. The texture is silt loam, loam, or silty clay loam throughout the profile.

The A horizon has hue of 10YR or N, value of 2 or 3 (3 or 4 dry), and chroma of 1 or less. The B horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 or 4 dry), and chroma of 1 to 3, dry or moist. The Bk horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 1 to 3, dry or moist. Some pedons do not have a Bk horizon. Some have an Ab horizon. The C horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 1 to 3.

Lamoure Series

The Lamoure series consists of poorly drained soils that are moderately permeable or moderately slowly permeable. These soils formed in calcareous, silty alluvial sediments on flood plains. Slopes are 0 to 2 percent.

Typical pedon of Lamoure silty clay loam, 900 feet north and 650 feet east of the southwest corner of sec. 23, T. 126 N., R. 46 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; mildly alkaline; slight effervescence; abrupt smooth boundary.

A1—9 to 17 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium and fine subangular blocky structure; friable; mildly alkaline; slight effervescence; abrupt smooth boundary.

A2—17 to 24 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate very fine subangular blocky structure; friable; mildly alkaline; slight effervescence; clear wavy boundary.

Cg1—24 to 34 inches; olive gray (5Y 4/2) silty clay loam; few fine distinct light olive brown (2.5Y 5/4) mottles; massive; friable; moderately alkaline; strong effervescence; clear wavy boundary.

Cg2—34 to 49 inches; olive gray (5Y 4/2) silty clay loam; few medium distinct light olive brown (2.5Y 5/4) mottles; massive; common fine white (5Y 8/1) threads of calcium carbonates; firm; moderately alkaline; strong effervescence; clear wavy boundary.

Ab—49 to 55 inches; very dark gray (5Y 3/1) silty clay loam, dark gray (N 4/0) dry; strong fine angular blocky structure; friable; mildly alkaline; slight effervescence; clear smooth boundary.

C'g—55 to 60 inches; olive gray (5Y 5/2) silty clay loam; common medium distinct light olive brown (2.5Y 5/4) mottles; massive; friable; mildly alkaline; slight effervescence.

The thickness of the solum and of the mollic epipedon ranges from 24 to 42 inches. The depth to calcium carbonates ranges from 0 to 10 inches.

The A horizon has hue of 10YR, N, 2.5Y, or 5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1 or less. It is typically silty clay loam, but silt loam is within the range.

The Cg horizon has hue of N, 2.5Y, or 5Y, value of 3 to 5, and chroma of 2 or less. It is silty clay loam or silt loam.

Lindaas Series

The Lindaas series consists of poorly drained soils that are slowly permeable. These soils formed in silty and clayey lacustrine sediments or glacial till on lake plains, till plains, and uplands. Slopes are less than 1 percent.

Typical pedon of Lindaas clay loam, in an area of the Hamerly-Aazdahl-Lindaas complex; 1,070 feet south and 1,510 feet east of the northwest corner of sec. 15, T. 125 N., R. 47 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; common very fine roots; about 1 percent coarse fragments 2 to 20 millimeters in size; neutral; abrupt smooth boundary.

Btg1—9 to 19 inches; very dark gray (10Y 3/1) silty clay loam, dark gray (10YR 4/1) dry; few fine prominent yellowish brown (10YR 5/8) mottles; strong fine angular blocky structure; firm; common very fine roots; common faint very dark grayish brown (10YR 3/2) clay films on faces of peds; about 1 percent coarse fragments 2 to 20 millimeters in size; neutral; clear wavy boundary.

Btg2—19 to 28 inches; very dark gray (10Y 3/1) silty clay, dark gray (10YR 4/1) dry; few fine prominent yellowish brown (10YR 5/8) mottles; weak medium prismatic structure parting to strong medium angular blocky; firm; common very fine roots; common faint very dark grayish brown (10YR 3/2) clay films on faces of peds; about 2 percent coarse fragments 2 to 20 millimeters in size; neutral; gradual wavy boundary.

Bk—28 to 36 inches; light brownish gray (2.5 6/2) silty clay loam; few fine prominent yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; common very fine root pores; about 1 percent coarse fragments 2 to 20 millimeters in size; violent effervescence; moderately alkaline; gradual wavy boundary.

Cg1—36 to 46 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine prominent yellowish brown (10YR 5/6) mottles; massive; friable; many very fine roots; about 1 percent coarse fragments 2 to 20 millimeters in size; violent effervescence; moderately alkaline; gradual smooth boundary.

Cg2—46 to 60 inches; light brownish gray (2.5Y 6/2) clay loam; many medium prominent brownish yellow (10YR 6/6) and few medium prominent brown (7.5Y 4/4) mottles; massive; friable; common very fine root pores; about 1 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 24 to 40 inches. The depth to calcium carbonates ranges from 18 to 35 inches. The mollic epipedon ranges from 16 to 30 inches in thickness.

The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 or less. It is typically clay loam or silty clay loam, but silt loam is within the range. The Btg horizon has hue of 10YR or 2.5Y and chroma of 1 or 2. It is clay or silty clay. Some pedons have a Bkg horizon. The Cg horizon has hue of 2.5Y or 5Y, value of 5 to 7, and chroma of 1 to 4. It is clay loam, silty clay loam, or silt loam.

Lohnes Series

The Lohnes series consists of well drained soils that are rapidly permeable. These soils formed in loamy and sandy lacustrine sediments on old beach ridges. Slopes range from 1 to 6 percent.

Typical pedon of Lohnes sandy loam, 1 to 6 percent slopes, 260 feet west and 1,600 feet north of the southeast corner of sec. 21, T. 127 N., R. 47 W.

Ap—0 to 9 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; moderate medium granular structure; very friable; few fine roots; about 6 percent coarse fragments 2 to 20 millimeters in size; neutral; abrupt smooth boundary.

A—9 to 14 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak medium granular structure; very friable; few fine roots; about 6 percent coarse fragments 2 to 20 millimeters in size; neutral; clear wavy boundary.

C1—14 to 27 inches; brown (10YR 5/3) sand; single grain; loose; about 10 percent coarse fragments 2 to 20 millimeters in size; slight effervescence; mildly alkaline; gradual wavy boundary.

C2—27 to 40 inches; yellowish brown (10YR 5/4) sand; single grain; loose; about 8 percent coarse fragments 2 to 20 millimeters in size; slight effervescence; mildly alkaline; gradual wavy boundary.

C3—40 to 60 inches; yellowish brown (10YR 5/4) sand; single grain; loose; about 6 percent coarse fragments 2 to 20 millimeters in size; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 10 to 20 inches. The 10- to 40-inch control section is sand, coarse sand, or loamy coarse sand. The content of coarse fragments ranges from 0 to 35 percent throughout the profile.

The A horizon has value of 2 or 3 (3 to 5 dry). It is typically sandy loam, but sand, loamy coarse sand, loamy sand, coarse sandy loam, and the gravelly analog of those textures are within the range. The C horizon has hue of 10YR or 2.5Y, value of 3 to 6, and chroma of 2 to 4. It is sand or gravelly sand.

Ludden Series

The Ludden series consists of poorly drained soils that are slowly permeable. These soils formed in calcareous, clayey alluvium on flood plains. Slopes are less than 1 percent. Ludden soils are subject to frequent flooding.

Typical pedon of Ludden silty clay loam, 2,600 feet south and 2,190 feet east of the northwest corner of sec. 4, T. 127 N., R. 46 W.

Ap—0 to 10 inches; black (2.5Y 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate very fine angular blocky structure; firm, sticky and plastic; common very fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

A1—10 to 25 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; moderate fine angular blocky structure; firm, very sticky and very plastic; common very fine roots; common white (5Y 8/1) concretions; strong effervescence; moderately alkaline; gradual wavy boundary.

A2—25 to 33 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; weak coarse prismatic structure parting to moderate medium angular blocky; firm, very sticky and very plastic; few very fine roots; strong effervescence; moderately alkaline; abrupt irregular boundary.

Cg1—33 to 48 inches; dark gray (5Y 4/1) silty clay loam; massive; firm, sticky and plastic; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg2—48 to 60 inches; dark gray (5Y 4/1) silty clay loam; massive; firm, sticky and plastic; common light gray (5Y 7/1) gypsum crystals; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 24 to 48 inches. The depth to free calcium carbonates ranges from 0 to 10 inches. The clay content of the control section ranges from 40 to 60 percent. The texture is silty clay, clay, or silty clay loam throughout the profile.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1 or less. The Cg horizon has hue of 2.5Y or 5Y, value of 2 to 4, and chroma of 2 or less.

McIntosh Series

The McIntosh series consists of somewhat poorly drained soils that are moderately permeable or moderately slowly permeable. These soils formed in calcareous, silty lacustrine sediments over loamy glacial till. They are on lake plains and till plains. Slopes are 0 to 2 percent.

Typical pedon of McIntosh silt loam, in an area of McIntosh-Lindaas complex, 2,300 feet south and 200 feet east of the northwest corner of sec. 14, T. 125 N., R. 45 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; common very fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

Ak—8 to 14 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak fine and very fine subangular blocky structure; friable; common very fine roots; calcium carbonates disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary.

Bk1—14 to 19 inches; grayish brown (2.5Y 5/2) silt loam; weak medium subangular blocky structure; friable; few very fine roots; calcium carbonates disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary.

Bk2—19 to 27 inches; light yellowish brown (2.5Y 6/4) silt loam; massive; friable; calcium carbonates disseminated throughout; violent effervescence; moderately alkaline; clear smooth boundary.

2C1—27 to 40 inches; light olive brown (2.5Y 5/4) loam; few fine distinct gray (10YR 5/1) mottles; massive; friable; about 3 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; moderately alkaline; abrupt wavy boundary.

2C2—40 to 60 inches; light olive brown (2.5Y 5/4) clay loam; common medium distinct grayish brown (2.5Y 5/2) mottles; massive; friable; about 3 percent coarse fragments 2 to 20 millimeters in size; slight effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The thickness of the silty mantle ranges from 24 to 40 inches. Free calcium carbonates are throughout the profile. The calcium carbonate equivalent ranges from 20 to 35 percent. The content of coarse fragments ranges from 0 to 5 percent in the silty sediments and from 2 to 10 percent in the glacial till.

The A horizon has hue of 10YR or 2.5Y and chroma of 1 or 2. It is typically silt loam, but silty clay loam and loam are within the range. The Bk horizon has value of 4 to 6 and chroma of 1 to 4. It is silt loam, silty clay loam, or loam. The 2C horizon has value of 5 or 6 and chroma of 3 to 6.

Oldham Series

The Oldham series consists of very poorly drained soils that are slowly permeable. These soils formed in calcareous, clayey alluvium in depressions on uplands. Slopes are less than 2 percent.

Typical pedon of Oldham silty clay loam, 150 feet east and 2,610 feet south of the northwest corner of sec. 33, T. 125 N., R. 47 W.

Ap—0 to 10 inches; black (5Y 2.5/1) silty clay loam, dark gray (5Y 4/1) dry; few fine prominent olive yellow (5Y 6/6) mottles; weak fine subangular blocky structure; friable; common small white snail shell fragments; strong effervescence; mildly alkaline; clear wavy boundary.

Bg1—10 to 24 inches; black (5Y 2.5/1) silty clay loam, dark gray (5Y 4/1) dry; few medium distinct olive gray (5Y 4/2) mottles; weak fine subangular blocky structure; friable; common small white snail shell fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

Bg2—24 to 44 inches; very dark gray (5Y 3/1) silty clay loam, gray (5Y 5/1) dry; few fine prominent olive yellow (5Y 6/6) mottles; weak fine subangular blocky structure; friable; few fine white snail shell fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg—44 to 60 inches; olive gray (5Y 4/2) silty clay loam; common medium prominent strong brown (7.5YR 5/6) mottles; massive; friable; few fine white snail shell fragments; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 24 to 55 inches. The thickness of the solum ranges from 30 to 55 inches. The depth to free calcium carbonates ranges from 0 to 10 inches.

The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 or 3 (3 or 4 dry), and chroma of 1 or less. It is typically silty clay loam, but silty clay is within the range. The Bg horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 5 dry, and chroma of 1 or less. It is silty clay loam or clay loam. The Cg horizon has hue of 2.5Y or 5Y, value of 3 to 5, and chroma of 1 or 2.

Parnell Series

The Parnell series consists of very poorly drained soils that are slowly permeable. These soils formed in silty and clayey alluvium in closed depressions and sloughs on uplands, till plains, and lake plains. Slopes are less than 1 percent.

Typical pedon of Parnell silty clay loam, 310 feet east and 1,780 feet north of the southwest corner of sec. 19, T. 125 N., R. 48 W.

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

A—10 to 16 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; common very fine roots; neutral; abrupt wavy boundary.

Btg1—16 to 33 inches; black (5Y 2.5/1) clay, very dark gray (5Y 3/1) dry; weak coarse prismatic structure parting to strong fine angular blocky; firm; common very fine roots; many black (5Y 2.5/1) clay films on faces of peds; neutral; gradual wavy boundary.

Btg2—33 to 46 inches; black (5Y 2.5/1) clay, very dark gray (5Y 3/1) dry; moderate coarse prismatic structure parting to strong fine angular blocky; firm; common very fine roots; many black (5Y 2.5/1) clay films on faces of peds; neutral; clear wavy boundary.

Btg3—46 to 60 inches; very dark gray (5Y 3/1) clay, dark gray (5Y 4/1) dry; weak medium subangular blocky structure; firm; few very fine roots; few very dark gray (5Y 3/1) clay films on faces of peds; few medium white (10YR 8/1) concentrations of calcium carbonates; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 35 to 70 inches. The depth to free calcium carbonates ranges from 35 to 80 inches. The mollic epipedon ranges from 24 to 65 inches in thickness.

The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 or 3, and chroma of 1 or less. It is typically silty clay loam, but silt loam and silty clay are within the range. Some pedons have an E horizon, which is as much as 4 inches thick. The Btg horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 to 4, and chroma of 1 or 2. It is typically clay or silty clay, but silty clay loam and clay loam are within the range. The content of clay in this horizon ranges from 35 to 60 percent. Some pedons have a C horizon.

Peever Series

The Peever series consists of well drained soils that are slowly permeable or moderately slowly permeable. These soils formed in clayey glacial till on uplands. Slopes range from 2 to 6 percent.

Typical pedon of Peever clay, in an area of Peever-Buse complex, 2 to 6 percent slopes; 200 feet north and 1,800 feet east of the southwest corner of sec. 19, T. 125 N., R. 48 W.

Ap—0 to 10 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate fine granular structure; friable; common very fine roots; about 1 percent coarse fragments 2 to 20 millimeters in size; neutral; abrupt smooth boundary.

Bt1—10 to 16 inches; dark grayish brown (10YR 4/2) clay; moderate coarse prismatic structure parting to strong fine angular blocky; very firm; common very fine roots; few very dark gray (10YR 3/1) organic coatings on faces of peds; common dark grayish brown (10YR 4/2) clay films on faces of peds; about 1 percent coarse fragments 2 to 20 millimeters in size; slightly acid; clear wavy boundary.

Bt2—16 to 23 inches; dark brown (10YR 4/3) clay; weak coarse subangular blocky structure parting to strong fine angular blocky; very firm; common very fine roots; common dark grayish brown (10YR 4/2) clay films on faces of peds; few very dark gray (10YR 3/1) organic coatings on faces of peds; about 1 percent coarse fragments 2 to 20 millimeters in size; neutral; clear wavy boundary.

Bk—23 to 36 inches; light olive brown (2.5Y 5/4) clay; weak medium subangular blocky structure; firm; few very fine roots; about 2 percent coarse fragments 2 to 20 millimeters in size; calcium carbonates disseminated throughout; violent effervescence; moderately alkaline; gradual wavy boundary.

C—36 to 60 inches; light olive brown (2.5Y 5/4) clay; common medium prominent gray (10YR 5/1) and few strong brown (7.5YR 5/6) mottles; massive; firm; common white (10YR 8/1) accumulations of calcium carbonate; about 3 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 21 to 56 inches. The depth to free calcium carbonates ranges from 13 to 26 inches. The mollic epipedon ranges from 7 to 16 inches in thickness.

The A horizon has value of 2 or 3 (3 or 4 dry) and chroma of 1.5 or less, dry or moist. It is typically clay, but clay loam, silty clay loam, and silty clay are within the range.

The Bt horizon has hue of 10YR or 2.5Y, value of 2 to 4 (4 to 6 dry), and chroma of 1 to 3, dry or moist. It is clay or silty clay.

The Bk and C horizons have value of 4 to 6 and chroma of 2 to 4. They are clay, silty clay, silty clay loam, or clay loam.

Perella Series

The Perella series consists of poorly drained soils that are moderately slowly permeable. These soils formed in silty lacustrine sediments on lake plains. Slopes are less than 1 percent.

Typical pedon of Perella silty clay loam, 1,980 feet west and 100 feet south of the northeast corner of sec. 11, T. 129 N., R. 47 W.

Ap—0 to 10 inches; black (2.5Y 2/0) silty clay loam, very dark gray (2.5Y 3/0) dry; moderate fine granular structure; friable; common very fine roots; neutral; abrupt smooth boundary.

A—10 to 18 inches; black (5Y 2.5/1) silty clay loam, dark gray (5Y 4/1) dry; weak medium subangular blocky structure; friable; few very fine roots; neutral; clear wavy boundary.

Bg1—18 to 23 inches; black (5Y 2.5/1) silty clay loam, dark gray (5Y 4/1) dry; moderate medium subangular blocky structure; friable; few very fine roots; neutral; clear wavy boundary.

Bg2—23 to 29 inches; olive gray (5Y 4/2) silty clay loam; few fine prominent yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; few very fine roots; weak effervescence; mildly alkaline; clear wavy boundary.

Cg—29 to 41 inches; olive gray (5Y 4/2) silty clay loam; common medium prominent yellowish brown (10YR 5/8) mottles; massive; friable; weak effervescence; mildly alkaline; clear wavy boundary.

2Cg—41 to 60 inches; light olive gray (5Y 6/2) clay loam; common medium prominent yellowish brown (10YR 5/8) mottles; massive; friable; about 2 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to calcium carbonates range from 18 to 36 inches. The thickness of the mollic epipedon ranges from 10 to 24 inches.

The A horizon has hue of 10YR, 2.5Y, 5Y, or N, value of 1 to 3 (3 or 4 dry), and chroma of 1 or less. It is typically silty clay loam, but silt loam, silty clay, clay,

clay loam, and loam are included in the range. The Bg horizon has hue of 10YR, 2.5Y, 5Y, or N, value of 2 to 4 (3 to 6 dry), and chroma of 3 or less. It is silty clay loam or silt loam. Some pedons have a BC horizon. The Cg and 2Cg horizons have hue of 5Y or 2.5Y, value of 4 to 6, and chroma of 1 to 4. The Cg horizon is silty clay loam or silt loam. The 2Cg horizon is clay loam or loam.

Quam Series

The Quam series consists of very poorly drained soils that are moderately slowly permeable. These soils formed in silty, water-sorted sediments in depressions on uplands, lake plains, and till plains. Some areas are underlain by loamy glacial till. Slopes are less than 1 percent.

Typical pedon of Quam silt loam, 450 feet south and 2,150 feet east of the northwest corner of sec. 14, T. 125 N., R. 48 W.

Ap—0 to 14 inches; black (N 2/0) silt loam, dark gray (N 4/0) dry; weak very fine subangular blocky structure; friable; common very fine roots; neutral; abrupt smooth boundary.

A1—14 to 28 inches; black (10YR 2/1) silty clay loam, gray (N 5/0) dry; weak fine subangular blocky structure; friable; common very fine roots; common light gray (10YR 7/1) accumulations of calcium carbonate; slight effervescence; mildly alkaline; clear wavy boundary.

A2—28 to 37 inches; very dark gray (10YR 3/1) silty clay loam, gray (N 5/0) dry; weak fine subangular blocky structure; friable; few very fine roots; few light gray (10YR 7/1) accumulations of calcium carbonate; strong effervescence; mildly alkaline; clear wavy boundary.

Cg1—37 to 47 inches; olive gray (5Y 5/2) silty clay loam; few medium prominent brownish yellow (10YR 6/8) mottles; weak fine subangular blocky structure; friable; strong effervescence; mildly alkaline; gradual wavy boundary.

Cg2—47 to 60 inches; olive gray (5Y 5/2) silty clay loam; common medium prominent brownish yellow (10YR 6/8) mottles; massive; friable; about 1 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; mildly alkaline.

The depth to free calcium carbonates ranges from 12 to 30 inches. The thickness of the mollic epipedon typically is 30 to 60 inches but ranges from 24 to 80 inches.

The A horizon has hue of 10YR, 2.5Y, 5Y, or N. It has value of 2 or 3 in the lower part. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is loam, silt loam, silty clay loam, or clay loam.

Rauville Series

The Rauville series consists of very poorly drained soils that are moderately permeable or moderately slowly permeable. These soils formed in calcareous, silty alluvium on flood plains. Slopes are less than 1 percent.

Typical pedon of Rauville silt loam, 480 feet north and 2,200 feet west of the southeast corner of sec. 20, T. 127 N., R. 47 W.

A1—0 to 5 inches; black (N 2/0) silt loam, very dark gray (10YR 3/1) dry; weak fine platy structure parting to moderate fine granular; very friable; common fine prominent white (10YR 8/1) accumulations of calcium carbonate; many very fine roots; slight effervescence; mildly alkaline; clear wavy boundary.

A2—5 to 22 inches; black (5Y 2.5/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure parting to moderate fine granular; friable; common very fine roots; many fine prominent white (10YR 8/1) accumulations of calcium carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

A3—22 to 33 inches; black (5Y 2.5/1) silty clay loam, gray (10YR 5/1) dry; moderate medium subangular blocky structure parting to moderate fine granular; friable; common very fine roots; many fine prominent white (10YR 8/1) accumulations of calcium carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg1—33 to 42 inches; dark gray (5Y 4/1) silty clay loam; massive; friable; few gypsum nests; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg2—42 to 54 inches; olive gray (5Y 4/2) silty clay loam; few fine prominent light olive brown (2.5Y 5/6) mottles; massive; friable; few gypsum nests; strong effervescence; moderately alkaline; clear wavy boundary.

Cg3—54 to 60 inches; olive gray (5Y 5/2) silt loam; massive; friable; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 24 to 35 inches. The control section is silty clay loam or silt loam.

The A horizon has hue of 10YR, N, 2.5Y, 5Y, value of 2 or 3, and chroma of 2 or less. It is typically silt loam, but silty clay loam is within the range. The Cg horizon has hue of 10YR, 2.5Y, or 5Y. It typically is mottled where chroma is 2. Some pedons have a 2C horizon.

Roliss Series

The Roliss series consists of poorly drained soils that are moderately permeable or moderately slowly permeable. These soils formed in calcareous, loamy glacial till on till plains. Slopes are 0 to 1 percent.

Typical pedon of Roliss clay loam, 150 feet east and 1,350 feet north of the southwest corner of sec. 20, T. 129 N., R. 45 W.

Ap—0 to 10 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; common very fine roots; about 1 percent coarse fragments 2 to 20 millimeters in size; slight effervescence; mildly alkaline; abrupt smooth boundary.

Bg—10 to 17 inches; dark gray (5Y 4/1) clay loam; few fine prominent yellowish brown (10YR 5/8) mottles; weak fine subangular blocky structure; friable; common very fine roots; about 2 percent coarse fragments 2 to 20 millimeters in size; slight effervescence; mildly alkaline; abrupt smooth boundary.

Bkg—17 to 22 inches; grayish brown (2.5Y 5/2) clay loam; weak fine subangular blocky structure; very friable; common very fine roots; calcium carbonates disseminated throughout; about 2 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; moderately alkaline; clear smooth boundary.

Cg1—22 to 32 inches; olive gray (5Y 4/2) clay loam; common fine prominent dark yellowish brown (10YR 5/8) mottles; massive; friable; few very fine roots; about 5 percent coarse fragments 2 to 20 millimeters in size; slight effervescence; moderately alkaline; gradual smooth boundary.

Cg2—32 to 60 inches; dark gray (5Y 4/1) clay loam; few fine prominent yellowish brown (10YR 5/8) mottles; massive; friable; about 5 percent coarse fragments 2 to 20 millimeters in size; slight effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 18 inches. The content of coarse fragments in the control section ranges from 2 to 20 percent.

The A horizon has hue of 10YR or 2.5Y and chroma of 1 or less. It is typically clay loam, but sandy clay loam, loam, silty clay loam, silt loam, and sandy loam are within the range. The Bg horizon has hue of 2.5Y or 5Y, value of 3 to 5, and chroma of 1 or 2. It has the same textures as the A horizon. The Bk and C horizons are clay loam or loam. The Bk horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 to 4.

Swenoda Series

The Swenoda series consists of moderately well drained soils that are moderately rapidly permeable in the solum and moderately slowly permeable in the underlying material. These soils formed in loamy sediments over silty sediments or in loamy glacial till. They are on uplands. Slopes range from 0 to 3 percent.

Typical pedon of Swenoda loam, 1,120 feet west and 610 feet south of the northeast corner of sec. 34, T. 125 N., R. 49 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; moderate medium granular structure; friable; common very fine roots; about 1 percent coarse fragments 2 to 20 millimeters in size; neutral; abrupt smooth boundary.

A—10 to 23 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; friable; common very fine roots; about 1 percent coarse fragments 2 to 20 millimeters in size; neutral; clear wavy boundary.

Bw—23 to 31 inches; yellowish brown (10YR 5/4) sandy loam; weak fine subangular blocky structure; friable; common very fine roots; about 1 percent coarse fragments 2 to 20 millimeters in size; neutral; abrupt wavy boundary.

Bk—31 to 41 inches; brownish yellow (10YR 6/6) silt loam; common medium distinct light brownish gray (10YR 6/2) and common fine distinct yellowish brown (10YR 5/8) mottles; weak fine subangular blocky structure; friable; many very fine roots; about 1 percent coarse fragments 2 to 20 millimeters in size; violent effervescence; moderately alkaline; clear wavy boundary.

2C—41 to 60 inches; light yellowish brown (10YR 6/4) silt loam; many large distinct gray (10YR 6/1) and common medium distinct yellowish brown (10YR

5/8) mottles; massive; friable; few very fine roots; about 1 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; mildly alkaline.

The depth to calcium carbonates and the depth to silty or loamy sediments range from 20 to 40 inches.

The Ap horizon has value of 2 or 3 (3 or 4 dry) and chroma of 1 or less. The A horizon has colors similar to those of the Ap horizon but has chroma of 1 or 2. These horizons are loam, fine sandy loam, or sandy loam.

The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4, and chroma of 1 to 3. It is dominantly fine sandy loam or sandy loam. In some pedons, however, the lower part is loamy sand or loamy fine sand.

The 2Bk and 2C horizons have hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 2 to 4. They are silt loam, loam, clay loam, or silty clay loam.

Vallers Series

The Vallers series consists of poorly drained soils that are moderately slowly permeable. These soils formed in calcareous, loamy glacial till on uplands and till plains. Slopes are 0 to 2 percent.

Typical pedon of Vallers clay loam, 900 feet west and 200 feet south of the northeast corner of sec. 16, T. 125 N., R. 47 W.

Ap—0 to 10 inches; black (5Y 2.5/1) clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; common very fine roots; about 1 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; mildly alkaline; abrupt smooth boundary.

Bkg1—10 to 17 inches; light olive gray (5Y 6/2) clay loam; few fine prominent light olive brown (2.5Y 5/6) mottles; weak medium subangular blocky structure; friable; common very fine roots; common very dark gray (10YR 3/1) organic coatings on faces of peds; calcium carbonates disseminated throughout; about 1 percent coarse fragments 2 to 20 millimeters in size; violent effervescence; moderately alkaline; clear wavy boundary.

Bkg2—17 to 24 inches; olive gray (5Y 5/2) clay loam; common fine prominent light olive brown (2.5Y 5/6) mottles; weak medium subangular blocky structure; friable; few fine roots; calcium carbonates disseminated throughout; about 1 percent coarse fragments 2 to 20 millimeters in size; violent effervescence; moderately alkaline; clear wavy boundary.

Cg1—24 to 31 inches; gray (5Y 6/1) clay loam; common fine prominent brownish yellow (10YR 6/8) mottles; massive; friable; few very fine roots; about 1 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg2—31 to 60 inches; gray (5Y 5/1) clay loam; common coarse prominent brownish yellow (10YR 6/8) mottles; massive; friable; about 3 percent coarse fragments 2 to 20 millimeters in size; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 24 inches. The content of coarse fragments ranges from 1 to 8 percent throughout the profile. The upper boundary of the calcic horizon is within a depth of 16 inches.

The A horizon has hue of 10YR, 2.5Y, 5Y, or N, value of 2 or 3 (3 to 5 dry), and chroma of 1 or less. It is typically clay loam, but silt loam, loam, and silty clay loam are within the range. Some pedons have an Ak horizon.

The Bk horizon has hue of 2.5Y or 5Y, value of 3 to 6, and chroma of 1 or 2. It is typically clay loam, but loam and silty clay loam are within the range.

The Cg horizon has hue of 2.5Y or 5Y, value of 4 to 7, and chroma of 1 to 3. It is clay loam or loam.

Wheatville Series

The Wheatville series consists of somewhat poorly drained and moderately well drained soils that are moderately rapidly permeable in the upper part and slowly permeable in underlying material. These soils formed in calcareous, silty and loamy lacustrine sediments over clayey lacustrine sediments. They are on lake plains. Slopes are 0 to 2 percent.

Typical pedon of Wheatville silt loam, 650 feet west and 200 feet north of the southeast corner of sec. 32, T. 126 N., R. 45 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; common very fine roots; strong effervescence; moderately alkaline; abrupt smooth boundary.

Bk1—8 to 15 inches; grayish brown (2.5Y 5/2) silt loam; weak medium subangular blocky structure; very friable; few very fine roots; calcium carbonates disseminated throughout; violent effervescence; moderately alkaline; clear wavy boundary.

Bk2—15 to 25 inches; light brownish gray (2.5Y 6/2) very fine sandy loam; weak medium subangular blocky structure; very friable; few very fine roots; calcium carbonates disseminated throughout; violent effervescence; moderately alkaline; clear smooth boundary.

C—25 to 35 inches; light olive brown (2.5Y 5/4) loamy very fine sand; common fine prominent yellowish brown (10YR 5/6) mottles; massive; very friable; few very fine roots; slight effervescence; mildly alkaline; abrupt wavy boundary.

2C—35 to 60 inches; olive (5Y 5/3) silty clay; common fine and medium distinct yellowish brown (10YR 5/6) and few fine prominent light brownish gray (2.5Y 6/2) mottles; moderate fine angular blocky structure; firm; slight effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 14 inches. Depth to the 2C horizon ranges from 20 to 40 inches.

The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2. It is typically silt loam, but loam, sandy clay loam, and very fine sandy loam are within the range.

The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. It is very fine sandy loam, silt loam, loam, sandy clay loam, or loamy very fine sand.

The C horizon has hue of 2.5Y or 10YR, value of 5 or 6, and chroma of 3 to 6. It is loamy very fine sand, very fine sandy loam, silt loam, or loam.

The 2C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 to 3. It is silty clay, clay, or silty clay loam. The maximum clay content in this horizon ranges from 35 to 75 percent.

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Formation of the Soils

In Traverse County there are more than 30 different soil series. In the United States there are more than 12,000 series. Only five factors are responsible for this diversity among soils. These factors are vegetation and other living organisms, climate, time, parent material, and topography. The most important factors in Traverse County are the parent material and the topography. The other factors are relatively uniform throughout the county.

Parent Material

Most of the soils in Traverse County formed in calcareous glacial material deposited about 10,000 years ago *(5)*. The soils in the southern third of the county formed in glacial till, and those in the remaining two-thirds of the county formed in material deposited or altered by Glacial Lake Agassiz *(4)*.

Glacial till is the unsorted, mostly pulverized rock material that was transported and deposited by glacial ice. It is a mixture of sand, silt, and clay that has coarse fragments ranging in size from small pebbles to large boulders. In Traverse County, it commonly has a texture of clay loam. The soils that formed in the till generally are on a gently rolling landscape that has low hills and shallow depressions. Aazdahl, Buse, Formdale, Hamerly, Lindaas, and Parnell soils are examples.

Traverse County is on the southern edge of Glacial Lake Agassiz. The size of this lake was determined by the melting glaciers to the north and the outflow through Glacial River Warren at Brown's Valley. This river formed the present valley of the Minnesota River. Lake Traverse is a remnant of the glacial river. The bluffs next to the lake were originally the banks of Glacial River Warren. The boulders that formed the riverbed are evident a few miles north of Brown's Valley. As the lake shrank, a new series of beaches formed. The county has four series of beaches. The changing size of the lake had a significant impact on the parent material in which the soils formed.

The lake deposited sediments in a complex pattern. Several miles outside of the stable beach area, silt and very fine sand were deposited as a result of overwash during stormy periods. Sand and gravel were deposited on the beaches. Glacial till was planed smooth, and stones were rounded into cobbles and concentrated in shallow, turbulent waters. Very fine sand, silt, and finally clay were deposited as the lake deepened and the water calmed. As the lake shrank or expanded, a new series of beaches formed. If the lake shrank, silt and very fine sand were deposted over clay. If the lake expanded, however, clay was deposted over the silt and very fine sand. According to some researchers, Lake Agassiz went through four expansion cycles and three shrinking cycles. The soils that formed in the lake-deposited material range from clay to gravel. They occur as intermixed areas because of the expansion and contraction cycles of Lake Agassiz.

Topography

Topography significantly affected the formation of soils in Traverse County. The landscape within the Glacial Lake Agassiz basin is nearly flat. The relief in a quarter section of land generally is very slight, commonly only 6 inches in several hundred feet. Yet the soils on the slight rises are very different from the soils in the shallow depressions.

Bearden, Doran, Glyndon, Hamerly, and Wheatville soils are common on the rises. Bearden, Glyndon, Hamerly, and Wheatville soils generally have an accumulation of calcium carbonates within 16 inches of the surface. Bearden soils formed in fine-silty material. Glyndon soils formed in coarse-silty material. Hamerly soils formed in glacial till that in some areas was modified by the waves of Glacial Lake Agassiz. Wheatville soils formed in coarse-silty material underlain by clayey material at a depth of 20 to 40 inches.

The soils in the shallow depressions generally are not calcareous at the surface. In fact, they are leached to a depth of more than 40 inches in some areas. As the soils are leached and calcium carbonates are removed, clay particles are transported from the surface layer and subsurface layer and deposited in a subsoil layer, called an argillic horizon. Examples of soils that have an argillic horizon are Doran soils on low-gradient slopes and Lindaas and Parnell soils in depressions.

In areas on the uplands where glacial till was deposited, the relief is stronger and the slopes are steeper than is typical in the basin of Glacial Lake Agassiz. On the steepest slopes, the dark surface layer is calcareous and very thin or, if the soils have been cultivated, it has been removed by erosion. Buse soils are an example of soils on the steep slopes. At the base of steep hills, the dark surface layer may be more than 16 inches thick. Darnen soils are at the base of the steep slope breaks next to Lake Traverse.

Soils in the relatively level areas have a dark surface layer about 9 to 15 inches thick. Beneath this layer is a leached subsoil layer, generally 3 to 6 inches thick. The leached layer, or cambic horizon, does not have the accumulation of clay characteristic of argillic horizons. Examples of soils that have a cambic horizon are Aazdahl, Darnen, and Formdale soils. Cambic horizons indicate a stage of soil formation intermediate between the stage of soils characterized by deep leaching and an argillic horizon and the stage of calcareous soils that have thin surface layers.

Vegetation and Other Living Organisms

Living organisms, including plants, animals, insects, earthworms, bacteria, and fungi, play an important role in soil formation. Most of the soils in Traverse County formed under tall and mid prairie vegetation. Mainly because of this vegetation, the soils have a dark surface soil, called a mollic epipedon. The plants obtained carbon dioxide from the air during photosynthesis. As these plants died and decayed each year, organic material and carbon was added to the soil. The roots of the plants strongly influenced the structure of the soils. As the roots decayed, small channels formed in the soils. These channels allow for more rapid movement of air and water beneath the surface.

Human activities generally have had destructive effects on the soils in the county. Accelerated erosion has thinned the surface layer of the soils. Human activities can improve the quality of the soils used for crops. Careful tillage and additions of organic matter can be beneficial over a period of time.

Climate

Traverse County has a continental climate characterized by cold winters and hot summers. The climate favors prairie grasses since it is a little too dry for trees. Periodic fires kept the trees from invading the prairies. Soils that formed under trees generally do not have the thick, dark surface layer characteristic of the soils in this county. They commonly have a clayey subsoil layer, or argillic horizon.

Time

The soils in Traverse County are geologically quite young. The last glaciers retreated about 10,000 years ago. Naturally, the soils would look very different had the other four factors acted on them for 50,000 or 100,000 years. The youngest soils, such as Lamoure and Rauville soils, are on active flood plains.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

Ablation till. Loose, permeable till deposited during the final downwasting of glacial ice. Lenses of crudely sorted sand and gravel are common.

AC soil. A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Basal till. Compact glacial till deposited beneath the ice.

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bench terrace. A raised, level or nearly level strip of earth constructed on or nearly on the contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

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. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Congeliturbate. Soil material disturbed by frost action.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coprogenous earth (sedimentary peat). Fecal material deposited in water by aquatic organisms.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also, the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Graded stripcropping. Growing crops in strips that grade toward a protected waterway.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash 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.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan*.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are —

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep-sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slick spot. 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.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Sodicity. The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na^{+} to Ca^{++} + Mg^{++}. The degrees of sodicity and their respective ratios are—

Slight	less than 13:1
Moderate	13-30:1
Strong	more than 30:1

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

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 soil blowing and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil 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.

Subsoiling. Breaking up a compact subsoil by pulling a special chisel through the soil.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial meltwater. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Varve. A sedimentary layer of a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

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Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-80 at Wheaton, Minnesota)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	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-----	19.3	-0.3	9.5	43	-27	0	0.61	0.15	0.98	2	7.4
February----	26.3	6.0	16.2	49	-25	0	.59	.24	.88	2	6.4
March-------	37.8	18.3	28.1	68	-14	19	1.06	.38	1.63	3	9.3
April-------	56.6	33.7	45.2	87	13	62	2.25	1.00	3.30	5	2.7
May---------	71.4	45.5	58.5	92	26	288	2.86	1.28	4.19	6	.1
June--------	80.0	55.8	67.9	97	39	537	4.11	2.38	5.64	7	.0
July--------	85.8	60.1	73.0	100	46	713	2.71	1.43	3.82	5	.0
August------	84.4	58.4	71.4	99	42	663	2.42	.87	3.70	5	.0
September---	74.2	48.3	61.3	96	29	345	1.71	.48	2.69	4	.0
October-----	62.7	37.7	50.2	89	17	125	1.37	.31	2.21	3	.3
November----	41.6	22.6	32.1	69	-7	0	1.03	.25	1.63	2	3.2
December----	26.4	8.2	17.3	50	-23	0	.56	.14	.89	2	6.3
Yearly:											
Average---	55.5	32.9	44.2	---	---	---	---	---	---	---	---
Extreme---	---	---	---	102	-29	---	---	---	---	---	---
Total-----	---	---	---	---	---	2,752	21.28	16.21	25.91	46	35.7

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-80 at Wheaton, Minnesota)

Probability	Temperature		
	24^{o} F or lower	28^{o} F or lower	32^{o} F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 2	May 11	May 23
2 years in 10 later than--	Apr. 26	May 6	May 18
5 years in 10 later than--	Apr. 16	Apr. 25	May 10
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 6	Sept. 29	Sept. 17
2 years in 10 earlier than--	Oct. 12	Oct. 4	Sept. 21
5 years in 10 earlier than--	Oct. 23	Oct. 13	Sept. 29

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-80 at Wheaton, Minnesota)

Probability	Daily minimum temperature during growing season		
	Higher than 24^{o} F	Higher than 28^{o} F	Higher than 32^{o} F
	Days	Days	Days
9 years in 10	170	148	123
8 years in 10	177	155	129
5 years in 10	189	170	141
2 years in 10	201	185	153
1 year in 10	207	192	159

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
26	Aazdahl clay loam	24,791	6.9
34	Parnell silty clay loam	2,513	0.7
46	Borup loam	792	0.2
47	Colvin silty clay loam	2,086	0.6
51	La Prairie silt loam	1,488	0.4
56	Fargo silty clay loam	7,606	2.1
57	Fargo silty clay	4,363	1.2
58	Kittson loam	7,239	2.0
60	Glyndon loam	14,276	3.9
67A	Bearden silt loam, 0 to 2 percent slopes	12,378	3.4
67B	Bearden silty clay loam, 2 to 6 percent slopes	1,919	0.5
108	McIntosh silt loam	1,823	0.5
141	Egeland loam	767	0.2
171B	Formdale clay loam, 1 to 6 percent slopes	8,479	2.3
184	Hamerly clay loam	18,721	5.1
236	Vallers clay loam	1,902	0.5
245B	Lohnes sandy loam, 1 to 6 percent slopes	3,668	1.0
276	Oldham silty clay loam	820	0.2
293	Swenoda loam	1,750	0.5
343	Wheatville silt loam	11,188	3.1
344	Quam silt loam	520	0.1
371	Clontarf sandy loam	2,838	0.8
418	Lamoure silty clay loam	6,200	1.7
434	Perella silty clay loam	471	0.1
437E	Buse clay loam, 18 to 35 percent slopes	2,928	0.8
450	Rauville silt loam	1,547	0.4
494B	Darnen loam, 1 to 6 percent slopes	1,202	0.3
582	Roliss clay loam	1,301	0.4
642	Clearwater silty clay loam	1,009	0.3
646B	Peever clay, 2 to 6 percent slopes	290	0.1
698	Doran clay loam	30,351	8.4
814	Hamerly-Lindaas clay loams	37,906	10.4
816	Fargo clay, saline	2,167	0.6
821	Doran-Lindaas silty clay loams	54,153	14.9
822B	Peever-Buse complex, 2 to 6 percent slopes	2,085	0.6
900	Hamerly-Aazdahl-Lindaas complex	23,647	6.5
915B	Formdale-Buse clay loams, 2 to 6 percent slopes	4,804	1.3
915C2	Buse-Formdale clay loams, 6 to 14 percent slopes, eroded	2,411	0.7
922	Hamerly-Parnell complex	6,553	1.8
948	McIntosh-Lindaas complex	11,540	3.2
1020	Udorthents, sloping	712	0.2
1030	Udorthents-Pits complex	472	0.1
1916	Lindaas clay loam	10,836	3.0
1918	Croke loam	9,097	2.5
1933	Bearden-Lindaas complex	8,303	2.3
1940	Quam silty clay loam, ponded	2,426	0.7
1947	Doran silty clay loam, loamy substratum	2,231	0.6
1948	Fargo-Lindaas silty clay loams	2,726	0.7
1949	Gardena loam	1,127	0.3
1950	Ludden silty clay loam	3,098	0.9
	Total	363,520	100.0

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
26	Aazdahl clay loam
46	Borup loam (where drained)
47	Colvin silty clay loam (where drained)
51	La Prairie silt loam
56	Fargo silty clay loam (where drained)
57	Fargo silty clay (where drained)
58	Kittson loam
60	Glyndon loam
67A	Bearden silt loam, 0 to 2 percent slopes
67B	Bearden silty clay loam, 2 to 6 percent slopes
108	McIntosh silt loam
141	Egeland loam
171B	Formdale clay loam, 1 to 6 percent slopes
184	Hamerly clay loam
236	Vallers clay loam (where drained)
293	Swenoda loam
343	Wheatville silt loam
344	Quam silt loam (where drained)
371	Clontarf sandy loam (where irrigated)
418	Lamoure silty clay loam (where drained)
434	Perella silty clay loam (where drained)
494B	Darnen loam, 1 to 6 percent slopes
582	Roliss clay loam (where drained)
642	Clearwater silty clay loam (where drained)
646B	Peever clay, 2 to 6 percent slopes
698	Doran clay loam
814	Hamerly-Lindaas clay loams (where drained)
821	Doran-Lindaas silty clay loams (where drained)
822B	Peever-Buse complex, 2 to 6 percent slopes
900	Hamerly-Aazdahl-Lindaas complex (where drained)
915B	Formdale-Buse clay loams, 2 to 6 percent slopes
922	Hamerly-Parnell complex (where drained)
948	McIntosh-Lindaas complex (where drained)
1916	Lindaas clay loam (where drained)
1918	Croke loam
1933	Bearden-Lindaas complex (where drained)
1947	Doran silty clay loam, loamy substratum
1948	Fargo-Lindaas silty clay loams (where drained)
1949	Gardena loam
1950	Ludden silty clay loam (where drained)

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Land capability	Corn	Soybeans	Spring wheat	Barley	Oats	Sunflowers	Bromegrass-alfalfa hay
		Bu	Bu	Bu	Bu	Bu	Lbs	Tons
26-------------- Aazdahl	I	88	38	50	72	92	1,650	5.7
34-------------- Parnell	IIIw	60	23	30	43	60	1,150	3.3
46-------------- Borup	IIw	70	27	35	53	70	1,300	4.5
47-------------- Colvin	IIw	70	27	35	51	70	1,300	4.5
51-------------- La Prairie	IIw	89	38	49	71	90	1,650	5.7
56, 57---------- Fargo	IIw	78	30	40	65	80	1,500	5.7
58-------------- Kittson	I	90	38	50	72	92	1,650	5.7
60-------------- Glyndon	IIs	89	32	43	67	80	1,600	5.7
67A------------- Bearden	IIs	83	32	43	67	80	1,600	5.7
67B------------- Bearden	IIe	79	30	40	65	75	1,400	5.4
108------------- McIntosh	IIs	83	32	43	67	80	1,600	5.7
141------------- Egeland	IIs	60	23	30	43	60	1,350	4.8
171B------------ Formdale	IIe	80	35	41	66	78	1,450	5.4
184------------- Hamerly	IIs	83	32	43	67	80	1,600	5.7
236------------- Vallers	IIw	67	25	34	50	68	1,250	4.5
245B------------ Lohnes	IVs	40	11	18	28	42	1,000	2.1
276------------- Oldham	IIIw	65	24	32	45	65	1,200	4.5
293------------- Swenoda	I	90	38	50	72	92	1,650	5.7
343------------- Wheatville	IIs	89	32	43	67	80	1,600	5.7
344------------- Quam	IIIw	60	23	30	43	60	1,150	3.3

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Spring wheat	Barley	Oats	Sunflowers	Bromegrass-alfalfa hay
		Bu	Bu	Bu	Bu	Bu	Lbs	Tons
371------------- Clontarf	IIIs	60	23	30	43	60	1,350	4.8
418------------- Lamoure	IIw	66	28	---	---	71	---	---
434------------- Perella	IIw	73	13	38	60	73	1,350	4.5
437E------------ Buse	VIIe	---	---	---	---	---	---	---
450------------- Rauville	VIw	---	---	---	---	---	---	---
494B------------ Darnen	IIe	83	36	43	67	80	1,500	5.7
582------------- Roliss	IIw	73	28	38	60	73	1,350	4.5
642------------- Clearwater	IIw	70	27	35	55	70	1,300	4.8
646B------------ Peever	IIIe	79	33	40	65	75	1,400	5.4
698------------- Doran	IIw	85	37	45	70	85	1,550	5.7
814-------------		77	30	40	65	75	1,400	4.8
Hamerly--------	IIs							
Lindaas--------	IIw							
816------------- Fargo	IIIs	40	18	25	48	50	1,100	2.7
821------------- Doran-Lindaas	IIw	77	30	40	65	75	1,400	4.8
822B------------ Peever-Buse	IIIe	73	28	38	60	73	1,350	5.4
900-------------		77	30	40	65	75	1,400	4.8
Hamerly--------	IIs							
Aazdahl--------	I							
Lindaas--------	IIw							
915B------------ Formdale-Buse	IIe	77	29	40	65	75	1,400	5.4
915C2----------- Buse-Formdale	IIIe	55	21	28	40	55	1,150	4.8
922-------------		65	24	32	45	65	1,200	4.5
Hamerly--------	IIs							
Parnell--------	IIIw							
948-------------		77	---	40	65	75	1,400	4.8
McIntosh-------	IIs							
Lindaas--------	IIw							
1020. Udorthents								

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Spring wheat	Barley	Oats	Sunflowers	Bromegrass-alfalfa hay
		Bu	Bu	Bu	Bu	Bu	Lbs	Tons
1030. Udorthents-Pits								
1916------------ Lindaas	IIw	67	25	34	47	68	1,250	4.5
1918------------ Croke	I	90	38	49	71	90	1,650	5.7
1933------------		77	30	40	65	75	1,400	4.8
Bearden--------	IIs							
Lindaas--------	IIw							
1940------------ Quam	VIIIw	---	---	---	---	---	---	---
1947------------ Doran	IIw	85	37	45	70	85	1,550	5.1
1948------------ Fargo-Lindaas	IIw	77	30	40	65	75	1,400	4.8
1949------------ Gardena	I	90	38	50	72	92	1,650	5.7
1950------------ Ludden	IIIw	65	24	32	45	65	1,200	4.5

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
26----------------- Aazdahl	---	Eastern redcedar, American plum, Siberian peashrub, late lilac, Peking cotoneaster, redosier dogwood.	Hackberry, Siberian crabapple, white spruce, common chokecherry, Russian olive.	Golden willow, Siberian elm, green ash.	Eastern cottonwood, silver maple, robusta cottonwood.
34----------------- Parnell	---	Siberian peashrub, gray dogwood.	Green ash, white spruce, hackberry.	Golden willow, Siberian elm, white willow.	Robusta cottonwood.
46----------------- Borup	Redosier dogwood	Lilac, common chokecherry, Siberian peashrub, eastern redcedar.	Russian olive, blue spruce, white spruce, bur oak.	Golden willow-----	Eastern cottonwood.
47----------------- Colvin	Redosier dogwood	Lilac, redosier dogwood, American plum, Siberian peashrub, common chokecherry.	Manchurian crabapple, white spruce, blue spruce.	Golden willow-----	Eastern cottonwood, Carolina poplar.
51----------------- La Prairie	---	Siberian peashrub, American plum, late lilac, redosier dogwood.	Ponderosa pine, hackberry, Siberian crabapple, eastern redcedar.	Golden willow, green ash, Siberian elm.	Eastern cottonwood, robusta cottonwood, silver maple.
56, 57------------ Fargo	---	Redosier dogwood, American plum, Siberian peashrub, common chokecherry, eastern redcedar, lilac.	Siberian crabapple, Black Hills spruce, hackberry, Amur maple.	Golden willow, green ash, Siberian elm.	Eastern cottonwood, silver maple, white willow.
58----------------- Kittson	---	Eastern redcedar, Peking cotoneaster, American plum, Tatarian honeysuckle, redosier dogwood, Siberian peashrub.	Hackberry, white spruce, Manchurian crabapple.	Golden willow, green ash, Siberian elm.	Eastern cottonwood, silver maple, robusta cottonwood.
60----------------- Glyndon	Lilac-------------	Eastern redcedar, Siberian peashrub, common chokecherry, American plum.	White spruce, bur oak, Russian olive, hackberry.	Golden willow, white willow, green ash.	Eastern cottonwood, Siberian elm.
67A, 67B----------- Bearden	---	Siberian peashrub, American plum, lilac, common chokecherry.	Hackberry, Russian olive, blue spruce, Siberian crabapple, eastern redcedar.	Golden willow, green ash, white willow.	Eastern cottonwood, Siberian elm.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
108. McIntosh	Lilac.	Siberian peashrub, common chokecherry, eastern redcedar.	Russian olive, blue spruce, white spruce, bur oak.	Golden willow, white willow.	Eastern cottonwood, Siberian elm.
141. Egeland	---	Eastern redcedar, American plum, Siberian peashrub, lilac.	Green ash, hackberry, ponderosa pine, Russian olive, Manchurian crabapple.	Siberian elm.	Eastern cottonwood, Siberian elm.
171B. Formdale	Peking cotoneaster	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Green ash, blue spruce, Russian olive, Manchurian crabapple, red pine.	Hackberry, Siberian elm.	Eastern cottonwood, silver maple.
184. Hamerly	---	Siberian peashrub, American plum, lilac, common chokecherry, eastern redcedar.	Scotch pine, Siberian crabapple, hackberry, eastern redcedar.	Golden willow, green ash, white willow.	Eastern cottonwood, Siberian elm.
236. Vallers	Redosier dogwood	Lilac, Siberian peashrub, common chokecherry, eastern redcedar.	White spruce, bur oak, Russian olive, blue spruce.	Golden willow.	Eastern cottonwood.
245B. Lohnes	Lilac.	Eastern redcedar, American plum, Siberian peashrub, late lilac, common chokecherry.	Green ash, silver maple, white spruce.	Siberian elm, golden willow.	---
276. Oldham	Redosier dogwood	Cotoneaster, Siberian peashrub.	Hackberry, green ash, white spruce.	Golden willow, white willow, Siberian elm.	Eastern cottonwood, robusta cottonwood.
293. Swenoda	Peking cotoneaster	Common chokecherry, eastern redcedar, American plum, Siberian peashrub, lilac.	Bur oak, hackberry, red pine, Russian olive, Amur maple.	Siberian elm, green ash.	Eastern cottonwood, silver maple.
343. Wheatville	---	Common chokecherry, eastern redcedar, Siberian peashrub, American plum.	Blue spruce, white spruce, Russian olive, bur oak, Scotch pine.	Golden willow, green ash, white willow.	Eastern cottonwood, Siberian elm.
344. Quam	---	Gray dogwood, redosier dogwood.	Green ash, hackberry.	Siberian elm, golden willow, white willow.	Eastern cottonwood, robusta cottonwood.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
371. Clontarf	---	Eastern redcedar, Amur maple, redosier dogwood, common chokecherry, American plum, Siberian peashrub.	Blue spruce, Siberian crabapple, white spruce.	Golden willow	Eastern cottonwood, silver maple.
418. Lamoure	Redosier dogwood	Siberian peashrub, American plum, common chokecherry.	Russian olive, blue spruce, ponderosa pine, Siberian crabapple.	Golden willow	Eastern cottonwood, Siberian elm.
434. Perella	Buffaloberry, redosier dogwood.	Siberian peashrub, gray dogwood.	Hackberry, green ash, ponderosa pine, Siberian crabapple, eastern redcedar.	Golden willow, Siberian elm, white willow.	Eastern cottonwood, robusta cottonwood.
437E. Buse	Late lilac, Siberian peashrub.	American plum, eastern redcedar.	Green ash, Siberian elm.	Eastern cottonwood	---
450. Rauville					
494B. Darnen	Peking cotoneaster	American plum, redosier dogwood, eastern redcedar, lilac, Siberian peashrub.	Russian olive, blue spruce, green ash, bur oak, ponderosa pine, Siberian crabapple.	Hackberry, Siberian elm.	Eastern cottonwood, silver maple.
582. Roliss	Redosier dogwood	Cotoneaster, Siberian peashrub, lilac, eastern redcedar, common chokecherry.	White spruce, blue spruce, bur oak, Russian olive.	Golden willow	Eastern cottonwood, Siberian elm.
642. Clearwater	Redosier dogwood	Lilac, cotoneaster, eastern redcedar, Siberian peashrub, common chokecherry.	White spruce, bur oak, blue spruce, Russian olive.	Golden willow	Eastern cottonwood, Siberian elm.
646B. Peever	American plum, Peking cotoneaster.	Eastern redcedar, Siberian peashrub, lilac.	Hackberry, red pine, Russian olive, Siberian crabapple, bur oak, blue spruce.	Siberian elm, silver maple, white willow.	Eastern cottonwood.
698. Doran	---	Siberian peashrub, American plum, lilac, common chokecherry, eastern redcedar.	Hackberry, white spruce, Siberian crabapple, eastern redcedar.	Golden willow, green ash, white willow.	Eastern cottonwood, Siberian elm.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
814*:					
Hamerly	---	Siberian peashrub, American plum, lilac.	Ponderosa pine, blue spruce, Siberian crabapple, eastern redcedar.	Golden willow, green ash, hackberry.	Eastern cottonwood, Siberian elm.
Lindaas	Peking cotoneaster	Lilac, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow, green ash, Siberian elm.	Eastern cottonwood, silver maple, white willow.
816 Fargo	Lilac, silver buffaloberry, Siberian peashrub.	Rocky Mountain juniper, eastern redcedar.	Green ash, Russian olive.	Siberian elm, white willow, golden willow.	Eastern cottonwood.
821*:					
Doran	---	Siberian peashrub, American plum, lilac.	Hackberry, blue spruce, Siberian crabapple, eastern redcedar.	Golden willow, green ash, Siberian elm.	Eastern cottonwood, silver maple, white willow.
Lindaas	Peking cotoneaster	Lilac, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow, green ash, Siberian elm.	Eastern cottonwood, silver maple, white willow.
822B*:					
Peever	American plum, Peking cotoneaster.	Eastern redcedar, American plum, Siberian peashrub, lilac.	Hackberry, red pine, Russian olive, Manchurian crabapple, bur oak, blue spruce.	Siberian elm, silver maple, white willow.	Eastern cottonwood.
Buse	---	Eastern redcedar, American plum, hackberry.	Green ash, Siberian elm.	Eastern cottonwood	---
900*:					
Hamerly	---	Siberian peashrub, American plum, lilac.	Hackberry, white spruce, Siberian crabapple, eastern redcedar.	White willow, green ash, hackberry.	Eastern cottonwood, Siberian elm.
Aazdahl	---	Eastern redcedar, American plum, Siberian peashrub, common chokecherry, Peking cotoneaster, redosier dogwood.	Hackberry, Manchurian crabapple, white spruce, common chokecherry, Russian olive.	Golden willow, Siberian elm, green ash.	Eastern cottonwood, silver maple, robusta cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
900*:					
Lindaas	Peking cotoneaster	Lilac, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Siberian crabapple, Black Hills spruce, bur oak, hackberry.	Golden willow, green ash, Siberian elm.	Eastern cottonwood, silver maple, white willow.
915B*:					
Formdale	Peking cotoneaster	Eastern redcedar, American plum, lilac, redosier dogwood.	Green ash, blue spruce, Russian olive, bur oak, Manchurian crabapple, red pine.	Hackberry, Siberian elm.	Eastern cottonwood, silver maple.
Buse	Late lilac, Siberian elm.	Eastern redcedar, American plum, lilac, Russian olive.	Green ash, Siberian elm.	Eastern cottonwood	---
915C2*:					
Buse	Late lilac, Siberian elm.	Eastern redcedar, American plum, lilac, Russian olive.	Green ash, Siberian elm.	Eastern cottonwood	---
Formdale	Peking cotoneaster	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood.	Green ash, blue spruce, Russian olive, bur oak, Manchurian crabapple, red pine.	Hackberry, Siberian elm.	Eastern cottonwood.
922*:					
Hamerly	---	Siberian peashrub, American plum, lilac.	Hackberry, blue spruce, Siberian crabapple, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood, Siberian elm.
Parnell	---	Siberian peashrub, lilac, redosier dogwood.	Green ash, white spruce, Russian olive, hackberry.	Golden willow, Siberian elm, white willow.	Carolina poplar, eastern cottonwood.
948*:					
McIntosh	---	Siberian peashrub, common chokecherry, eastern redcedar.	Hackberry, Russian olive, white spruce, bur oak.	Golden willow, green ash, white willow.	Eastern cottonwood, Siberian elm.
Lindaas	Peking cotoneaster	Lilac, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Siberian crabapple, Black Hills spruce, bur oak.	Golden willow, green ash.	Eastern cottonwood, silver maple.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1020*. Udorthents					
1030*: Udorthents.					
Pits.					
1916 Lindaas	Peking cotoneaster	Lilac, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Siberian crabapple, green ash, Black Hills spruce, hackberry.	Golden willow, green ash, Siberian elm.	Eastern cottonwood, silver maple, white willow.
1918 Croke	---	American plum, Amur maple, eastern cottonwood, lilac.	Hackberry, common chokecherry, Russian olive, white spruce.	Green ash, golden willow, Siberian elm.	Eastern cottonwood, silver maple.
1933*: Bearden	---	Siberian peashrub, American plum, lilac.	Ponderosa pine, blue spruce, Siberian crabapple, eastern redcedar.	Golden willow, green ash, hackberry.	Eastern cottonwood, Siberian elm.
Lindaas	---	Lilac, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Siberian crabapple, Black Hills spruce, bur oak.	Golden willow, green ash.	Eastern cottonwood, silver maple, white willow.
1940. Quam					
1947 Doran	---	Siberian peashrub, American plum, lilac.	Hackberry, blue spruce, Siberian crabapple, common chokecherry.	Golden willow, green ash, Siberian elm.	Eastern cottonwood, silver maple, robusta cottonwood.
1948*: Fargo	Peking cotoneaster	Redosier dogwood, American plum, Siberian peashrub, common chokecherry, eastern redcedar, lilac.	Green ash, hackberry, Siberian crabapple, Black Hills spruce, Amur maple.	Golden willow, green ash, Siberian elm.	Eastern cottonwood, silver maple.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1948*:					
Lindaas	Peking cotoneaster	Lilac, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Siberian crabapple, Black Hills spruce, bur oak.	Golden willow, green ash, Siberian elm.	Eastern cottonwood, silver maple.
1949 Gardena	---	Siberian peashrub, American plum, lilac.	Hackberry, blue spruce, Siberian crabapple, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood, Siberian elm.
1950 Ludden	Peking cotoneaster	Eastern redcedar, lilac, redosier dogwood, Siberian peashrub, American plum, common chokecherry.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow, green ash, Siberian elm.	Eastern cottonwood, silver maple.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
26----- Aazdahl	Slight-----	Slight-----	Slight-----	Slight-----	Slight.
34----- Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
46----- Borup	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
47----- Colvin	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
51----- La Prairie	Severe: flooding.	Slight-----	Moderate: flooding.	Slight-----	Moderate: flooding.
56----- Fargo	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
57----- Fargo	Severe: flooding, wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.	Severe: wetness, too clayey.
58----- Kittson	Slight-----	Slight-----	Slight-----	Slight-----	Slight.
60----- Glyndon	Slight-----	Slight-----	Slight-----	Slight-----	Slight.
67A----- Bearden	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness.	Slight-----	Slight.
67B----- Bearden	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness.	Slight-----	Slight.
108----- McIntosh	Slight-----	Slight-----	Slight-----	Slight-----	Slight.
141----- Egeland	Slight-----	Slight-----	Slight-----	Slight-----	Slight.
171B----- Formdale	Slight-----	Slight-----	Moderate: slope.	Slight-----	Slight.
184----- Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight-----	Slight.
236----- Vallers	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
245B----- Lohnes	Slight-----	Slight-----	Moderate: slope.	Slight-----	Moderate: droughty.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
276 Oldham	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
293 Swenoda	Slight	Slight	Slight	Slight	Slight.
343 Wheatville	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: percs slowly.	Slight	Slight.
344 Quam	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
371 Clontarf	Slight	Slight	Slight	Slight	Moderate: droughty.
418 Lamoure	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
434 Perella	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
437E Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
450 Rauville	Severe: flooding, ponding.	Severe: ponding.	Severe: ponding, flooding.	Severe: ponding.	Severe: ponding, flooding.
494B Darnen	Slight	Slight	Moderate: slope.	Slight	Slight.
582 Roliss	Severe: flooding, wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
642 Clearwater	Severe: flooding, wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
646B Peever	Slight	Slight	Moderate: slope.	Slight	Slight.
698 Doran	Slight	Slight	Slight	Slight	Slight.
814*:					
Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight	Slight.
Lindaas	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
816 Fargo	Severe: flooding, wetness, too clayey.	Severe: wetness, too clayey, excess salt.	Severe: wetness.	Severe: wetness, too clayey.	Severe: excess salt, wetness.
821*:					
Doran	Slight	Slight	Slight	Slight	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
821*:					
Lindaas	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
822B*:					
Peever	Slight	Slight	Moderate: slope.	Slight	Slight.
Buse	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
900*:					
Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight	Slight.
Aazdahl	Slight	Slight	Slight	Slight	Slight.
Lindaas	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
915B*:					
Formdale	Slight	Slight	Moderate: slope.	Slight	Slight.
Buse	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
915C2*:					
Buse	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Formdale	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
922*:					
Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight	Slight.
Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
948*:					
McIntosh	Slight	Slight	Slight	Slight	Slight.
Lindaas	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1020*. Udorthents					
1030*:					
Udorthents.					
Pits.					
1916 Lindaas	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
1918 Croke	Slight	Slight	Slight	Slight	Slight.
1933*:					
Bearden	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness.	Slight	Slight.
Lindaas	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1940 Quam	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1947 Doran	Slight	Slight	Slight	Slight	Slight.
1948*:					
Fargo	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Lindaas	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1949 Gardena	Slight	Slight	Slight	Slight	Slight.
1950 Ludden	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba-ceous plants	Hardwood trees	Conif-erous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
26----------------- Aazdahl	Good	Good	Good	Good	Good	Poor	Fair	Good	Fair	Poor.
34----------------- Parnell	Fair	Fair	Poor	Poor	Very poor.	Good	Good	Fair	Poor	Good.
46----------------- Borup	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
47----------------- Colvin	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
51----------------- La Prairie	Good	Good	Good	---	---	Poor	Poor	Good	---	Poor.
56----------------- Fargo	Good	Good	Fair	---	---	Good	Fair	Fair	---	Fair.
57----------------- Fargo	Good	Good	Fair	---	---	Poor	Fair	Fair	---	Poor.
58----------------- Kittson	Good	Good	Good	Fair	Fair	Fair	Poor	Good	Fair	Fair.
60----------------- Glyndon	Good	Good	Good	Fair	Poor	Poor	Poor	Good	Fair	Poor.
67A, 67B----------- Bearden	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
108---------------- McIntosh	Good	Good	Good	Fair	Fair	Fair	Fair	Good	Fair	Fair.
141---------------- Egeland	Fair	Good	Good	Good	Fair	Very poor.	Very poor.	Good	Fair	Very poor.
171B--------------- Formdale	Good	Good	Good	Good	Fair	Poor	Fair	Good	Fair	Poor.
184---------------- Hamerly	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
236---------------- Vallers	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
245B--------------- Lohnes	Fair	Good	Good	Poor	Poor	Poor	Very poor.	Good	Poor	Very poor.
276---------------- Oldham	Good	Good	Good	Poor	Poor	Good	Good	Good	Poor	Good.
293---------------- Swenoda	Fair	Fair	Good	Good	Very poor.	Very poor.	Very poor.	Fair	Very poor.	Very poor.
343---------------- Wheatville	Good	Good	Good	Fair	Poor	Poor	Fair	Good	Fair	Fair.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
344: Quam	Fair	Fair	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
371: Clontarf	Fair	Fair	Good	Good	Good	Poor	Poor	Fair	Good	Poor.
418: Lamoure	Good	Good	Fair	Good	Good	Fair	Fair	Good	Good	Fair.
434: Perella	Poor	Fair	Good	Fair	Fair	Good	Good	Fair	Fair	Good.
437E: Buse	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
450: Rauville	Very poor.	Poor	Fair	Very poor.	Very poor.	Good	Good	Very poor.	Very poor.	Fair.
494B: Darnen	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
582: Roliss	Good	Good	Good	Fair	---	Good	Fair	Good	Fair	Fair.
642: Clearwater	Good	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair.
646B: Peever	Fair	Fair	Good	Fair	Very poor.	Very poor.	Very poor.	Fair	Very poor.	Very poor.
698: Doran	Good	Good	Good	---	---	Fair	Fair	Good	---	Fair.
814*:										
Hamerly	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Lindaas	Poor	Poor	Fair	---	---	Good	Good	Poor	---	Good.
816: Fargo	Fair	Fair	Fair	---	---	Poor	Good	Fair	---	Fair.
821*:										
Doran	Good	Good	Good	---	---	Fair	Fair	Good	---	Fair.
Lindaas	Poor	Poor	Fair	---	---	Good	Good	Poor	---	Good.
822B*:										
Peever	Fair	Fair	Good	Fair	Very poor.	Very poor.	Very poor.	Fair	Very poor.	Very poor.
Buse	Good	Good	Fair	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.
900*:										
Hamerly	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Aazdahl	Good	Good	Good	Good	Good	Poor	Fair	Good	Fair	Poor.
Lindaas	Poor	Poor	Fair	---	---	Good	Good	Poor	---	Good.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
915B*:										
Formdale	Good	Good	Good	Good	Fair	Poor	Fair	Good	Fair	Poor.
Buse	Good	Good	Fair	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.
915C2*:										
Buse	Fair	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Formdale	Good	Good	Good	Good	Fair	Poor	Fair	Good	Fair	Poor.
922*:										
Hamerly	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Parnell	Fair	Fair	Poor	Poor	Very poor.	Good	Good	Fair	Poor	Good.
948*:										
McIntosh	Good	Good	Good	Fair	Fair	Fair	Fair	Good	Fair	Fair.
Lindaas	Poor	Poor	Fair	---	---	Good	Good	Poor	---	Good.
1020*. Udorthents										
1030*:										
Udorthents.										
Pits.										
1916 Lindaas	Poor	Poor	Fair	---	---	Good	Good	Poor	---	Good.
1918 Croke	Good	Good	Good	Fair	Fair	Poor	Fair	Good	Fair	Poor.
1933*:										
Bearden	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Lindaas	Poor	Poor	Fair	---	---	Good	Good	Poor	---	Good.
1940 Quam	Very poor.	Poor	Very poor.	Very poor.	Very poor.	Good	Good	Very poor.	Very poor.	Good.
1947 Doran	Good	Good	Good	---	---	Fair	Fair	Good	---	Fair.
1948*:										
Fargo	Good	Good	Fair	---	---	Good	Fair	Fair	---	Fair.
Lindaas	Poor	Poor	Fair	---	---	Good	Good	Poor	---	Good.
1949 Gardena	Good	Good	Good	Good	Very poor.	Very poor.	Very poor.	Good	Very poor.	Very poor.
1950 Ludden	Fair	Fair	Good	---	---	Poor	Good	Fair	---	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
26---------------- Aazdahl	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: frost action, low strength.	Slight.
34---------------- Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.	Severe: ponding.
46---------------- Borup	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
47---------------- Colvin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
51---------------- La Prairie	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, low strength.	Moderate: flooding.
56---------------- Fargo	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness.
57---------------- Fargo	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness, too clayey.
58---------------- Kittson	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: frost action.	Slight.
60---------------- Glyndon	Severe: cutbanks cave.	Slight---------	Moderate: wetness.	Slight---------	Severe: frost action.	Slight.
67A--------------- Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.	Slight.
67B--------------- Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell, slope.	Severe: low strength, frost action.	Slight.
108--------------- McIntosh	Moderate: wetness.	Slight---------	Moderate: wetness, shrink-swell.	Slight---------	Severe: frost action.	Slight.
141--------------- Egeland	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Slight.
171B-------------- Formdale	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
184 Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.	Slight.
236 Vallers	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: frost action.	Moderate: wetness.
245B Lohnes	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
276 Oldham	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.	Severe: ponding.
293 Swenoda	Moderate: wetness.	Slight	Moderate: wetness, shrink-swell.	Slight	Moderate: frost action.	Slight.
343 Wheatville	Severe: cutbanks cave.	Slight	Severe: shrink-swell.	Slight	Severe: frost action.	Slight.
344 Quam	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
371 Clontarf	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.	Moderate: droughty.
418 Lamoure	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.	Severe: wetness.
434 Perella	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
437E Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
450 Rauville	Severe: cutbanks cave, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: low strength, ponding, flooding.	Severe: ponding, flooding.
494B Darnen	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action.	Slight.
582 Roliss	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, frost action.	Moderate: wetness.
642 Clearwater	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, frost action.	Moderate: wetness.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
646B Peever	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.	Slight.
698 Doran	Moderate: wetness.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, frost action, shrink-swell.	Slight.
814*:						
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.	Slight.
Lindaas	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
816 Fargo	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: excess salt, wetness.
821*:						
Doran	Moderate: wetness.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, frost action, shrink-swell.	Slight.
Lindaas	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
822B*:						
Peever	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.	Slight.
Buse	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell.	Slight.
900*:						
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.	Slight.
Aazdahl	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: frost action, low strength.	Slight.
Lindaas	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
915B*:						
Formdale	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
Buse	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell.	Slight.
915C2*:						
Buse	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, shrink-swell.	Moderate: slope.
Formdale	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
922*:						
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.	Slight.
Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.	Severe: ponding.
948*:						
McIntosh	Moderate: wetness.	Slight	Moderate: wetness, shrink-swell.	Slight	Severe: frost action.	Slight.
Lindaas	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
1020*. Udorthents						
1030*:						
Udorthents.						
Pits.						
1916 Lindaas	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
1918 Croke	Severe: cutbanks cave.	Slight	Severe: shrink-swell.	Slight	Severe: frost action.	Slight.
1933*:						
Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.	Slight.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
1933*:						
Lindaas	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
1940 Quam	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
1947 Doran	Moderate: wetness.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength, frost action.	Slight.
1948*:						
Fargo	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness.
Lindaas	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
1949 Gardena	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.	Slight.
1950 Ludden	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness.	Severe: wetness, flooding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
26 Aazdahl	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
34 Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
46 Borup	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness, seepage, too sandy.	Severe: seepage, wetness.	Poor: wetness.
47 Colvin	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
51 La Prairie	Severe: flooding, wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Good.
56, 57 Fargo	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
58 Kittson	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
60 Glyndon	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Fair: too sandy, wetness.
67A, 67B Bearden	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack.
108 McIntosh	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
141 Egeland	Moderate: percs slowly.	Severe: seepage.	Moderate: too sandy.	Severe: seepage.	Poor: seepage.
171B Formdale	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
184 Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
236 Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
245B----------------- Lohnes	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
276----------------- Oldham	Severe: ponding, percs slowly.	Slight-----------	Severe: ponding.	Severe: ponding.	Poor: hard to pack, ponding.
293----------------- Swenoda	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
343----------------- Wheatville	Severe: wetness, percs slowly.	Severe: seepage.	Severe: wetness, too clayey.	Severe: seepage, wetness.	Poor: too clayey, hard to pack.
344----------------- Quam	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
371----------------- Clontarf	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
418----------------- Lamoure	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
434----------------- Perella	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
437E---------------- Buse	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
450----------------- Rauville	Severe: flooding, ponding, percs slowly.	Severe: seepage, flooding, ponding.	Severe: flooding, seepage, ponding.	Severe: flooding, ponding.	Poor: hard to pack, ponding.
494B---------------- Darnen	Moderate: percs slowly.	Moderate: seepage, slope.	Slight-----------	Slight-----------	Good.
582----------------- Roliss	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
642----------------- Clearwater	Severe: wetness, percs slowly.	Slight-----------	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
646B---------------- Peever	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight-----------	Poor: too clayey, hard to pack.
698----------------- Doran	Severe: wetness, percs slowly.	Slight-----------	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
814*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Lindaas	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
816 Fargo	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
821*:					
Doran	Severe: wetness, percs slowly.	Slight	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Lindaas	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
822B*:					
Peever	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
Buse	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
900*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Aazdahl	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Lindaas	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
915B*:					
Formdale	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Buse	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
915C2*:					
Buse	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Formdale	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
922*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
948*:					
McIntosh	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Lindaas	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
1020*. Udorthents					
1030*: Udorthents.					
Pits.					
1916 Lindaas	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
1918 Croke	Severe: wetness, percs slowly.	Severe: seepage.	Severe: wetness, too clayey.	Severe: seepage, wetness.	Poor: too clayey, hard to pack.
1933*:					
Bearden	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack.
Lindaas	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
1940 Quam	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
1947 Doran	Severe: wetness, percs slowly.	Severe: seepage.	Severe: seepage, wetness.	Severe: wetness.	Poor: hard to pack.
1948*:					
Fargo	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Lindaas	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1949 Gardena	Moderate: wetness.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Good.
1950 Ludden	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
26 Aazdahl	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
34 Parnell	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
46 Borup	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
47 Colvin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
51 La Prairie	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
56, 57 Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, too clayey.
58 Kittson	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
60 Glyndon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
67A, 67B Bearden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
108 McIntosh	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
141 Egeland	Good	Improbable: thin layer.	Improbable: too sandy.	Fair: too sandy, small stones.
171B Formdale	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
184 Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
236 Vallers	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
245B Lohnes	Good	Probable	Improbable: too sandy.	Poor: too sandy.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
276------------------- Oldham	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
293------------------- Swenoda	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
343------------------- Wheatville	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too sandy, thin layer.
344------------------- Quam	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
371------------------- Clontarf	Good-----------------	Probable-------------	Improbable: too sandy.	Fair: thin layer.
418------------------- Lamoure	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
434------------------- Perella	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
437E------------------ Buse	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
450------------------- Rauville	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
494B------------------ Darnen	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
582------------------- Roliss	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
642------------------- Clearwater	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
646B------------------ Peever	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
698------------------- Doran	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
814*: Hamerly---------------	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Lindaas---------------	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
816: Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness, too clayey.
821*:				
Doran	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Lindaas	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
822B*:				
Peever	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
900*:				
Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Aazdahl	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Lindaas	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
915B*:				
Formdale	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
915C2*:				
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
Formdale	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
922*:				
Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
922*:				
Parnell	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
948*:				
McIntosh	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
Lindaas	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
1020*. Udorthents				
1030*: Udorthents.				
Pits.				
1916 Lindaas	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
1918 Croke	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too sandy, thin layer.
1933*:				
Bearden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Lindaas	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
1940 Quam	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
1947 Doran	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
1948*:				
Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, too clayey.
Lindaas	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
1949 Gardena	Good	Improbable: excess fines.	Improbable: excess fines.	Good.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1950------------------ Ludden	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
26 Aazdahl	Slight	Moderate: wetness.	Deep to water	Favorable	Erodes easily	Erodes easily.
34 Parnell	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
46 Borup	Severe: seepage.	Severe: piping, wetness.	Frost action, cutbanks cave.	Wetness	Wetness	Wetness.
47 Colvin	Slight	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
51 La Prairie	Moderate: seepage.	Severe: piping.	Deep to water	Flooding	Favorable	Favorable.
56 Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
57 Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
58 Kittson	Moderate: seepage.	Moderate: piping, wetness.	Frost action	Wetness	Wetness	Favorable.
60 Glyndon	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness	Wetness	Erodes easily.
67A Bearden	Slight	Moderate: piping, hard to pack, wetness.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily, rooting depth.
67B Bearden	Moderate: slope.	Moderate: piping, hard to pack, wetness.	Frost action, slope.	Slope, wetness.	Erodes easily, wetness.	Erodes easily, rooting depth.
108 McIntosh	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Favorable	Favorable.
141 Egeland	Severe: seepage.	Severe: seepage, piping.	Deep to water	Favorable	Too sandy	Favorable.
171B Formdale	Moderate: slope.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.
184 Hamerly	Slight	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
236 Vallers	Slight	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
245B: Lohnes	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty.	Too sandy, soil blowing.	Droughty.
276: Oldham	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
293: Swenoda	Severe: seepage.	Severe: piping.	Favorable	Wetness	Erodes easily, wetness.	Erodes easily.
343: Wheatville	Severe: seepage.	Severe: hard to pack.	Percs slowly, frost action.	Wetness	Wetness, percs slowly.	Percs slowly.
344: Quam	Slight	Severe: piping, ponding.	Ponding, frost action.	Ponding	Ponding	Wetness, erodes easily.
371: Clontarf	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
418: Lamoure	Moderate: seepage.	Severe: hard to pack, wetness.	Flooding, frost action.	Wetness, flooding.	Wetness	Wetness.
434: Perella	Slight	Severe: piping, ponding.	Ponding, frost action.	Ponding	Ponding	Wetness.
437E: Buse	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
450: Rauville	Severe: seepage.	Severe: hard to pack, ponding.	Ponding, flooding, frost action.	Ponding, flooding.	Ponding	Wetness.
494B: Darnen	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
582: Roliss	Moderate: seepage.	Severe: piping, wetness.	Frost action	Wetness	Wetness	Wetness.
642: Clearwater	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
646B: Peever	Moderate: slope.	Severe: hard to pack.	Deep to water	Slope, percs slowly.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
698: Doran	Slight	Moderate: piping, wetness.	Deep to water	Percs slowly	Erodes easily, percs slowly.	Erodes easily, percs slowly.
814*:						
Hamerly	Slight	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
814*:						
Lindaas	Moderate: seepage.	Severe: thin layer, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding.	Wetness, erodes easily, percs slowly.
816 Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, excess salt, percs slowly.
821*:						
Doran	Slight	Moderate: piping, wetness.	Deep to water	Percs slowly	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Lindaas	Moderate: seepage.	Severe: thin layer, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding.	Wetness, erodes easily, percs slowly.
822B*:						
Peever	Moderate: slope.	Severe: hard to pack.	Deep to water	Slope, percs slowly.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Buse	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
900*:						
Hamerly	Slight	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Aazdahl	Slight	Moderate: wetness.	Deep to water	Favorable	Erodes easily	Erodes easily.
Lindaas	Moderate: seepage.	Severe: thin layer, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding.	Wetness, erodes easily, percs slowly.
915B*:						
Formdale	Moderate: slope.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.
Buse	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
915C2*:						
Buse	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Formdale	Severe: slope.	Slight	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
922*:						
Hamerly	Slight	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Parnell	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
948*:						
McIntosh	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Favorable	Favorable.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
948*:						
Lindaas	Moderate: seepage.	Severe: thin layer, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding.	Wetness, erodes easily, percs slowly.
1020*. Udorthents						
1030*: Udorthents.						
Pits.						
1916 Lindaas	Moderate: seepage.	Severe: thin layer, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding.	Wetness, erodes easily, percs slowly.
1918 Croke	Severe: seepage.	Severe: hard to pack.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Percs slowly.
1933*:						
Bearden	Slight	Moderate: piping, hard to pack, wetness.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily, rooting depth.
Lindaas	Moderate: seepage.	Severe: thin layer, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding.	Wetness, erodes easily, percs slowly.
1940 Quam	Slight	Severe: piping, ponding.	Ponding, frost action.	Ponding	Ponding	Wetness, erodes easily.
1947 Doran	Severe: seepage.	Severe: thin layer.	Deep to water	Percs slowly	Erodes easily, percs slowly.	Erodes easily, percs slowly.
1948*:						
Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
Lindaas	Moderate: seepage.	Severe: thin layer, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding.	Wetness, erodes easily, percs slowly.
1949 Gardena	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
1950 Ludden	Slight	Severe: wetness.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
26--------------- Aazdahl	0-10	Clay loam--------	CL	A-7, A-6	0-3	95-100	90-100	85-100	75-90	35-50	15-30
	10-18	Clay loam, silty clay loam.	CL	A-7, A-6	0-3	95-100	90-100	85-95	70-80	35-50	15-30
	18-60	Clay loam, silty clay loam, loam.	CL	A-7, A-6	0-3	95-100	90-100	85-95	70-80	35-50	15-30
34--------------- Parnell	0-16	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-100	40-60	15-30
	16-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
46--------------- Borup	0-10	Loam-------------	ML	A-4	0	100	100	95-100	70-95	20-34	NP-7
	10-25	Very fine sandy loam, silt loam, sandy clay loam.	ML	A-4	0	100	100	90-100	60-95	<30	NP-5
	25-60	Loamy very fine sand, very fine sand, very fine sandy loam.	ML	A-4	0	100	100	85-100	50-90	<30	NP-5
47--------------- Colvin	0-10	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	35-50	15-30
	10-26	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	26-60	Loam, silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25
51--------------- La Prairie	0-6	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	85-95	70-80	25-40	5-15
	6-30	Silt loam, loam, silty clay loam.	CL-ML, CL	A-4, A-6, A-7	0	100	100	85-100	50-80	25-45	5-25
	30-43	Silt loam, loam, silty clay loam.	CL-ML, CL	A-4, A-6, A-7	0	100	100	85-100	70-80	25-45	5-25
	43-60	Stratified fine sandy loam to silty clay loam.	CL-ML, CL, SC, SM-SC	A-4, A-6, A-7	0	100	95-100	75-100	45-80	25-45	5-25
56--------------- Fargo	0-8	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	30-50	11-25
	8-16	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	16-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
57--------------- Fargo	0-7	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	7-23	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	23-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
58--------------- Kittson	0-10	Loam-------------	CL, CL-ML	A-6, A-4	0	100	95-100	85-95	50-75	20-40	5-20
	10-16	Loam, fine sandy loam, sandy loam.	CL, SC	A-6	0-5	90-100	65-100	60-90	40-75	20-40	10-20
	16-60	Loam, clay loam	CL	A-6	0-2	95-100	85-98	80-90	50-75	20-40	10-20
60--------------- Glyndon	0-10	Loam-------------	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	10-25	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	85-95	20-30	NP-10
	25-60	Loamy very fine sand, very fine sand, very fine sandy loam.	ML, SM, SC, CL	A-4	0	100	100	85-100	35-75	10-30	NP-10

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
67A-------------- Bearden	0-11	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	90-100	70-90	20-40	5-20
	11-29	Silt loam, silty clay loam.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	25-55	10-30
	29-60	Silt loam, silty clay loam, loam.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	25-55	10-30
67B-------------- Bearden	0-7	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	80-95	25-55	10-30
	7-17	Silt loam, silty clay loam.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	25-55	10-30
	17-60	Silt loam, silty clay loam, loam.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	25-55	10-30
108-------------- McIntosh	0-8	Silt loam--------	CL-ML, CL, ML	A-4, A-7, A-6	0	100	100	85-100	70-95	20-50	3-25
	8-27	Silt loam, silty clay loam, loam.	ML, CL, CL-ML	A-4, A-6	0	100	95-100	90-100	70-90	20-40	2-15
	27-60	Loam, clay loam	CL, ML	A-6, A-4	0-5	95-100	90-100	80-95	60-80	30-40	7-15
141-------------- Egeland	0-14	Loam-------------	CL, CL-ML	A-4, A-6	0	100	95-100	80-100	50-80	25-40	5-15
	14-19	Sandy loam, fine sandy loam.	SM, SM-SC	A-2, A-4	0	95-100	90-100	70-100	15-50	<30	NP-7
	19-41	Loamy sand, very fine sandy loam, sandy loam.	SM, SP-SM, SM-SC	A-2, A-4	0	95-100	85-100	70-100	10-45	<25	NP-5
	41-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	60-75	20-45	5-25
171B------------- Formdale	0-8	Clay loam--------	CL	A-7, A-6	0-3	95-100	90-100	85-100	75-90	35-50	15-30
	8-18	Clay loam, loam	CL	A-7, A-6	0-3	95-100	90-100	85-95	70-80	35-50	15-30
	18-60	Clay loam, silty clay loam, loam.	CL	A-7, A-6	0-3	95-100	90-100	85-95	70-80	35-50	15-30
184-------------- Hamerly	0-9	Clay loam--------	CL	A-6, A-7	0-5	95-100	90-100	80-95	75-95	30-45	10-25
	9-32	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
	32-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	55-75	20-45	5-25
236-------------- Vallers	0-10	Clay loam--------	OL, CL, ML	A-6, A-7	0	95-100	95-100	95-100	85-95	30-50	11-20
	10-24	Clay loam, silty clay loam, sandy clay loam.	CL	A-6	0	95-100	90-100	80-95	50-80	30-40	11-20
	24-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-100	85-95	60-85	20-40	5-20
245B------------- Lohnes	0-14	Sandy loam-------	SM, SM-SC	A-2, A-4	0	100	100	60-70	30-40	<20	NP-5
	14-60	Coarse sand, loamy coarse sand, loamy sand.	SM, SP-SM, SP	A-2, A-1, A-3	0	80-100	65-100	35-60	2-20	---	NP
276-------------- Oldham	0-10	Silty clay loam	CL, CH, MH, ML	A-7	0	100	95-100	90-100	85-100	40-60	15-25
	10-44	Silty clay loam, clay loam.	CL, CH, MH, ML	A-7	0	100	95-100	85-100	85-100	40-60	15-25
	44-60	Silty clay loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0	100	95-100	85-100	70-100	25-45	5-20
293-------------- Swenoda	0-23	Loam-------------	CL, CL-ML	A-4, A-6	0	100	100	85-95	50-80	25-40	5-15
	23-31	Fine sandy loam, sandy loam.	SM-SC, SM, ML, CL-ML	A-2, A-4	0	100	95-100	60-100	30-55	15-30	NP-10
	31-60	Silt loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6, A-7	0-5	90-100	90-100	75-100	50-95	25-50	5-30

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
343-------------- Wheatville	0-8	Silt loam--------	ML, CL, CL-ML	A-4	0	100	100	90-100	50-95	15-35	NP-10
	8-35	Very fine sandy loam, silt loam, loamy very fine sand.	ML, CL, CL-ML	A-4	0	100	100	85-100	80-95	15-35	NP-10
	35-60	Clay, silty clay, silty clay loam.	CH, CL	A-7, A-6	0	100	100	95-100	90-100	35-80	15-45
344-------------- Quam	0-14	Silt loam--------	OL, ML	A-7, A-4, A-6, A-5	0	100	100	80-100	70-95	30-50	5-20
	14-37	Silty clay loam, silt loam, loam.	CL, ML	A-7, A-6, A-4	0	100	100	80-100	70-95	30-50	5-25
	37-60	Clay loam, silty clay loam, silt loam.	CL, ML, CL-ML	A-4, A-6, A-7	0	100	90-100	85-95	70-90	20-50	5-20
371-------------- Clontarf	0-15	Sandy loam-------	SM	A-2, A-4	0	100	95-100	60-85	25-50	<30	NP-7
	15-29	Sandy loam, loam, fine sandy loam.	SM, ML	A-2, A-4	0	100	95-100	60-95	20-60	<30	NP-7
	29-60	Sand, fine sand, loamy sand.	SP-SM, SM	A-2, A-3	0	100	95-100	50-80	5-35	<20	NP
418-------------- Lamoure	0-24	Silty clay loam	CL, CH, MH, ML	A-7	0	100	100	95-100	85-100	45-70	20-35
	24-55	Silty clay loam, silt loam.	CL, CH, MH, ML	A-7	0	100	100	90-100	85-100	40-70	15-35
	55-60	Silty clay loam, silt loam, loam.	CL, ML	A-6, A-7	0	95-100	95-100	90-100	75-100	30-50	10-20
434-------------- Perella	0-18	Silty clay loam	CL	A-6, A-7	0	100	95-100	95-100	85-95	25-50	10-30
	18-29	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-7, A-6	0	100	95-100	95-100	80-100	25-45	5-25
	29-60	Silt loam, silt, silty clay loam.	ML, CL, CL-ML	A-4, A-6, A-7	0	100	95-100	95-100	80-100	25-50	5-25
437E------------- Buse	0-3	Clay loam--------	CL, ML	A-6, A-7	0	90-100	85-95	70-95	55-90	35-45	10-20
	3-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
450-------------- Rauville	0-33	Silt loam--------	CL, ML	A-6, A-7	0	100	100	90-100	80-100	35-50	10-25
	33-60	Silty clay loam, silt loam.	CL, CH, MH	A-6, A-7	0	100	100	90-100	85-100	35-60	15-28
494B------------- Darnen	0-24	Loam-------------	ML, CL, CL-ML	A-4	0	100	100	85-100	60-90	20-35	2-10
	24-37	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0	100	100	85-100	60-90	20-45	5-25
	37-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0	90-100	90-100	80-95	60-85	20-45	5-25
582-------------- Roliss	0-10	Clay loam--------	CL	A-6, A-7	0	95-100	80-100	80-100	60-80	35-50	15-25
	10-17	Loam, clay loam, silty clay loam.	CL	A-6, A-7	0	95-100	80-100	80-90	60-80	20-50	10-30
	17-60	Loam, clay loam	CL, CL-ML	A-6, A-7, A-4	0	95-100	80-100	80-95	60-80	20-50	5-30
642-------------- Clearwater	0-7	Silty clay loam	CL	A-6, A-7	0	95-100	90-97	80-95	65-90	35-50	15-25
	7-17	Clay, silty clay, silty clay loam.	CL, CH	A-7	0	95-100	90-97	80-95	70-95	40-80	20-50
	17-60	Clay, silty clay, silty clay loam.	CH, CL	A-7	0	95-100	90-100	80-97	75-95	40-80	20-50

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
646B: Peever	0-10	Clay	CL	A-6, A-7	0	100	95-100	90-100	65-90	35-50	12-25
	10-23	Clay, silty clay, clay loam.	CL, CH, MH, ML	A-7	0	100	95-100	85-100	70-85	40-65	15-30
	23-60	Clay loam, clay	CL, CH, MH, ML	A-7	0-5	95-100	90-100	85-100	70-85	40-65	15-30
698: Doran	0-10	Clay loam	CH, CL	A-6, A-7	0	100	100	95-100	65-95	30-60	11-35
	10-16	Clay, clay loam, silty clay.	CH, CL	A-7, A-6	0	100	95-100	90-100	70-95	35-75	15-50
	16-60	Clay loam	CL	A-6, A-7	0-3	100	95-100	85-100	70-80	30-50	11-30
814*: Hamerly	0-9	Clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	75-95	30-45	10-25
	9-32	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
	32-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	55-75	20-45	5-25
Lindaas	0-11	Clay loam	CL	A-6, A-7	0	100	100	95-100	75-95	30-50	11-25
	11-32	Silty clay, clay	CH	A-7	0	100	100	95-100	80-95	50-70	25-45
	32-60	Silt loam, silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	95-100	75-95	30-50	11-25
816: Fargo	0-10	Clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	10-15	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	15-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
821*: Doran	0-10	Silty clay loam	CH, CL	A-6, A-7	0	100	100	95-100	65-95	30-60	11-35
	10-16	Clay, clay loam, silty clay.	CH, CL	A-7, A-6	0	100	95-100	90-100	70-95	35-75	15-50
	16-60	Clay loam	CL	A-6, A-7	0-3	100	95-100	85-100	70-80	30-50	11-30
Lindaas	0-10	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	75-95	30-50	11-25
	10-26	Silty clay, clay	CH	A-7	0	100	100	95-100	80-95	50-70	25-45
	26-60	Silt loam, silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	95-100	75-95	30-50	11-25
822B*: Peever	0-10	Clay	CL	A-6, A-7	0	100	95-100	90-100	65-90	35-50	12-25
	10-36	Clay, silty clay, clay loam.	CL, CH, MH, ML	A-7	0	100	95-100	85-100	70-85	40-65	15-30
	36-60	Clay loam, clay	CL, CH, MH, ML	A-7	0-5	95-100	90-100	85-100	70-85	40-65	15-30
Buse	0-7	Clay loam	CL, ML	A-6, A-7	0	90-100	85-95	70-95	55-90	35-45	10-20
	7-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
900*: Hamerly	0-11	Clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	75-95	30-45	10-25
	11-27	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
	27-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	55-75	20-45	5-25

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
900*:											
Aazdahl----------	0-15	Clay loam--------	CL	A-7, A-6	0-3	95-100	90-100	85-100	75-90	35-50	15-30
	15-20	Clay loam, silty clay loam.	CL	A-7, A-6	0-3	95-100	90-100	85-95	70-80	35-50	15-30
	20-60	Clay loam, silty clay loam, loam.	CL	A-7, A-6	0-3	95-100	90-100	85-95	70-80	35-50	15-30
Lindaas----------	0-19	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	75-95	30-50	11-25
	19-28	Silty clay, clay	CH	A-7	0	100	100	95-100	80-95	50-70	25-45
	28-60	Silt loam, silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	95-100	75-95	30-50	11-25
915B*:											
Formdale---------	0-10	Clay loam--------	CL	A-7, A-6	0-3	95-100	90-100	85-100	75-90	35-50	15-30
	10-17	Clay loam, loam	CL	A-7, A-6	0-3	95-100	90-100	85-95	70-80	35-50	15-30
	17-60	Clay loam, silty clay loam, loam.	CL	A-7, A-6	0-3	95-100	90-100	85-95	70-80	35-50	15-30
Buse-------------	0-10	Clay loam--------	CL, ML	A-6, A-7	0	90-100	85-95	70-95	55-90	35-45	10-20
	10-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
915C2*:											
Buse-------------	0-9	Clay loam--------	CL, ML	A-6, A-7	0	90-100	85-95	70-95	55-90	35-45	10-20
	9-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
Formdale---------	0-8	Clay loam--------	CL	A-7, A-6	0-3	95-100	90-100	85-100	75-90	35-50	15-30
	8-25	Clay loam, loam	CL	A-7, A-6	0-3	95-100	90-100	85-95	70-80	35-50	15-30
	25-60	Clay loam, silty clay loam, loam.	CL	A-7, A-6	0-3	95-100	90-100	85-95	70-80	35-50	15-30
922*:											
Hamerly----------	0-8	Clay loam--------	CL	A-6, A-7	0-5	95-100	90-100	80-95	75-95	30-45	10-25
	8-28	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
	28-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	55-75	20-45	5-25
Parnell----------	0-18	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-100	40-60	15-30
	18-39	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	39-60	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
948*:											
McIntosh---------	0-14	Silt loam--------	CL-ML, CL, ML	A-4, A-7, A-6	0	100	100	85-100	70-95	20-50	3-25
	14-27	Silt loam, silty clay loam, loam.	ML, CL, CL-ML	A-4, A-6	0	100	95-100	90-100	70-90	20-40	2-15
	27-60	Loam, clay loam	CL, ML	A-6, A-4	0-5	95-100	90-100	80-95	60-80	30-40	7-15
Lindaas----------	0-16	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	75-95	30-50	11-25
	16-33	Silty clay, clay	CH	A-7	0	100	100	95-100	80-95	50-70	25-45
	33-60	Silt loam, silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	95-100	75-95	30-50	11-25

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
1020*. Udorthents											
1030*: Udorthents.											
Pits.											
1916------------- Lindaas	0-9	Clay loam--------	CL	A-6, A-7	0	100	100	95-100	75-95	30-50	11-25
	9-25	Silty clay, clay	CH	A-7	0	100	100	95-100	80-95	50-70	25-45
	25-60	Silt loam, silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	95-100	75-95	30-50	11-25
1918------------- Croke	0-9	Loam-------------	OL, ML, CL-ML, CL	A-4	0	100	100	90-100	50-95	15-35	NP-10
	9-25	Very fine sandy loam, silt loam, loamy very fine sand.	ML, CL-ML, CL	A-4	0	100	100	85-100	80-95	15-35	NP-10
	25-60	Clay, silty clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	90-100	40-75	20-45
1933*: Bearden---------	0-10	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	90-100	70-90	20-40	5-20
	10-18	Silt loam, silty clay loam.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	25-55	10-30
	18-60	Silt loam, silty clay loam, loam.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	25-55	10-30
Lindaas---------	0-10	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	75-95	30-50	11-25
	10-26	Silty clay, clay	CH	A-7	0	100	100	95-100	80-95	50-70	25-45
	26-60	Silt loam, silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	95-100	75-95	30-50	11-25
1940------------- Quam	0-30	Silty clay loam	CL, ML, OL	A-7	0	100	100	90-100	85-95	40-50	15-25
	30-40	Silty clay loam, silt loam, loam.	CL, ML	A-7, A-6, A-4	0	100	100	80-100	70-95	30-50	5-25
	40-60	Clay loam, silty clay loam, silt loam.	CL, ML, CL-ML	A-4, A-6, A-7	0	100	90-100	85-95	70-90	20-50	5-20
1947------------- Doran	0-10	Silty clay loam	CH, CL	A-6, A-7	0	100	100	95-100	65-95	30-60	11-35
	10-16	Clay, clay loam, silty clay.	CH, CL	A-7, A-6	0	100	95-100	90-100	70-95	35-70	20-50
	16-40	Silty clay loam, clay loam.	CH, CL	A-6, A-7	0	100	95-100	90-100	70-80	30-60	11-35
	40-60	Very fine sandy loam, silt loam.	ML, SM, CL, SC	A-4	0	100	100	85-100	35-75	10-30	NP-10
1948*: Fargo-----------	0-11	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	30-50	11-25
	11-16	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	16-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
Lindaas---------	0-8	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	75-95	30-50	11-25
	8-31	Silty clay, clay	CH	A-7	0	100	100	95-100	80-95	50-70	25-45
	31-60	Silt loam, silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	95-100	75-95	30-50	11-25

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
1949------------- Gardena	0-17	Loam-------------	ML, CL-ML, CL	A-4, A-6	0	100	100	75-100	60-100	25-40	NP-15
	17-60	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4, A-6	0	100	100	75-100	55-100	20-40	NP-15
1950------------- Ludden	0-10	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	30-50	11-25
	10-33	Silty clay, clay	CH	A-7	0	100	100	95-100	75-95	50-75	25-50
	33-60	Silty clay, clay, clay loam.	CH	A-7	0	100	100	95-100	75-95	50-75	25-50

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
26---------------Aazdahl	0-10	27-35	1.30-1.50	0.6-2.0	0.17-0.19	6.6-7.3	<2	Moderate	0.24	5	6	4-6
	10-18	27-35	1.40-1.60	0.2-0.6	0.17-0.19	6.6-7.8	<2	Moderate	0.37			
	18-60	24-35	1.50-1.65	0.2-0.6	0.14-0.17	7.4-8.4	<2	Moderate	0.37			
34---------------Parnell	0-16	27-40	1.20-1.30	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	7	6-10
	16-60	35-60	1.20-1.30	0.06-0.2	0.13-0.19	6.1-7.8	<2	High------	0.28			
46---------------Borup	0-10	15-27	1.20-1.40	2.0-6.0	0.20-0.23	7.4-8.4	<4	Low-------	0.28	4	4L	4-8
	10-25	10-18	1.30-1.50	2.0-6.0	0.17-0.20	7.4-8.4	<4	Low-------	0.28			
	25-60	5-18	1.35-1.65	2.0-20	0.15-0.19	7.4-8.4	2-8	Low-------	0.28			
47---------------Colvin	0-10	27-34	1.20-1.50	0.2-0.6	0.20-0.22	7.4-9.0	<2	Moderate	0.32	5	4L	4-7
	10-26	18-34	1.20-1.50	0.2-0.6	0.16-0.20	7.4-9.0	<2	Moderate	0.32			
	26-60	18-34	1.30-1.50	0.2-0.6	0.15-0.20	7.4-9.0	<2	Moderate	0.32			
51---------------La Prairie	0-6	18-27	1.10-1.40	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low-------	0.28	5	6	2-6
	6-30	18-35	1.10-1.50	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28			
	30-43	18-35	1.30-1.70	0.6-2.0	0.15-0.22	6.6-8.4	<2	Moderate	0.28			
	43-60	18-30	1.30-1.70	0.6-2.0	0.15-0.22	6.6-8.4	<2	Moderate	0.28			
56---------------Fargo	0-8	27-39	1.10-1.30	0.06-0.2	0.18-0.23	6.6-7.8	<2	Moderate	0.32	5	7	4-10
	8-16	40-60	1.20-1.50	0.06-0.2	0.14-0.17	6.6-8.4	<2	High------	0.32			
	16-60	40-60	1.20-1.50	0.06-0.2	0.14-0.17	7.9-8.4	<2	High------	0.32			
57---------------Fargo	0-7	40-60	1.10-1.30	0.06-0.2	0.15-0.18	6.6-7.8	<2	High------	0.32	5	4	4-10
	7-23	40-60	1.20-1.50	0.06-0.2	0.14-0.17	6.6-8.4	<2	High------	0.32			
	23-60	40-60	1.20-1.50	0.06-0.2	0.14-0.17	7.9-8.4	<2	High------	0.32			
58---------------Kittson	0-10	10-27	1.30-1.45	0.6-2.0	0.20-0.22	6.6-7.8	<2	Low-------	0.24	5	5	4-6
	10-16	18-30	1.35-1.55	0.6-2.0	0.17-0.19	6.6-7.8	<2	Low-------	0.32			
	16-60	18-30	1.40-1.65	0.2-2.0	0.15-0.18	7.4-8.4	<2	Moderate	0.32			
60---------------Glyndon	0-10	15-27	1.20-1.40	0.6-2.0	0.20-0.23	7.4-9.0	<4	Low-------	0.28	5	4L	3-7
	10-25	10-18	1.30-1.50	0.6-6.0	0.17-0.20	7.4-9.0	<4	Low-------	0.43			
	25-60	5-18	1.35-1.65	2.0-6.0	0.15-0.19	7.4-9.0	<4	Low-------	0.43			
67A--------------Bearden	0-11	10-26	1.20-1.40	0.6-2.0	0.20-0.24	7.4-8.4	<4	Moderate	0.28	5	4L	3-7
	11-29	18-34	1.30-1.50	0.2-0.6	0.16-0.22	7.4-8.4	<4	Moderate	0.28			
	29-60	18-34	1.30-1.80	0.2-0.6	0.16-0.22	7.4-8.4	<4	Moderate	0.43			
67B--------------Bearden	0-7	27-39	1.20-1.40	0.2-0.6	0.17-0.23	7.4-8.4	<4	Moderate	0.28	5	4L	3-7
	7-17	18-34	1.30-1.50	0.2-0.6	0.16-0.22	7.4-8.4	<4	Moderate	0.28			
	17-60	18-34	1.30-1.80	0.2-0.6	0.16-0.22	7.4-8.4	<4	Moderate	0.43			
108--------------McIntosh	0-8	18-29	1.35-1.50	0.6-2.0	0.18-0.24	7.4-8.4	<2	Moderate	0.28	5	4L	4-7
	8-27	18-35	1.40-1.50	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low-------	0.28			
	27-60	18-35	1.30-1.60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.28			
141--------------Egeland	0-14	15-25	1.20-1.30	0.6-2.0	0.18-0.20	5.6-7.3	<2	Low-------	0.28	5	5	1-3
	14-19	10-18	1.30-1.45	2.0-6.0	0.09-0.15	6.1-7.8	<2	Low-------	0.20			
	19-41	5-10	1.45-1.65	2.0-6.0	0.08-0.12	7.4-8.4	<2	Low-------	0.20			
	41-60	18-35	1.40-1.65	0.6-2.0	0.12-0.16	7.4-8.4	<2	Moderate	0.37			
171B-------------Formdale	0-8	27-35	1.30-1.50	0.6-2.0	0.17-0.19	6.6-7.3	<2	Moderate	0.24	5	6	2-5
	8-18	24-35	1.40-1.60	0.2-0.6	0.17-0.19	6.6-7.8	<2	Moderate	0.37			
	18-60	18-35	1.50-1.65	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodi-bility group	Organic matter
									K	T		
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
184-------------- Hamerly	0-9	27-35	1.20-1.50	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L	4-7
	9-32	18-35	1.20-1.60	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28			
	32-60	18-35	1.30-1.60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
236-------------- Vallers	0-10	28-35	1.20-1.35	0.2-0.6	0.18-0.22	7.4-8.4	<4	Moderate	0.28	5	4L	5-8
	10-24	18-35	1.40-1.55	0.2-0.6	0.15-0.19	7.4-8.4	<4	Moderate	0.28			
	24-60	18-35	1.50-1.70	0.2-0.6	0.17-0.19	7.4-8.4	<4	Low--------	0.28			
245B------------- Lohnes	0-14	5-15	1.50-1.70	2.0-20	0.10-0.13	6.6-7.8	<2	Low--------	0.24	5	3	1-3
	14-60	0-10	1.50-1.70	6.0-20	0.03-0.07	6.6-8.4	<2	Low--------	0.15			
276-------------- Oldham	0-10	35-40	1.15-1.30	0.2-0.6	0.13-0.19	6.6-7.8	<4	High-------	0.28	5	4	4-7
	10-44	35-45	1.25-1.40	0.06-0.6	0.14-0.20	7.4-8.4	<4	High-------	0.28			
	44-60	20-40	1.30-1.50	0.06-0.6	0.14-0.20	7.4-8.4	<2	Moderate	0.43			
293-------------- Swenoda	0-23	15-25	1.20-1.30	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low--------	0.28	5	5	3-7
	23-31	10-18	1.30-1.45	2.0-6.0	0.11-0.17	6.6-7.8	<2	Low--------	0.20			
	31-60	20-35	1.35-1.65	0.2-2.0	0.17-0.20	7.4-8.4	<4	Moderate	0.37			
343-------------- Wheatville	0-8	15-27	1.25-1.40	2.0-6.0	0.18-0.22	7.4-8.4	<4	Low--------	0.28	4	4L	3-7
	8-35	5-18	1.35-1.55	2.0-6.0	0.15-0.21	7.4-8.4	<4	Low--------	0.28			
	35-60	35-80	1.15-1.50	0.06-0.2	0.10-0.14	7.4-7.8	<4	High-------	0.28			
344-------------- Quam	0-14	22-27	1.00-1.40	0.6-2.0	0.22-0.24	6.6-7.8	<2	Low--------	0.28	5	6	6-15
	14-37	22-35	1.25-1.45	0.2-0.6	0.16-0.22	6.6-7.8	<2	Moderate	0.28			
	37-60	20-35	1.40-1.65	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
371-------------- Clontarf	0-15	10-18	1.35-1.55	2.0-6.0	0.13-0.18	6.1-7.3	<2	Low--------	0.20	4	3	3-6
	15-29	10-18	1.45-1.60	2.0-6.0	0.12-0.19	6.1-7.8	<2	Low--------	0.20			
	29-60	5-10	1.55-1.70	6.0-20	0.05-0.09	6.6-7.8	<2	Low--------	0.15			
418-------------- Lamoure	0-24	27-34	1.15-1.25	0.2-2.0	0.19-0.22	7.4-8.4	<4	Moderate	0.28	5	4L	4-8
	24-55	25-34	1.20-1.35	0.2-2.0	0.17-0.20	7.4-8.4	<4	Moderate	0.28			
	55-60	25-34	1.20-1.35	0.2-2.0	0.17-0.20	7.4-8.4	<4	Moderate	0.28			
434-------------- Perella	0-18	27-39	1.20-1.40	0.2-2.0	0.18-0.23	6.6-7.8	<2	Moderate	0.28	5	7	4-8
	18-29	18-34	1.30-1.50	0.2-0.6	0.15-0.22	6.6-7.8	<2	Moderate	0.28			
	29-60	18-34	1.30-1.60	0.2-0.6	0.16-0.22	7.4-8.4	<2	Moderate	0.28			
437E------------- Buse	0-3	27-35	1.40-1.50	0.2-0.6	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L	1-3
	3-60	18-35	1.55-1.65	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
450-------------- Rauville	0-33	15-26	0.85-1.10	0.6-2.0	0.19-0.22	7.4-8.4	<2	Moderate	0.28	5	8	4-7
	33-60	20-35	1.10-1.30	0.2-2.0	0.17-0.20	7.4-8.4	<4	Moderate	0.28			
494B------------- Darnen	0-24	18-27	1.25-1.40	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	6	4-8
	24-37	18-30	1.40-1.60	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.28			
	37-60	18-30	1.55-1.65	0.6-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
582-------------- Roliss	0-10	28-35	1.10-1.40	0.2-0.6	0.18-0.22	6.6-8.4	<2	Moderate	0.28	5	6	3-7
	10-17	18-35	1.30-1.70	0.2-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28			
	17-60	18-35	1.30-1.70	0.2-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28			
642-------------- Clearwater	0-7	28-40	1.10-1.30	0.2-0.6	0.17-0.22	6.6-7.8	<2	Moderate	0.28	5	4	3-6
	7-17	35-60	1.20-1.50	0.06-0.2	0.15-0.18	7.4-8.4	<2	High-------	0.32			
	17-60	35-60	1.20-1.60	0.06-0.2	0.15-0.18	7.4-8.4	<2	High-------	0.32			
646B------------- Peever	0-10	35-40	1.25-1.35	0.2-0.6	0.19-0.22	6.1-7.3	<2	Moderate	0.28	5	6	3-6
	10-23	35-50	1.25-1.40	0.06-0.6	0.11-0.19	6.6-7.8	<2	High-------	0.28			
	23-60	30-45	1.50-1.70	0.06-0.6	0.08-0.17	7.4-8.4	<4	High-------	0.37			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
698----------------	0-10	27-35	1.25-1.45	0.2-0.6	0.18-0.23	6.6-7.3	<2	Moderate	0.28	5	6	4-8
Doran	10-16	35-50	1.30-1.60	0.06-0.6	0.15-0.19	6.6-7.8	<2	High------	0.28			
	16-60	27-40	1.45-1.65	0.06-0.2	0.14-0.16	7.4-8.4	<2	High------	0.37			
814*:												
Hamerly----------	0-9	27-35	1.20-1.50	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L	4-7
	9-32	18-35	1.20-1.60	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28			
	32-60	18-35	1.30-1.60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
Lindaas----------	0-11	27-35	1.10-1.30	0.6-2.0	0.18-0.23	6.6-7.3	<2	Moderate	0.32	5	6	5-10
	11-32	40-50	1.20-1.40	0.06-0.2	0.14-0.17	6.6-7.8	<2	High------	0.32			
	32-60	25-40	1.20-1.50	0.2-0.6	0.16-0.22	7.4-8.4	<2	Moderate	0.43			
816----------------	0-10	40-60	1.10-1.30	0.06-0.2	0.15-0.18	6.6-7.8	4-16	High------	0.32	5	4	4-10
Fargo	10-15	40-60	1.20-1.50	0.06-0.2	0.14-0.17	6.6-8.4	4-16	High------	0.32			
	15-60	40-60	1.20-1.50	0.06-0.2	0.14-0.17	7.9-8.4	4-16	High------	0.32			
821*:												
Doran------------	0-10	27-35	1.25-1.45	0.2-0.6	0.18-0.23	6.6-7.3	<2	Moderate	0.28	5	6	4-8
	10-16	35-50	1.30-1.60	0.06-0.6	0.15-0.19	6.6-7.8	<2	High------	0.28			
	16-60	27-40	1.45-1.65	0.06-0.2	0.14-0.16	7.4-8.4	<2	High------	0.37			
Lindaas----------	0-10	27-35	1.10-1.30	0.6-2.0	0.18-0.23	6.6-7.3	<2	Moderate	0.32	5	7	5-10
	10-26	40-50	1.20-1.40	0.06-0.2	0.14-0.17	6.6-7.8	<2	High------	0.32			
	26-60	25-40	1.20-1.50	0.2-0.6	0.16-0.22	7.4-8.4	<2	Moderate	0.43			
822B*:												
Peever-----------	0-10	35-40	1.25-1.35	0.2-0.6	0.19-0.22	6.1-7.3	<2	Moderate	0.28	5	6	3-6
	10-36	35-50	1.25-1.40	0.06-0.6	0.11-0.19	6.6-7.8	<2	High------	0.28			
	36-60	30-45	1.50-1.70	0.06-0.6	0.08-0.17	7.4-8.4	<4	High------	0.37			
Buse-------------	0-7	27-35	1.40-1.50	0.2-0.6	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L	1-3
	7-60	18-35	1.55-1.65	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
900*:												
Hamerly----------	0-11	27-35	1.20-1.50	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L	4-7
	11-27	18-35	1.20-1.60	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28			
	27-60	18-35	1.30-1.60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
Aazdahl----------	0-15	27-35	1.30-1.50	0.6-2.0	0.17-0.19	6.6-7.3	<2	Moderate	0.24	5	6	4-6
	15-20	27-35	1.40-1.60	0.2-0.6	0.17-0.19	6.6-7.8	<2	Moderate	0.37			
	20-60	24-35	1.50-1.65	0.2-0.6	0.14-0.17	7.4-8.4	<2	Moderate	0.37			
Lindaas----------	0-19	27-35	1.10-1.30	0.6-2.0	0.18-0.23	6.6-7.3	<2	Moderate	0.32	5	7	5-10
	19-28	40-50	1.20-1.40	0.06-0.2	0.14-0.17	6.6-7.8	<2	High------	0.32			
	28-60	25-40	1.20-1.50	0.2-0.6	0.16-0.22	7.4-8.4	<2	Moderate	0.43			
915B*:												
Formdale---------	0-10	27-35	1.30-1.50	0.6-2.0	0.17-0.19	6.6-7.3	<2	Moderate	0.24	5	6	2-5
	10-17	24-35	1.40-1.60	0.2-0.6	0.17-0.19	6.6-7.8	<2	Moderate	0.37			
	17-60	18-35	1.50-1.65	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
Buse-------------	0-10	27-35	1.40-1.50	0.2-0.6	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L	1-3
	10-60	18-35	1.55-1.65	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
915C2*:												
Buse-------------	0-9	27-35	1.40-1.50	0.2-0.6	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L	1-3
	9-60	18-35	1.55-1.65	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
915C2*:												
Formdale----------	0-8	27-35	1.30-1.50	0.6-2.0	0.17-0.19	6.6-7.3	<2	Moderate	0.24	5	6	2-5
	8-25	24-35	1.40-1.60	0.2-0.6	0.17-0.19	6.6-7.8	<2	Moderate	0.37			
	25-60	18-35	1.50-1.65	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
922*:												
Hamerly----------	0-8	27-35	1.20-1.50	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L	4-7
	8-28	18-35	1.20-1.60	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28			
	28-60	18-35	1.30-1.60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
Parnell----------	0-18	27-40	1.20-1.30	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	7	6-10
	18-39	35-60	1.20-1.30	0.06-0.2	0.13-0.19	6.1-7.8	<2	High------	0.28			
	39-60	35-45	1.20-1.40	0.06-0.2	0.11-0.19	6.6-8.4	<2	High------	0.28			
948*:												
McIntosh---------	0-14	18-29	1.35-1.50	0.6-2.0	0.18-0.24	7.4-8.4	<2	Moderate	0.28	5	4L	4-7
	14-27	18-35	1.40-1.50	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low-------	0.28			
	27-60	18-35	1.30-1.60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.28			
Lindaas----------	0-16	27-35	1.10-1.30	0.6-2.0	0.18-0.23	6.6-7.3	<2	Moderate	0.32	5	7	5-10
	16-33	40-50	1.20-1.40	0.06-0.2	0.14-0.17	6.6-7.8	<2	High------	0.32			
	33-60	25-40	1.20-1.50	0.2-0.6	0.16-0.22	7.4-8.4	<2	Moderate	0.43			
1020*. Udorthents												
1030*: Udorthents.												
Pits.												
1916------------- Lindaas	0-9	27-35	1.10-1.30	0.6-2.0	0.18-0.23	6.6-7.3	<2	Moderate	0.32	5	6	5-10
	9-25	40-50	1.20-1.40	0.06-0.2	0.14-0.17	6.6-7.8	<2	High------	0.32			
	25-60	25-40	1.20-1.50	0.2-0.6	0.16-0.22	7.4-8.4	<2	Moderate	0.43			
1918------------- Croke	0-9	10-18	1.25-1.40	2.0-6.0	0.20-0.24	6.6-7.8	<2	Low-------	0.28	4	5	3-7
	9-25	10-18	1.35-1.55	2.0-6.0	0.17-0.22	6.6-8.4	<2	Low-------	0.28			
	25-60	35-60	1.15-1.50	0.06-0.2	0.10-0.15	7.9-8.4	<2	High------	0.28			
1933*:												
Bearden----------	0-10	10-26	1.20-1.40	0.6-2.0	0.20-0.24	7.4-8.4	<4	Moderate	0.28	5	4L	3-7
	10-18	18-34	1.30-1.50	0.2-0.6	0.16-0.22	7.4-8.4	<4	Moderate	0.28			
	18-60	18-34	1.30-1.80	0.2-0.6	0.16-0.22	7.4-8.4	<4	Moderate	0.43			
Lindaas----------	0-10	27-35	1.10-1.30	0.6-2.0	0.18-0.23	6.6-7.3	<2	Moderate	0.32	5	7	5-10
	10-26	40-50	1.20-1.40	0.06-0.2	0.14-0.17	6.6-7.8	<2	High------	0.32			
	26-60	25-40	1.20-1.50	0.2-0.6	0.16-0.22	7.4-8.4	<2	Moderate	0.43			
1940------------- Quam	0-30	28-35	1.00-1.35	0.2-0.6	0.18-0.22	6.6-7.8	<2	Moderate	0.28	5	7	6-15
	30-40	22-35	1.25-1.45	0.2-0.6	0.16-0.22	6.6-7.8	<2	Moderate	0.28			
	40-60	20-35	1.40-1.65	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
1947------------- Doran	0-10	27-35	1.25-1.45	0.2-0.6	0.18-0.23	6.6-7.3	<2	Moderate	0.28	5	7	4-8
	10-16	35-50	1.30-1.60	0.06-0.6	0.15-0.19	6.6-7.8	<2	High------	0.28			
	16-40	27-40	1.45-1.65	0.06-0.2	0.16-0.22	7.4-8.4	<2	High------	0.37			
	40-60	5-18	1.35-1.65	2.0-6.0	0.18-0.20	7.4-8.4	<2	Low-------	0.28			
1948*:												
Fargo------------	0-11	27-39	1.10-1.30	0.06-0.2	0.18-0.23	6.6-7.8	<2	Moderate	0.32	5	7	4-10
	11-16	40-60	1.20-1.50	0.06-0.2	0.14-0.17	6.6-8.4	<2	High------	0.32			
	16-60	40-60	1.20-1.50	0.06-0.2	0.14-0.17	7.9-8.4	<2	High------	0.32			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
1948*:												
Lindaas----------	0-8	27-35	1.10-1.30	0.6-2.0	0.18-0.23	6.6-7.3	<2	Moderate	0.32	5	7	5-10
	8-31	40-50	1.20-1.40	0.06-0.2	0.14-0.17	6.6-7.8	<2	High------	0.32			
	31-60	25-40	1.20-1.50	0.2-0.6	0.16-0.22	7.4-8.4	<2	Moderate	0.43			
1949------------- Gardena	0-17	12-18	1.10-1.40	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	0.28	5	5	4-8
	17-60	10-18	1.20-1.70	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low-------	0.43			
1950------------- Ludden	0-10	27-39	1.10-1.30	0.06-0.2	0.18-0.23	6.1-8.4	<4	Moderate	0.28	5	4L	4-9
	10-33	40-60	1.20-1.50	0.06-0.2	0.13-0.16	7.9-8.4	<4	High------	0.28			
	33-60	35-60	1.20-1.50	0.06-0.2	0.13-0.16	7.9-8.4	<8	High------	0.28			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
26----------------- Aazdahl	B	None---------	---	---	3.0-6.0	Apparent	Mar-May	High-----	Moderate	Low.
34----------------- Parnell	C/D	None---------	---	---	+2-2.0	Apparent	Jan-Dec	High-----	High-----	Low.
46----------------- Borup	B/D	None---------	---	---	1.0-2.5	Apparent	Apr-Jul	High-----	High-----	Low.
47----------------- Colvin	C/D	None---------	---	---	1.0-2.0	Apparent	Apr-Jul	High-----	High-----	Low.
51----------------- La Prairie	B	Occasional	Brief-----	Mar-Jun	3.5-6.0	Apparent	Mar-Jun	Moderate	Moderate	Low.
56, 57------------- Fargo	D	Rare---------	---	---	0-3.0	Apparent	Sep-Jun	High-----	High-----	Low.
58----------------- Kittson	C	None---------	---	---	2.5-6.0	Apparent	Nov-Jun	High-----	High-----	Low.
60----------------- Glyndon	B	None---------	---	---	2.5-6.0	Apparent	Apr-Jul	High-----	High-----	Low.
67A, 67B----------- Bearden	C	None---------	---	---	2.0-4.0	Apparent	Apr-Jun	High-----	High-----	Low.
108---------------- McIntosh	B	None---------	---	---	3.0-6.0	Apparent	Apr-Nov	High-----	High-----	Low.
141---------------- Egeland	B	None---------	---	---	>6.0	---	---	Low------	Moderate	Low.
171B--------------- Formdale	B	None---------	---	---	>6.0	---	---	Moderate	Moderate	Low.
184---------------- Hamerly	C	None---------	---	---	2.0-4.0	Apparent	Apr-Jun	High-----	High-----	Low.
236---------------- Vallers	C	Rare---------	---	---	1.0-2.5	Apparent	Nov-Jun	High-----	High-----	Low.
245B--------------- Lohnes	A	None---------	---	---	>6.0	---	---	Low------	Moderate	Low.
276---------------- Oldham	C/D	None---------	---	---	+2-1.0	Apparent	Oct-Jun	High-----	Moderate	High.
293---------------- Swenoda	B	None---------	---	---	2.5-4.0	Perched	Mar-Jun	Moderate	High-----	Moderate.
343---------------- Wheatville	B	None---------	---	---	2.5-6.0	Apparent	Apr-Jul	High-----	High-----	Low.
344---------------- Quam	B/D	None---------	---	---	+2-1.0	Apparent	Jan-Dec	High-----	High-----	Low.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
371----------------- Clontarf	B	None---------	---	---	3.0-5.0	Apparent	Nov-Jun	Moderate	Low-------	Low.
418----------------- Lamoure	C	Occasional	Brief------	Mar-Oct	0-2.0	Apparent	Oct-Jun	High------	High------	Moderate.
434----------------- Perella	B/D	None---------	---	---	+1-1.0	Apparent	Apr-Jul	High------	High------	Low.
437E---------------- Buse	B	None---------	---	---	>6.0	---	---	Moderate	Low-------	Low.
450----------------- Rauville	D	Frequent-----	Brief------	Mar-Oct	+1-2.0	Apparent	Jan-Dec	High------	High------	Moderate.
494B---------------- Darnen	B	None---------	---	---	>6.0	---	---	Moderate	High------	Low.
582----------------- Roliss	B/D	Rare---------	---	---	1.0-3.0	Apparent	Apr-Jul	High------	High------	Low.
642----------------- Clearwater	D	Rare---------	---	---	1.0-3.0	Apparent	Apr-Jul	High------	High------	Low.
646B---------------- Peever	C	None---------	---	---	>6.0	---	---	Moderate	High------	Moderate.
698----------------- Doran	C	None---------	---	---	3.0-5.0	Apparent	Apr-Jun	High------	High------	Low.
814*:										
Hamerly------------	C	None---------	---	---	2.0-4.0	Apparent	Apr-Jun	High------	High------	Low.
Lindaas------------	C/D	None---------	---	---	+1-2.0	Apparent	Apr-Jun	High------	High------	Low.
816----------------- Fargo	D	Rare---------	---	---	0-3.0	Apparent	Sep-Jun	High------	High------	Moderate.
821*:										
Doran--------------	C	None---------	---	---	3.0-5.0	Apparent	Apr-Jun	High------	High------	Low.
Lindaas------------	C/D	None---------	---	---	+1-2.0	Apparent	Apr-Jun	High------	High------	Low.
822B*:										
Peever-------------	C	None---------	---	---	>6.0	---	---	Moderate	High------	Moderate.
Buse---------------	B	None---------	---	---	>6.0	---	---	Moderate	Low-------	Low.
900*:										
Hamerly------------	C	None---------	---	---	2.0-4.0	Apparent	Apr-Jun	High------	High------	Low.
Aazdahl------------	B	None---------	---	---	3.0-6.0	Apparent	Mar-May	High------	Moderate	Low.
Lindaas------------	C/D	None---------	---	---	+1-2.0	Apparent	Apr-Jun	High------	High------	Low.
915B*:										
Formdale-----------	B	None---------	---	---	>6.0	---	---	Moderate	Moderate	Low.
Buse---------------	B	None---------	---	---	>6.0	---	---	Moderate	Low-------	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Potential frost action	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft					
915C2*:										
Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
Formdale	B	None	---	---	>6.0	---	---	Moderate	Moderate	Low.
922*:										
Hamerly	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	High	High	Low.
Parnell	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec	High	High	Low.
948*:										
McIntosh	B	None	---	---	3.0-6.0	Apparent	Apr-Nov	High	High	Low.
Lindaas	C/D	None	---	---	+1-2.0	Apparent	Apr-Jun	High	High	Low.
1020*. Udorthents										
1030*:										
Udorthents.										
Pits.										
1916 Lindaas	C/D	None	---	---	+1-2.0	Apparent	Apr-Jun	High	High	Low.
1918 Croke	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	High	High	Low.
1933*:										
Bearden	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	High	High	Low.
Lindaas	C/D	None	---	---	+1-2.0	Apparent	Apr-Jun	High	High	Low.
1940 Quam	B/D	None	---	---	+2-1.0	Apparent	Jan-Dec	High	High	Low.
1947 Doran	C	None	---	---	3.0-5.0	Apparent	Apr-Jun	High	High	Low.
1948*:										
Fargo	D	Rare	---	---	0-3.0	Apparent	Sep-Jun	High	High	Low.
Lindaas	C/D	None	---	---	+1-2.0	Apparent	Apr-Jun	High	High	Low.
1949 Gardena	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	High	Moderate	Low.
1950 Ludden	D	Frequent	Brief to long.	Mar-Jun	0-2.0	Apparent	Mar-Jun	High	High	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Aazdahl	Fine-loamy, mixed Aquic Haploborolls
Bearden	Fine-silty, frigid Aeric Calciaquolls
Borup	Coarse-silty, frigid Typic Calciaquolls
*Buse	Fine-loamy, mixed Udorthentic Haploborolls
Clearwater	Fine, montmorillonitic (calcareous), frigid Typic Haplaquolls
Clontarf	Coarse-loamy, mixed Pachic Udic Haploborolls
Colvin	Fine-silty, frigid Typic Calciaquolls
Croke	Coarse-silty over clayey, mixed Aquic Haploborolls
Darnen	Fine-loamy, mixed Pachic Udic Haploborolls
Doran	Fine, mixed Aquic Argiborolls
Egeland	Coarse-loamy, mixed Udic Haploborolls
Fargo	Fine, montmorillonitic, frigid Vertic Haplaquolls
Formdale	Fine-loamy, mixed Udic Haploborolls
Gardena	Coarse-silty, mixed Pachic Udic Haploborolls
Glyndon	Coarse-silty, frigid Aeric Calciaquolls
Hamerly	Fine-loamy, frigid Aeric Calciaquolls
Kittson	Fine-loamy, mixed Aquic Haploborolls
La Prairie	Fine-loamy, mixed Cumulic Udic Haploborolls
Lamoure	Fine-silty, mixed (calcareous), frigid Cumulic Haplaquolls
Lindaas	Fine, montmorillonitic, frigid Typic Argiaquolls
Lohnes	Sandy, mixed Udorthentic Haploborolls
Ludden	Fine, montmorillonitic (calcareous), frigid Vertic Haplaquolls
McIntosh	Fine-silty, frigid Aeric Calciaquolls
Oldham	Fine, montmorillonitic (calcareous), frigid Cumulic Haplaquolls
Parnell	Fine, montmorillonitic, frigid Typic Argiaquolls
Peever	Fine, montmorillonitic Udic Argiborolls
Perella	Fine-silty, mixed, frigid Typic Haplaquolls
Quam	Fine-silty, mixed, frigid Cumulic Haplaquolls
Rauville	Fine-silty, mixed (calcareous), frigid Cumulic Haplaquolls
Roliss	Fine-loamy, mixed (calcareous), frigid Typic Haplaquolls
Swenoda	Coarse-loamy, mixed Pachic Udic Haploborolls
Udorthents, sloping	Loamy and clayey, mixed, nonacid, frigid Udorthents
Udorthents	Sandy and loamy, mixed, nonacid, frigid Udorthents
Vallers	Fine-loamy, frigid Typic Calciaquolls
Wheatville	Coarse-silty over clayey, frigid Aeric Calciaquolls

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