SOIL SURVEY OF

St. Croix County, Wisconsin

United States Department of Agriculture
Soil Conservation Service
In cooperation with
Research Division of the College of Agricultural
and Life Sciences
University of Wisconsin

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

Major fieldwork for this soil survey was completed in the period 1969–74. Soil names and descriptions were approved in 1975. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1975. This survey was made cooperatively by the Soil Conservation Service and the Research Division of the College of Agricultural and Life Sciences, University of Wisconsin. It is part of the technical assistance furnished to the St. Croix County Soil and Water Conservation District.

The fieldwork that is the basis for this soil survey was partly financed by the St. Croix County Soil and Water Conservation District.

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

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of St. Croix County are shown on the detailed map at the back of this survey. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used [illegible]

soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of management for crops and pasture and management by capability units.

Foresters and others can refer to the section "Woodland," where the soils of the county are grouped according to their suitability for woodland and landscaping and windbreak plantings.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Wildlife."

Community planners and others can read about soil properties that affect the choice of sites for dwellings, industrial buildings, and recreation areas in the section "Interpretation of the Soils for Town and Country Planning" and "Recreation."

Engineers and builders can find, under "Engineering," tables that contain test data, estimates of soil properties, and information [illegible]

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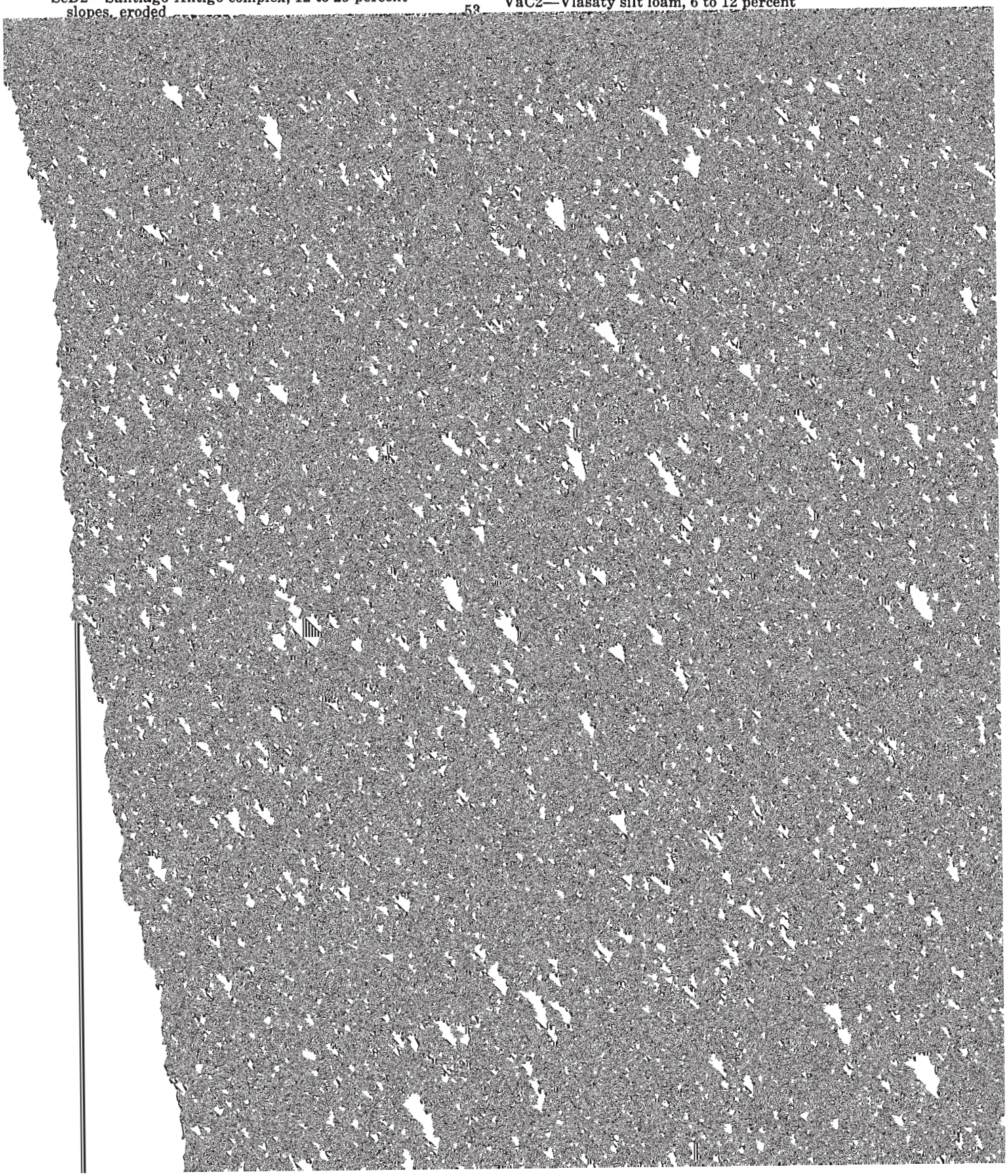

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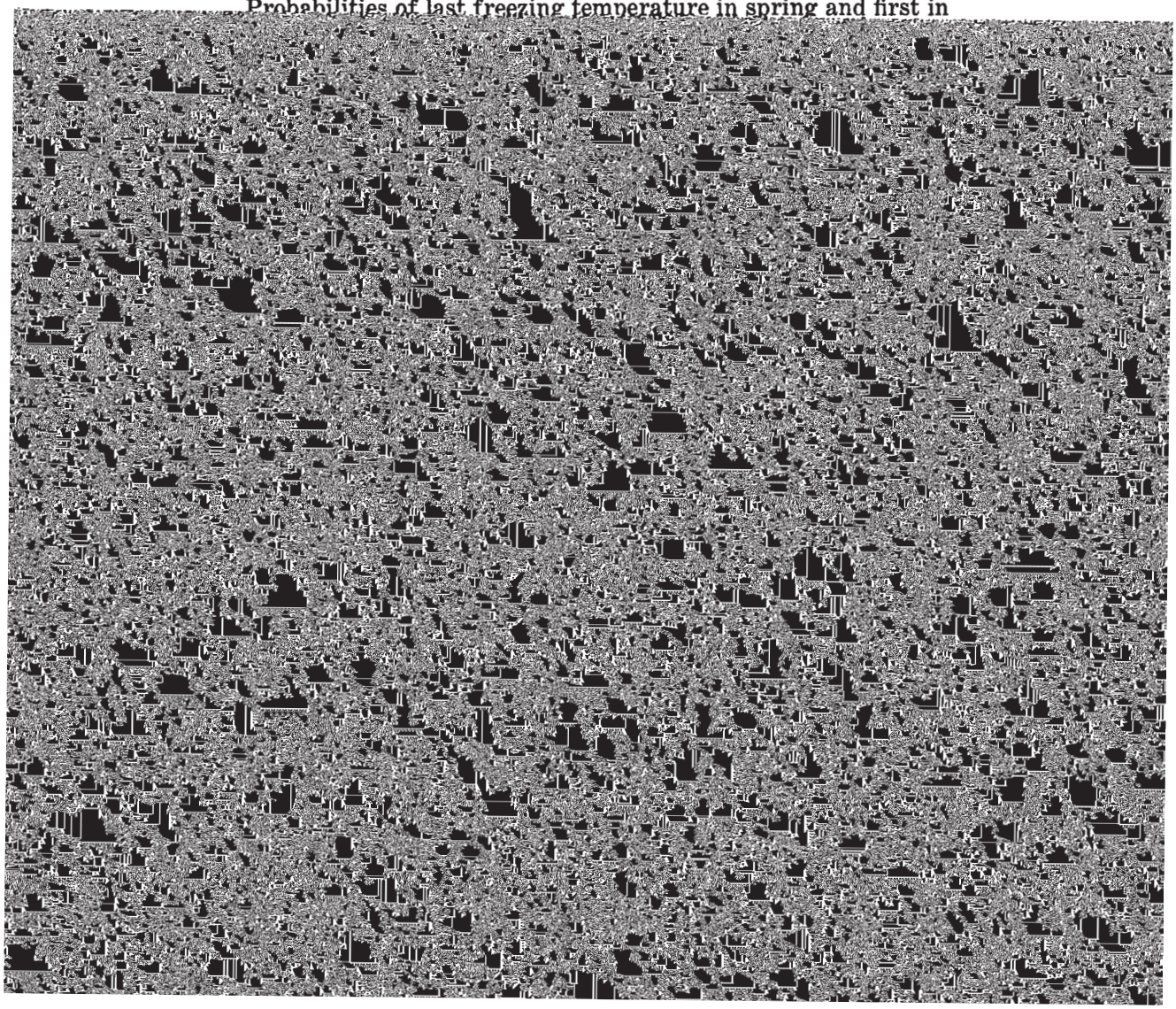


SUPERIOR
MILES

SOIL SURVEY OF ST. CROIX COUNTY, WISCONSIN

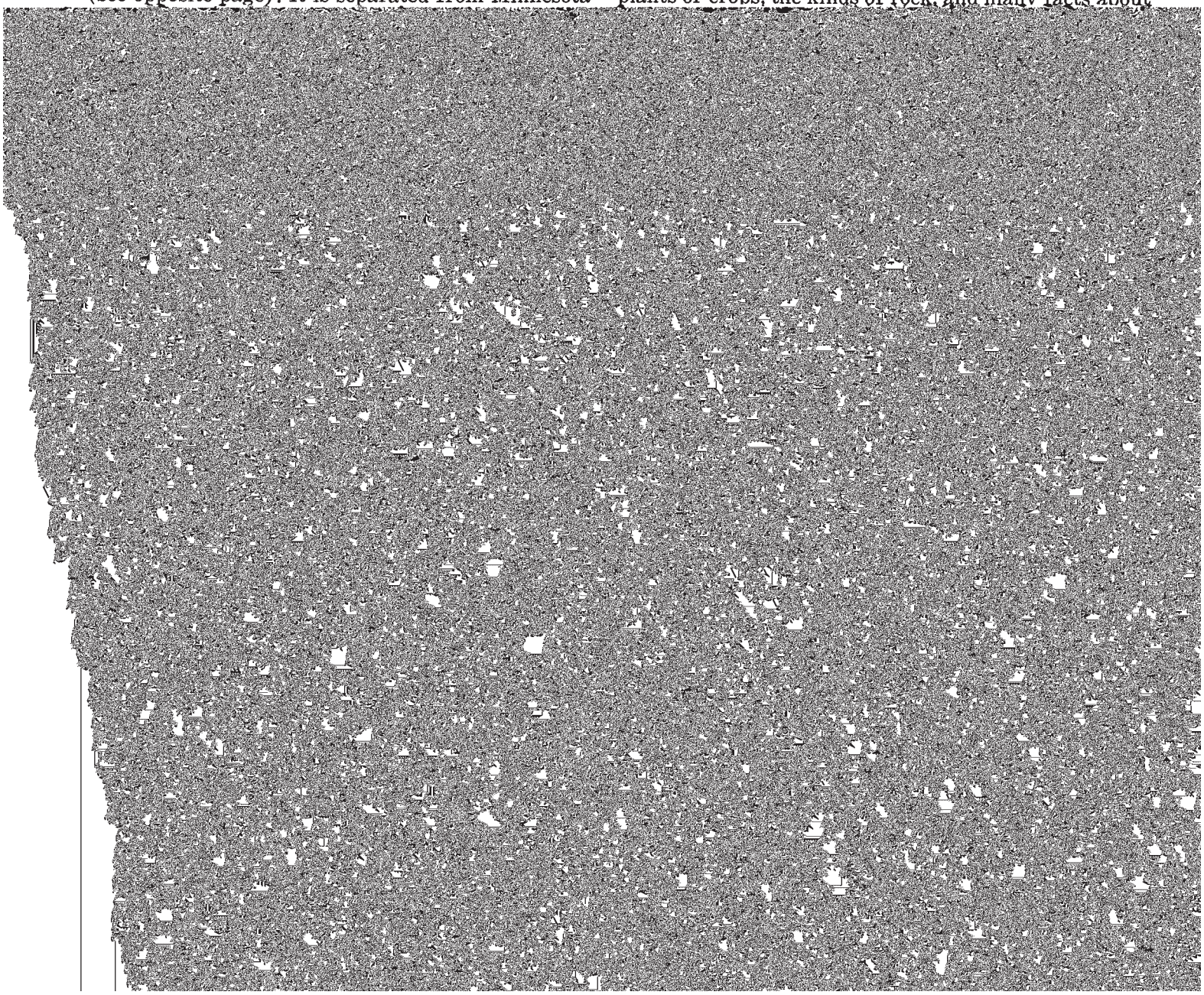
BY JOHN E. LANGTON, SOIL CONSERVATION SERVICE

FIELD WORK BY JOSEPH M. BOELTER, DALE E. JAKEL, KEITH H. WIDDEL AND JOHN E. LANGTON, SOIL CONSERVATION SERVICE.

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE IN COOPERATION WITH THE RESEARCH DIVISION OF THE COLLEGE OF AGRICULTURAL AND LIFE SCIENCES, UNIVERSITY OF WISCONSIN

ST. CROIX COUNTY is in west-central Wisconsin (see opposite page). It is separated from Minnesota

slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about



some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of St. Croix County: soil complexes and undifferentiated groups.

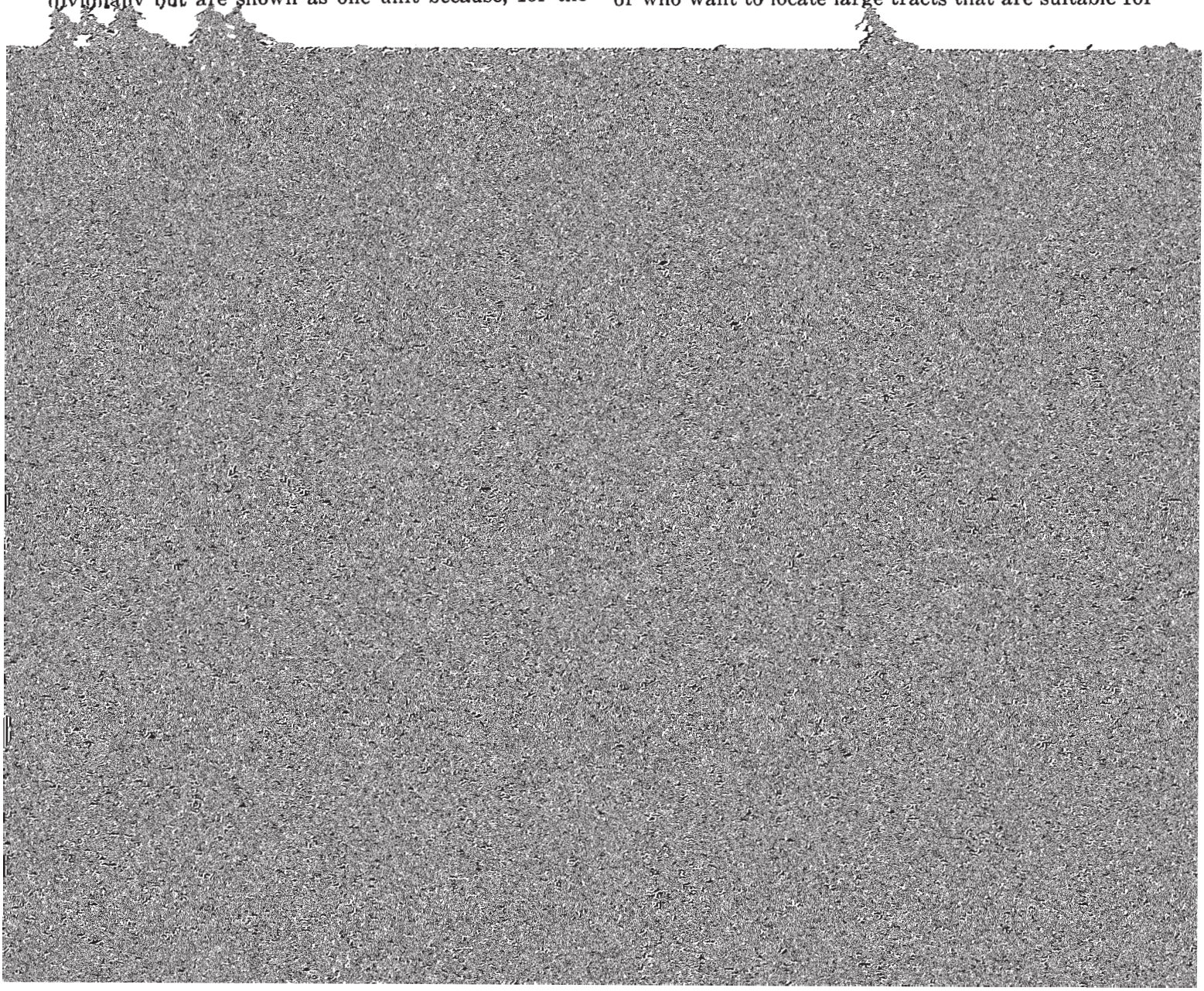
A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Burkhardt-Sattre complex is an example.

An undifferentiated group is made up of two or more soils or miscellaneous areas that could be delineated individually but are shown as one unit because, for the consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in the survey area. A soil association is a landscape that has a distinctive pattern of soils in defined proportions. It typically consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in an association can occur in other associations, but in different patterns.

A map showing soil associations is useful to people who want to have a general idea of the soils in a survey area, who want to compare different parts of that area, or who want to locate large tracts that are suitable for



drained. Typically, the surface layer is dark brown loam about 9 inches thick. The subsurface layer is about 3 inches of brown loam. The subsoil is about 19 inches thick. It is brown and reddish brown, friable sandy loam. The substratum, to a depth of 60 inches, is yellowish red, friable sandy loam.

Cromwell soils are sloping to steep and are somewhat excessively drained. Typically, the surface layer is dark brown sandy loam about 8 inches thick. The subsoil is about 34 inches thick. It is yellowish red, friable, heavy sandy loam in the upper part; yellowish red, very friable, heavy loamy sand in the middle part; and yellowish red, very friable gravelly loamy sand in the lower part. The substratum, to a depth of 60 inches, is strong brown, loose sand.

Among the minor soils in this association are Antigo, Chetek, Onamia, and Santiago soils and Jewett, sandy substratum. Antigo soils are on stream terraces, and Chetek and Onamia soils are on pitted outwash plains. Jewett, sandy substratum, and Santiago soils are on till plains. Ponds, small lakes, and small areas of Saprists and Aquents are common throughout this association.

This association is suited mainly to hay, pasture, and trees, but a few areas of gently sloping and sloping soils are suited to corn, oats, soybeans, and alfalfa. Controlling erosion and soil blowing and maintaining soil fertility are the main concerns of management.

The main enterprises are feeding beef cattle and some dairying, but land use is changing to recreational uses and to homesites. Where slopes are less than 6 percent, Amery soils have slight limitations for homesites and trench type sanitary landfill; they have moderate limitations for septic tank absorption fields, local roads and streets, and sewage lagoons. Where slopes are 6 to 12 percent, Cromwell soils have moderate limitations for homesites, septic tank absorption fields, and local roads and streets. They have severe limitations for trench type sanitary landfill and sewage lagoons.

2. *Burkhardt-Chetek-Sattre association*

Well drained and somewhat excessively drained, nearly level to steep, medium textured and moderately coarse textured soils on outwash plains and stream terraces

This association consists mostly of soils on pitted outwash plains (fig. 1). It makes up about 16 percent of the county.

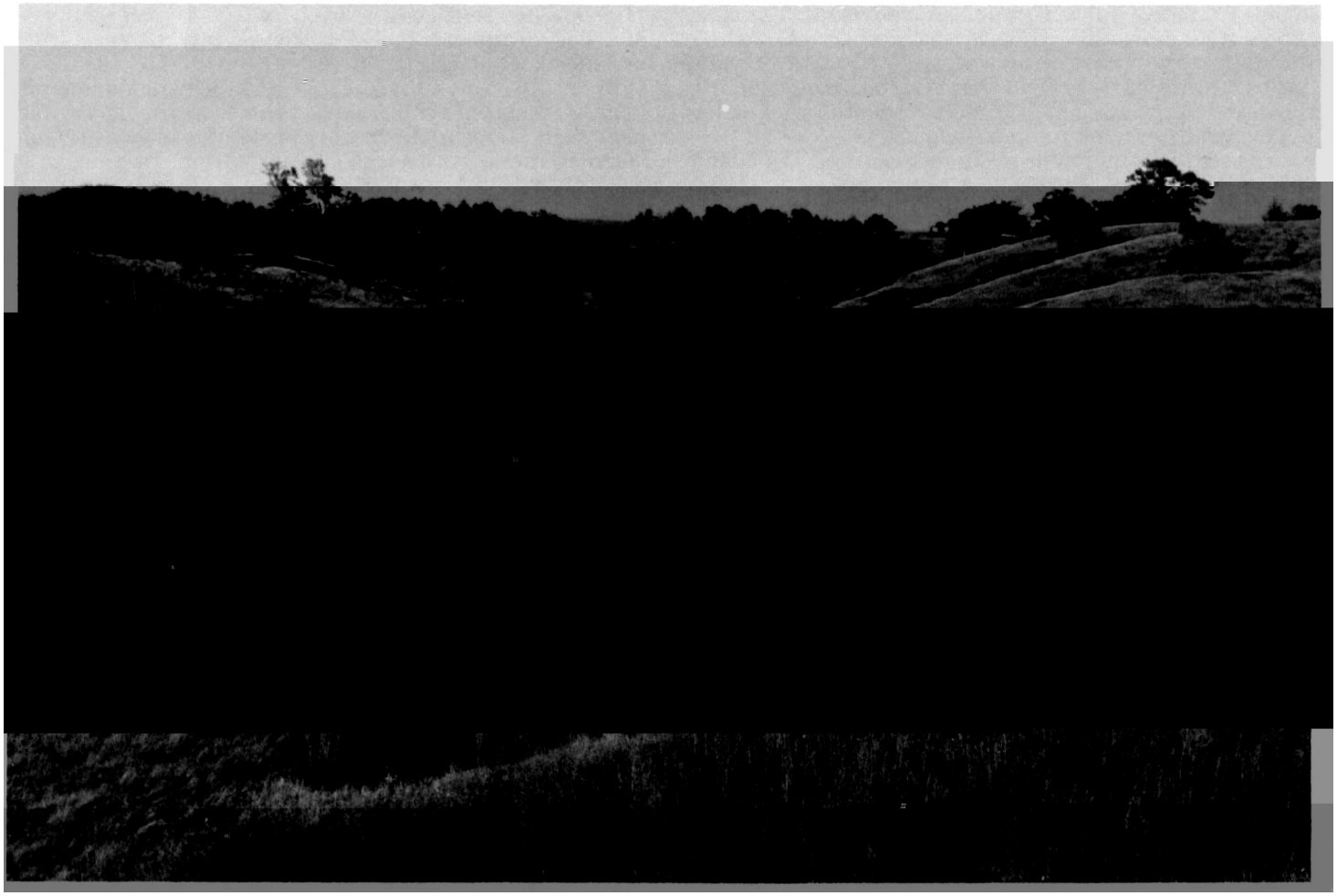


***Figure 1.*—Typical landscape in the Burkhardt-Chetek-Sattre association.**

and moderate available water capacity. Controlling erosion and maintaining soil tilth and fertility are the main concerns of good management.

The main enterprises are dairying and feeding beef cattle. Such cash crops as corn, soybeans, peas, and beans for canning are also frequently grown. Where slopes are less than 6 percent, Sattre, Pillot, and Antigo soils have slight limitations for homesites and septic tank absorption fields. Where slopes are less than 6 percent, Sattre soils have slight limitations and Pillot and Antigo soils have moderate limitations for local roads and streets. All the major soils in this association have severe limitations for trench type sanitary landfill and sewage lagoons.

4. *Plainfield-Boone association*

Excessively drained, gently sloping to moderately steep, coarse textured soils on outwash plains and stream terraces, and soils underlain by sandstone at a relatively shallow depth; on uplands

This association consists of solids on outwash plains, stream terraces, and sandstone uplands. It makes up about 2 percent of the county. It is about 60 percent Plainfield soils, 15 percent Boone soils, and 25 percent minor soils.

Plainfield soils are on outwash plains and stream terraces. They are gently sloping to moderately steep. slopes are less than 6 percent, Plainfield and Boone soils have slight or moderate limitations for septic tank absorption fields and local roads and streets. Where slopes are less than 6 percent, Plainfield soils have slight limitations for homesites and Boone soils have moderate limitations for homesites. Both soils have severe limitations for trench type sanitary landfill and sewage lagoons.

Soils With Moderate to Slow Permeability

This group consists of associations of soils that are well drained to somewhat poorly drained, that have medium textured surface layers, and that have moderate to slow permeability in the subsoil and substratum.

5. *Santiago-Otterholt-Arland association*

Well drained, gently sloping to steep, medium textured soils on till plains, and soils underlain by sandstone at a relatively shallow depth or that have a thick mantle of windblown silt loam

This association consists of soils on sandstone and limestone uplands that are covered in most places by a thin mantle of glacial drift or a thick mantle of windblown silt loam. It makes up about 8 percent of the county. It is about 25 percent Santiago soils, 20 per-

Amery, Boone, Hesch, Magnor, Nickin, Orion, Port Byron, Ritchey, Vlasaty, and Whalan soils. Fluvaquents are also minor soils in this association. Amery soils are on till plains and end moraines. Boone soils are on sandstone uplands. Magnor soils are in drainageways of till plains. Hesch and Nickin soils are on ridges, valleys, and foot slopes of sandstone uplands.

drained. Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsurface layer is dark grayish brown silt loam about 2 inches thick. The subsoil is about 19 inches thick. It is yellowish brown, mottled, friable silt loam in the upper part; dark brown, mottled, firm silty clay loam in the middle part; and olive gray, mottled, firm silty clay in

24 percent Santiago soils, 19 percent Jewett soils, 11 percent Magnor soils, and 46 percent minor soils.

Santiago soils are mostly in the eastern part of this association on ridges of till plains. They are gently sloping and sloping and are well drained. Typically, the surface layer is dark grayish brown silt loam about 7 inches thick. The subsurface layer is brown silt loam about 10 inches thick. The subsoil is about 17 inches thick. It is dark brown, very friable silt loam in the upper part; reddish brown, friable loam in the middle part; and yellowish red, friable heavy sandy loam in the lower part. The substratum, to a depth of 60 inches, is yellowish red, friable sandy loam.

Jewett soils are mostly in the western part of this association on ridges and wide drainageways of till plains. They are nearly level to sloping and are well drained. Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsurface layer is dark grayish brown silt loam about 2 inches thick. The subsoil is about 26 inches thick. It is brown, friable silt loam in the upper part; brown, friable, heavy loam in the middle part; and yellowish red, friable sandy loam in the lower part. The substratum, to a depth of 60 inches, is yellowish red, friable sandy loam.

Magnor soils are in the drainageways of till plains. They are nearly level and gently sloping and are somewhat poorly drained. Typically, the surface layer is very dark brown silt loam about 4 inches thick. The subsurface layer is pale brown silt loam about 14 inches thick. The subsoil is about 14 inches thick. It is mottled, brown, firm loam in the upper part and reddish brown, friable, heavy sandy loam in the lower part. The substratum, to a depth of 60 inches, is yellowish red, friable sandy loam.

Among the minor soils are Adolph, Amery, Antigo, Arland, Freeon, Halder, and Vlasaty soils, and Freeon, heavy substratum, and Jewett, sandy substratum. Adolph soils are in depressional areas on ground moraines and pitted glacial drift. Antigo and Halder soils are on stream terraces. Arland soils are on sandstone uplands that are covered by a thin mantle of glacial drift. Freeon and Freeon, heavy substratum, soils are on low ridges of ground moraines and are closely somewhat poorly drained; but, where adequately drained, they are suited to corn and most other crops. Controlling erosion, maintaining soil tilth and fertility, and draining the somewhat poorly drained to very poorly drained soils are the main concerns of management.

Most soils in this association are used for growing corn, oats, and alfalfa. Such special cash crops as corn, peas, and beans for canning are also commonly grown on Jewett soils. Dairying is the main enterprise.

Jewett soils and gently sloping and sloping Santiago soils have slight or moderate limitations for homesites, septic tank absorption fields, local roads and streets, trench type sanitary landfill, and sewage lagoons. Magnor soils have severe limitations for most of these uses.

8. *Vlasaty-Skyberg association*

Moderately well drained and somewhat poorly drained, nearly level to sloping, medium textured soils on till plains

This association consists of soils on till plains. It makes up about 14 percent of the county. It is about 30 percent Vlasaty soils, 24 percent Skyberg soils, and 46 percent minor soils.

Vlasaty soils are on low ridges of till plains. They are gently sloping and sloping, and are moderately well drained. Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsurface layer is pale brown silt loam about 3 inches thick. The subsoil is about 31 inches thick. It is dark yellowish brown, friable, heavy silt loam in the upper part and brown and dark grayish brown, mottled, very firm clay loam in the lower part. The substratum, to a depth of 60 inches, is olive brown, mottled, very firm clay loam.

Skyberg soils are in drainageways and on foot slopes of till plains. They are nearly level and gently sloping and are somewhat poorly drained. Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsurface layer is mottled, grayish brown silt loam about 10 inches thick. The subsoil is grayish brown, mottled, firm, heavy loam about 14 inches thick. The substratum, to a depth of 60 inches,

Most of this association is used to grow corn, oats, and hay, but many areas of the somewhat poorly drained to very poorly drained soils are in permanent pasture or woods. Dairying is the main enterprise. Vlasaty and Skyberg soils have mostly severe limitations for homesites, septic tank absorption fields, local roads and streets, and trench type sanitary landfill. Vlasaty soils have moderate limitations for homesites and, where slopes are less than 6 percent, they have moderate limitations for sewage lagoons. Skyberg soils have slight limitations for sewage lagoons.

Descriptions of the Soils

This section describes the soil series and mapping units in St. Croix County. Each soil series is described in detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. Color terms are for moist soil unless otherwise stated. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or they are differences that are

depressions of ground moraines. These soils formed in silt sediment and the underlying sandy loam glacial till. Native vegetation was mostly wetland grasses and sedges with some shrubs such as alder and willow and a few scattered trees such as elm, black ash, and tamarack. Unless these soils are drained, water is at or near the surface throughout the year.

In representative profile the surface layer is about 14 inches thick. It is black silt loam in the upper 10 inches and very dark gray, mottled silt loam in the lower 4 inches. The subsoil is about 24 inches thick. It is dark grayish brown and grayish brown, mottled, friable silt loam in the upper part and grayish brown, reddish brown, and yellowish red, mottled, friable, heavy sandy loam in the lower part. The substratum, to a depth of about 60 inches, is yellowish red, mottled, friable heavy sandy loam.

Available water capacity is high. Permeability is moderately slow. Natural fertility is medium. The organic matter content of the surface layer is high. Depth of the root zone is limited for major farm crops by a perched water table at or near the soil surface.

Most areas of these soils are in wetland pasture or wildlife habitat. Where drained, they are suited to corn and other row crops.

Representative profile of Adolph silt loam, 0 to 3 percent slopes, in an uncultivated pasture, about 100 yards south and 80 yards west of northeast corner of sec. 31, T. 30 N., R. 16 W.:

A1—0 to 10 inches; black (10YR 2/1) silt loam; moderate, medium subangular blocky and granular structure; friable; common roots; medium acid; clear smooth boundary.

A12—10 to 14 inches; very dark gray (10YR 3/1) silt loam; common medium faint dark grayish brown (10YR 4/2) mottles; weak medium and fine granular struc-

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Acres	Percent
Adolph silt loam, 0 to 3 percent slopes	1,750	0.4
Amery sandy loam, 2 to 6 percent slopes	1,000	.2
Amery sandy loam, 6 to 12 percent slopes, eroded	2,300	.5
Amery sandy loam, 12 to 25 percent slopes, eroded	3,000	.6
Amery loam, 2 to 6 percent slopes	4,550	1.0
Amery loam, 6 to 12 percent slopes, eroded	14,900	3.2
Amery loam, 12 to 20 percent slopes, eroded	9,700	2.1
Amery loam, 20 to 30 percent slopes, eroded	1,650	.4
Amery-Cromwell sandy loams, 6 to 12 percent slopes, eroded	4,900	1.0
Amery-Cromwell sandy loams, 12 to 25 percent slopes, eroded	4,700	1.0
Antigo silt loam, 0 to 2 percent slopes	2,200	.5
Antigo silt loam, 2 to 6 percent slopes	11,400	2.4
Arland sandy loam, 6 to 12 percent slopes, eroded	2,520	.5
Arland sandy loam, 12 to 25 percent slopes, eroded	3,450	.7
Arland sandy loam, 25 to 35 percent slopes	1,400	.3
Arland silt loam, 2 to 6 percent slopes	4,500	1.0
Arland silt loam, 6 to 12 percent slopes, eroded	3,800	.8
Auburndale silt loam, 0 to 3 percent slopes	2,380	.5
Freeon silt loam, heavy substratum, 6 to 12 percent slopes, eroded	1,650	0.4
Gotham loamy fine sand, 2 to 6 percent slopes	680	.1
Gotham loamy fine sand, 6 to 12 percent slopes	380	.1
Gravel pits	1,070	.2
Halder silt loam, 0 to 3 percent slopes	3,980	.8
Hesch fine sandy loam, 2 to 6 percent slopes	370	.1
Hesch fine sandy loam, 6 to 12 percent slopes, eroded	530	.1
Hesch fine sandy loam, 12 to 20 percent slopes, eroded	550	.1
Hubbard loamy sand, 0 to 6 percent slopes	1,420	.3
Hubbard loamy sand, loamy substratum, 0 to 6 percent slopes	890	.2
Hubbard loamy sand, loamy substratum, 6 to 12 percent slopes	670	.1
Huntsville silt loam, 0 to 3 percent slopes	4,460	.9
Jewett silt loam, 0 to 2 percent slopes	1,850	.4
Jewett silt loam, 2 to 6 percent slopes	15,100	3.2
Jewett silt loam, 6 to 12 percent slopes, eroded	900	.2
Jewett silt loam, sandy substratum, 0 to 2 percent slopes	2,100	.4
Jewett silt loam, sandy substratum, 2 to 6		

TABLE 1.—*Approximate acreage and proportionate extent of the soils*—Continued

Soil	Acres	Percent
Ritchey silt loam, 12 to 20 percent slopes, eroded	1,450	.3
Ritchey soils and Rock outcrop, 20 to 35 percent slopes	6,650	1.4
Rockton silt loam, 2 to 6 percent slopes	990	.2
Rockton silt loam, 6 to 12 percent slopes, eroded	500	.1
Rockton silt loam, 12 to 20 percent slopes, eroded	560	.1
Santiago silt loam, 2 to 6 percent slopes	34,800	7.5
Santiago silt loam, 6 to 12 percent slopes, eroded	13,300	2.8
Santiago-Antigo complex, 6 to 12 percent slopes, eroded	4,850	1.0
Santiago-Antigo complex, 12 to 25 percent slopes, eroded	1,250	.3
Saprists and Aquents	1,960	.4
Sattre loam, 0 to 2 percent slopes	2,050	.4
Sattre loam, 2 to 6 percent slopes	7,350	1.6
Sattre loam, 6 to 12 percent slopes, eroded	3,150	.7
Sattre silt loam, 0 to 2 percent slopes	7,000	1.5
Sattre silt loam, 2 to 6 percent slopes	16,800	3.6
Seelyeville muck	2,600	.6
Skyberg silt loam, 0 to 3 percent slopes	16,200	3.4
Udifluvents	1,100	.2
Vlasaty silt loam, 2 to 6 percent slopes	18,500	4.0
Vlasaty silt loam, 6 to 12 percent slopes, eroded	3,250	.7
Whalan silt loam, 2 to 6 percent slopes	2,950	.6
Whalan silt loam, 6 to 12 percent slopes, eroded	3,100	.7
Whalan silt loam, 12 to 25 percent slopes, eroded	1,300	.3
Water	5,730	1.2
Total	469,760	100.0

[1] Less than 0.05 percent.

friable; about 10 percent coarse fragments by volume; slightly acid; clear habitat. If adequately drained, a few areas are suited to row crops. Capability unit IVw-3; woodland group

structure; brown (7.5YR 4/4) heavy sandy loam (B2t); moderate medium and fine subangular blocky structure; friable; common roots; about 15 percent coarse fragments by volume; neutral; clear wavy boundary.

[illegible] 15 to 24 inches; reddish brown (5YR 4/4) [illegible]

as representative of the series, but its subsoil is thicker and the surface layer contains more sand.

Included with this soil in mapping are a few small areas of Amery loams and silt loams and Cromwell soils. Also included are a few areas where layers of silty sediment are in the till, a few small areas where the soil is severely eroded and has a cobbly and gravelly

Included with this soil in mapping are areas where the surface layer is sandy loam. Also included are a few small areas of Cromwell and Santiago soils and a few small areas where slopes are slightly less than 6 percent or more than 12 percent.

Runoff is medium, and the hazard of erosion is moderate. In many areas erosion has caused deterioration of tilth and soil structure in the surface layer.

This soil is suited to oats, alfalfa, and a limited amount of corn. Controlling erosion and maintaining tilth are important factors of good management. Capability unit IIIe–1; woodland group 2o1.

AmD2—Amery loam, 12 to 20 percent slopes, eroded. This soil is on narrow ridges of ground or end moraines and on areas of pitted glacial drift. Most areas are irregular in shape and range from 5 to 100

similar soils. Positions of these soils on the landscape vary, but the Amery soil is mainly on ridgetops and in slightly concave areas. The Amery soil is less eroded than the Cromwell soil, which is mainly on the crests of knolls and in convex areas.

The Amery soil has a profile similar to the one described as representative of the series, but in most places the surface layer is sandy loam rather than loam. Also, in some areas the sandy loam till is underlain by loamy sand or sand and gravel at a depth of 3 to 5 feet. The Cromwell soil has a profile similar to the one described as representative of the series.

Included with these soils in mapping are uneroded soils that have a surface layer of fine sandy loam, loam, or silt loam. Also included are areas of deep, dark, silty and loamy soils in drainageways; small areas of

In most areas erosion has caused tilth to deteriorate and has reduced the content of organic matter in the surface layer.

Most areas of this complex are in hay or pasture. These soils are generally unsuited to cultivated crops, but they are suited to pasture and hay. Slopes facing south and southwest are more droughty and less suited to trees than slopes facing north and northeast. Controlling erosion and maintaining organic matter content are important factors of good management. Capability unit VIe–4; woodland group 2r1.

Antigo Series

The Antigo series consists of nearly level to steep, well drained soils on stream terraces and outwash plains. These soils formed mainly in silty sediment that is underlain by sand and gravel. Native vegetation was mainly white pine, sugar maple, and red oak.

In a representative profile the surface layer is about 8 inches of dark grayish brown silt loam. The subsurface layer is brown silt loam about 10 inches thick. The subsoil is about 15 inches thick. It is dark yellowish brown, friable, heavy silt loam in the upper part, dark yellowish brown, friable loam in the middle part, and dark brown, very friable, heavy sandy loam in the lower part. The substratum, to a depth of 60 inches, is strong brown sand and gravel (fig. 2).

Available water capacity is moderate. Permeability ranges from moderate in the silty surface layer and upper part of the subsoil to very rapid in the underlying sand and gravel. Natural fertility is medium. The organic matter content of the surface layer is moderate.

Most areas of these soils are in corn. Some areas are used for soybeans and kidney or navy beans.

Representative profile of Antigo silt loam, 0 to 2 percent slopes, in a cultivated field in southwest corner of SE¼, sec. 25, T. 30 N., R. 19 W.:

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam; weak fine and medium subangular blocky structure; very friable; common roots; medium acid; abrupt smooth boundary.

A2—8 to 11 inches; brown (10YR 5/3) silt loam, pale brown (10YR 6/3) dry; moderate thick platy structure parting to weak fine subangular blocky; friable; common roots; medium acid; clear wavy boundary.

A&B—11 to 18 inches; brown (10YR 5/3) tongues of silt loam (A2); weak thin and medium platy structure; dark yellowish brown (10YR 4/4) slightly heavier silt loam (B21t); weak medium subangular blocky structure; friable; common roots; medium acid; clear irregular boundary.

B21t—18 to 25 inches; dark yellowish brown (10 YR 4/4) heavy silt loam; moderate medium subangular blocky structure; friable; uncoated silt and fine sand grains on faces of peds; thin patchy clay films; common roots; strongly acid; clear wavy boundary.

B22t—25 to 29 inches; dark yellowish brown (10 YR 4/4) heavy sandy loam; weak medium subangular blocky structure; friable; thin patchy clay films; common roots; strongly acid; clear wavy boundary.

IIB3—29 to 33 inches; dark brown (7.5YR 4/4) heavy sandy loam; weak medium sub-

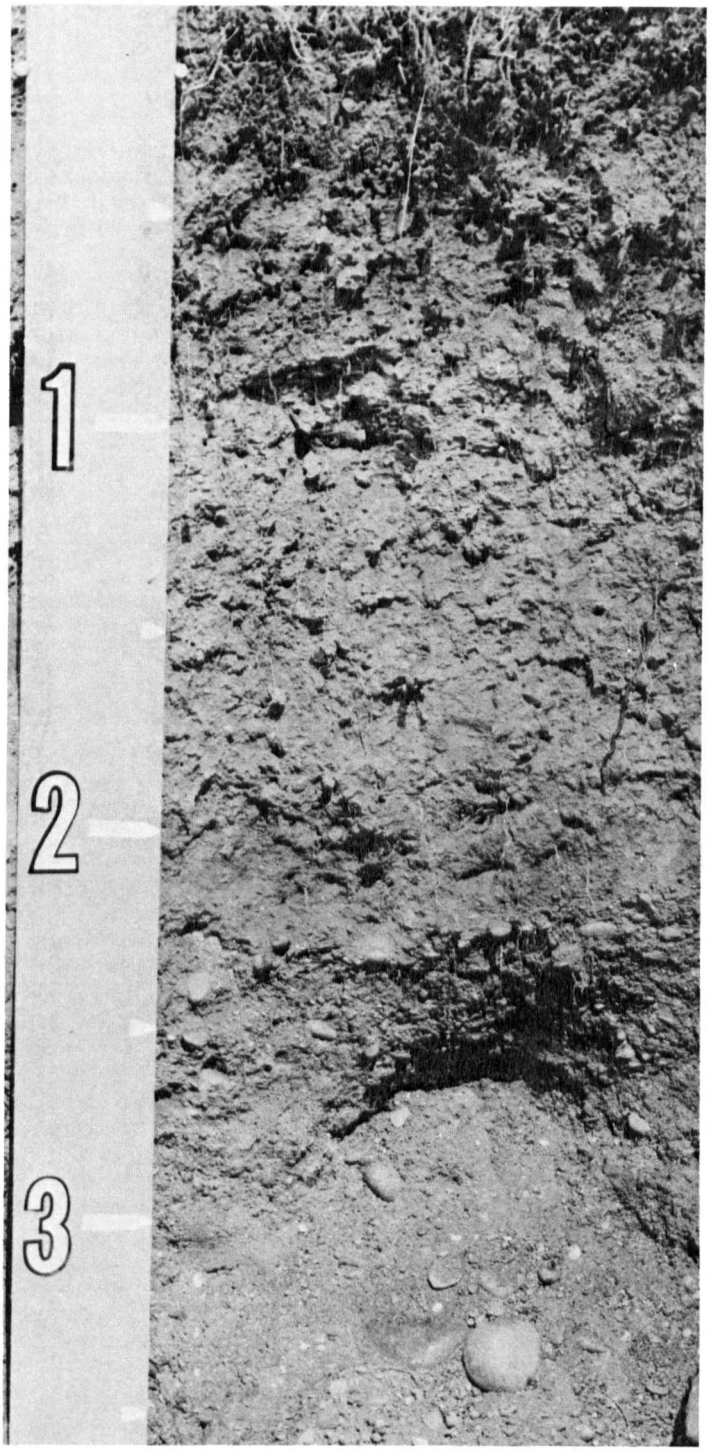


Figure 2.—**Profile of an Antigo silt loam. The underlying sand and gravel is at a depth of about 2½ feet.**

common pebbles; few roots; strongly acid; gradual wavy boundary.

IIC—33 to 60 inches; strong brown (7.5YR 5/6) sand and gravel; single grained; loose; strongly acid.

The solum thickness and depth to sand and gravel range from 20 to 40 inches. The silty mantle is 24 to 36 inches thick. The Ap horizon is very dark brown, dark brown, or dark grayish brown and 6 to 10 inches thick.

The Bt horizon is mainly silt loam or silty clay loam. The C horizon is 10 to 25 percent coarse fragments. This soil is strongly acid in the subsoil and substratum.

Antigo soils are near Onamia and Sattre soils. They contain more silt and less sand and have a thicker A2 horizon than Onamia and Sattre soils. Also, Antigo soils have a lighter colored A horizon than Sattre soils.

AoA—Antigo silt loam, 0 to 2 percent slopes. This soil is on outwash plains and stream terraces. Most areas are oblong and range from 10 to 100 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are a few areas of Onamia and Sattre soils. Also included are a few areas, mainly near the base of steeper slopes, where the silty mantle ranges from 3 to 5 feet in thickness.

Runoff is very slow, and the hazard of erosion is slight.

This soil is moderately well suited to corn and beans. surface layer is brown silt loam about 3 inches thick. The subsoil is about 24 inches thick. It is brown, friable silt loam in the upper part; brown, friable loam in the middle part; and strong brown, friable, heavy sandy loam in the lower part. The substratum, to a depth of 60 inches, is very pale brown, weakly cemented sandstone containing a few thin bands of loose fine sandy loam.

Available water capacity is moderate but ranges to low. Permeability is moderate. Natural fertility is medium but ranges to low in a few areas. The organic matter content of the surface layer is low or moderate.

Most areas of these soils that are gently sloping or sloping are in corn, oats, and alfalfa. Steeper areas of these soils are used mainly for pasture or woodland.

Representative profile of Arland silt loam, 2 to 6 percent slopes, in a cultivated area, 440 yards east and 220 yards south of northwest corner of the SW¼ of sec. 18, T. 28 N., R. 16 W.:

Ap—0 to 8 inches; very dark grayish brown (10 YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; friable; many roots; neutral; abrupt smooth boundary.

A2—8 to 11 inches; brown (10YR 4/3) silt loam; moderate thin and medium platy structure; friable; common roots; neutral; abrupt wavy boundary.

B1—11 to 15 inches; brown (7.5YR 4/4) silt loam;

the lower part of the B horizon. The C horizon is sand weathered from sandstone and weakly cemented sandstone. These soils are strongly acid or very strongly acid in the B horizon and strongly acid to slightly acid in the C horizon.

Arland soils are near Santiago, Skyberg, and Vlasaty soils. They are underlain by sandstone rather than the reddish sandy loam till typical of Santiago soils or the heavy loam or clay loam till typical of Skyberg and Vlasaty soils. Arland soils are well drained but Skyberg soils are somewhat poorly drained.

portant factors of good management. Capability unit IVe–7; woodland group 2r1.

ApF—Arland sandy loam, 25 to 35 percent slopes. This soil is on sandstone and limestone uplands where the mantle of glacial drift is thin or lacking. Most areas are elongated or irregular in shape and range from 10 to 100 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface layer and subsoil contain more sand, and the substratum contains more silt and clay.

ganic matter content are important factors of good management. Capability unit IIIe–2; woodland group 2o1.

Auburndale Series

The Auburndale series consists of nearly level and gently sloping, poorly drained soils in drainageways and depressions of low ground moraines. These soils formed mainly in silty sediment and in the underlying [illegible]

few roots; strongly acid; clear wavy boundary.

IIB3—36 to 40 inches; strong brown (7.5YR 5/6) sandy loam; common medium distinct grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; friable; about 15 percent coarse fragments by volume; neutral; clear wavy boundary.

IIC—40 to 60 inches; strong brown (7.5YR 5/6) [illegible]

These soils are used mainly for woodland, pine tree plantations, and wildlife habitat.

Representative profile of Boone loamy fine sand, 6 to 12 percent slopes, in a pine plantation, 300 yards south and 50 yards east of northwest corner of sec. 24, T. 28 N., R. 18 W.:

A1—0 to 3 inches; black (10YR 2/1) loamy fine

soils that are underlain by limestone bedrock at a depth of 2 to 4 feet.

Runoff is very slow, and the hazard of erosion is slight. This soil is subject to soil blowing.

This soil is poorly suited to row crops, but it is used for alfalfa, grasses, and pine tree plantations. Crop yields during most seasons are limited by low available

lower part. The substratum, to a depth of about 60 inches, is yellowish brown sand and gravel.

Available water capacity is moderate, and permeability ranges from moderate in the silty subsoil to rapid in the underlying sand and gravel. Natural fertility is medium. The organic matter content of the surface layer is moderate.

Most areas of these soils are used for corn, alfalfa, and grasses.

Representative profile of Brill silt loam, 0 to 3 percent slopes, in a cultivated field, 450 yards west and 95 yards north of center of sec. 12, T. 31 N., R. 15 W.:

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; weak fine and medium subangular blocky structure; friable; common roots; neutral; abrupt smooth boundary.

A&B—9 to 16 inches; brown (10YR 5/3) tongues of silt loam (A2); moderate thin platy structure; yellowish brown (10YR 5/4) slightly heavier silt loam (B); weak fine subangular blocky structure; very friable; common roots; slightly acid; clear wavy

races and outwash plains. Most areas are elongated and range from 8 to 20 acres in size.

Included with this soil in mapping are some areas where the subsoil is heavy loam or clay loam. Also included are some areas of Antigo and Halder soils. Some of the included Halder soils are less poorly drained than is typical for that soil.

Runoff is slow, and the hazard of erosion is slight. Tillage is delayed for relatively long periods because this soil remains saturated early in spring and after heavy rain.

This soil is moderately well suited to most of the commonly grown crops, such as corn, oats, and alfalfa-brome hay. The main concerns of management are maintaining tilth and soil structure and removing surface water. Capability unit IIs–1; woodland group 2o1.

Burkhardt Series

The Burkhardt series consists of nearly level to steep, somewhat excessively drained soils on stream terraces, outwash plains, and areas of pitted outwash plains. These soils formed in sandy loam sediment un-

loam; weak medium and coarse subangular blocky structure; friable; strongly acid; clear wavy boundary.

B3—16 to 20 inches; brown (7.5YR 4/4) loamy sand; weak very fine subangular blocky structure; very friable, about 15 percent coarse fragments by volume; strongly acid; clear wavy boundary.

IIC—20 to 60 inches; brownish yellow (10YR 6/6) sand and gravel; about 25 percent coarse fragments by volume; loose; medium acid.

The solum thickness and depth to sand and gravel range from 12 to 24 inches. The A horizon is dark reddish brown, very dark brown, or black. It is 6 to 20 inches thick.

The B horizon is sandy loam or light loam. The C horizon is mostly sand and gravel that originated

organic matter content are important factors of good management. Capability unit IVe–3; woodland group 3d1.

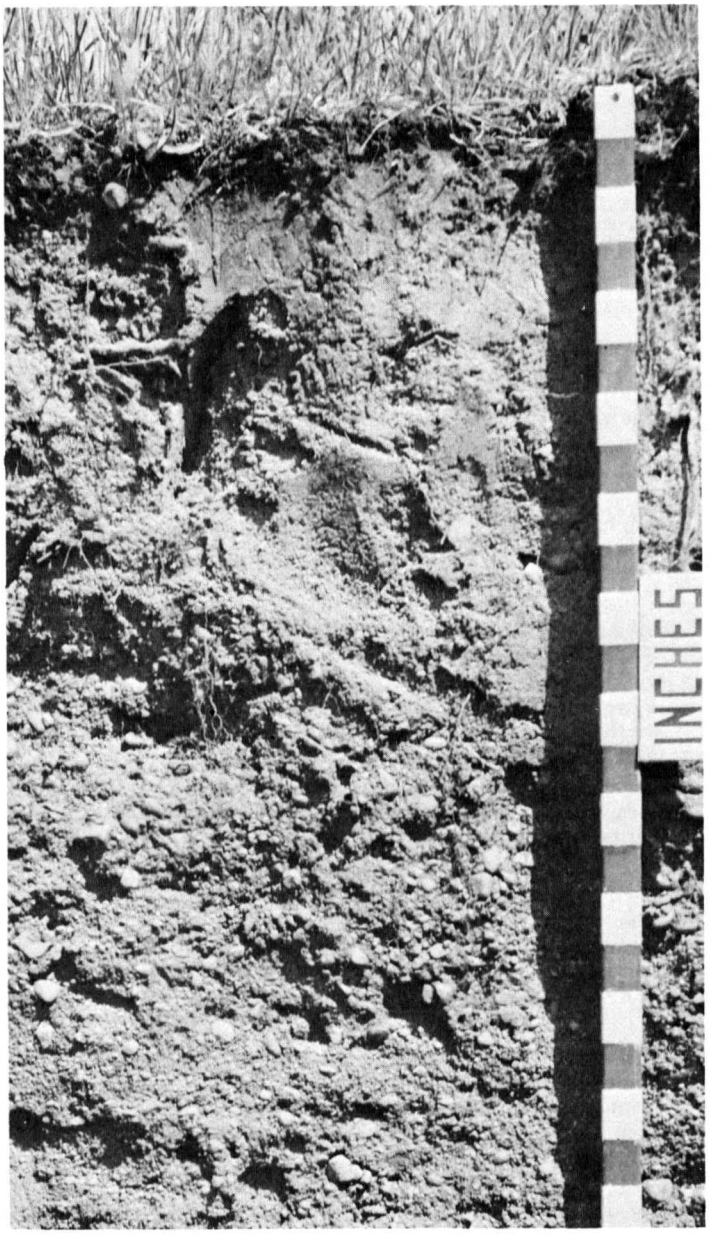
BxB—Burkhardt-Sattre complex, 2 to 6 percent slopes. The soils in this complex are on outwash plains and stream terraces. Most areas are irregular in shape and range from 10 to 60 acres in size.

This complex is about 40 percent Burkhardt sandy loam, 35 percent Sattre loam and silt loam, and 25 percent other soils, mainly Pillot and Dakota soils. The Burkhardt soil is mainly on or near the crests of knolls and in the steeper, more eroded parts of the complex. The Sattre soils are on slightly concave, less eroded parts of knolls, drainageways, and depressions. Pillot and Dakota soils are in some drainageways, depressions, and concave areas.

Included with these soils in mapping are a few areas

areas crop yields are limited by low available water capacity. Controlling erosion and soil blowing and maintaining tilth and organic matter content are important factors of good management. Areas of this complex are good sources of sand and gravel. Capability unit IVe–3; woodland group 3d1.

BxD2—Burkhardt-Sattre complex, 12 to 30 percent slopes, eroded. The soils in this complex are on pitted outwash plains. This complex is about 60 percent Burkhardt sandy loam and loam, 20 percent Sattre loam and silt loam, and 20 percent other soils, mainly Dakota, Pillot, and Chetek soils. The Burkhardt soils are mainly near the crest of knolls and on steeper, more eroded parts of this complex. The Sattre soils are mainly on



sandy loam; moderate coarse and medium subangular blocky structure; friable; common roots; thin patchy clay films on faces of ped; medium acid; clear wavy boundary.

B3—16 to 19 inches; brown (7.5YR 4/4) loamy sand; weak coarse subangular blocky structure; very friable; about 15 percent coarse fragments by volume; medium acid; clear wavy boundary.

C—19 to 60 inches; strong brown (7.5YR 5/6) sand and gravel; single grained; loose; about 25 percent coarse fragments by volume; slightly acid.

The solum thickness and depth to sand and gravel range from 12 to 24 inches. The Ap horizon is very dark grayish brown, dark grayish brown or brown. In uncultivated, wooded areas the Al horizon is very dark brown and less than 4 inches thick. The C horizon is 25 to 35 percent coarse fragments.

Chetek soils are near Antigo and Onamia soils. They are shallower to sand and gravel and they contain more sand than Onamia soils. Also, Chetek soils are shallower to sand and gravel and they lack the silty mantle typical of Antigo soils.

CoC2—Chetek-Onamia complex, 6 to 12 percent slopes, eroded. The soils in this complex are on pitted outwash plains. Most areas are irregular in shape and range from 10 to 200 acres in size. The surface layer in this complex is mainly sandy loam and loam, but in some small areas it is silt loam and loamy sand.

This complex is about 55 percent Chetek sandy loam and 45 percent Onamia sandy loam and loam. The Chetek soil is mainly near the crests of knolls. In most places it is more eroded than the Onamia soils, which are near drainageways and on concave parts of knolls.

The Chetek soil has a profile similar to the one described as representative of the series, but the subsoil is slightly thicker. The Onamia soils have a profile similar to the one described as representative of the series, but the surface layer and subsoil contain slightly more sand.

Included with these soils in mapping are wet soils in depressions, and areas of loams and sandy loams where most of the subsoil formed in silty glacial drift or in reddish colored sandy loam and loam till that is underlain by sand and gravel. Also included are a few small areas where the soil is sandy and gravelly and severely eroded, and a few small areas where slopes are less than 6 percent or more than 12 percent.

Runoff is medium, and the hazard of erosion is moderate. Chetek soils are subject to soil blowing. In most places erosion has caused tilth to deteriorate and has reduced the content of organic matter in the surface layer.

Most areas of this complex are in pasture and hay. These soils are suited mainly to oats, alfalfa, and grasses, but some corn and soybeans are also grown. In many areas crop yields are limited by low available water capacity. Controlling erosion and soil blowing

outwash plains. Most areas are irregular in shape and range from 10 to 150 acres in size. The surface layer in this complex is mainly loam and sandy loam but ranges from silt loam to loamy sand in small areas.

This complex is about 65 percent Chetek sandy loam and 35 percent Onamia sandy loam and loam. The Chetek soil is mainly near the crests of knolls. In most places the Chetek soil is more eroded than the Onamia soils, which are near drainageways and on slightly concave parts of knolls.

The Chetek soil has the profile described as representative of the series. The Onamia soils have a profile similar to the one described as representative of the series, but the surface layer and subsoil contain more sand, and in many areas the soils are more eroded and thinner.

Included with these soils in mapping are a few spots of wet soils in depressions and drainageways, and areas that have a thin mantle of reddish colored silt loam, loam, or sandy loam glacial drift that is underlain by sand and gravel at a depth of 3 to 5 feet. Also included are a few areas where slopes are less than 12 percent or more than 20 percent.

Runoff is rapid, and the hazard of erosion is severe. In most cleared and cultivated areas erosion has caused tilth to deteriorate and has reduced the content of organic matter in the surface layer. Small cobbles and pebbles are on the surface of the more severely eroded soils.

Most areas of this complex are in pasture. A few extensive areas are wooded. This complex is suited to alfalfa, grasses, or red and white pine. In many areas crop yields and tree growth are limited by low available water capacity. Slopes facing south and southwest are more droughty and less suited to trees than slopes facing north and northeast. Controlling erosion and maintaining organic matter content are important factors of good management. Capability unit VIe–3; woodland group 3d2.

CoE—Chetek-Onamia complex, 20 to 30 percent slopes. The soils in this complex are steep and on pitted outwash plains. The surface layer is mainly sandy loam and loam, but in some areas it ranges from loamy sand to silt loam. In some of the draws, depressions, and drainageways the surface layer is dark colored.

This complex is about 70 percent Chetek sandy loam and 30 percent Onamia sandy loam and loam. The Chetek soil is mainly near the crests of knolls. In most areas it is more eroded than the Onamia soils, which are near drainageways and on concave parts of knolls.

The Chetek soil has a profile similar to the one described as representative of the series, but the subsoil is thinner and contains less clay and more sand and gravel. The Onamia soils have a profile similar to the one described as representative of the series, but the surface layer and subsoil are thinner and contain more sand.

Included with these soils in mapping are wet soils in drainageways and depressions, and a few areas of

where slopes are less than 20 percent or more than 30 percent.

Runoff is very rapid, and the hazard of erosion is very severe.

Most areas of this complex are wooded or in pasture. These soils are suited to grasses for pasture. They are also suited to red and white pine. In many areas crop yields are limited by low available water capacity. Slopes facing south and southwest are more droughty and less suited to trees than slopes facing north and northeast. Controlling erosion is an important factor of good management. Capability unit VIIe–3; woodland group 3d2.

Clyde Series

The Clyde series consists of nearly level and gently sloping, poorly drained and very poorly drained soils in drainageways of low ground moraines. These soils formed in silty sediment and the underlying sticky, heavy loam till. Native vegetation was wetland prairie grasses, sedges, brush, and some trees, such as elm, ash, and tamarack. Water is at or near the surface throughout the year.

In a representative profile the surface layer is black silt loam about 18 inches thick (fig. 4). The subsoil is about 16 inches thick. In the upper part it is grayish brown and olive gray, friable, mottled, heavy silt loam; in the lower part it is gray, very sticky, heavy loam. The substratum, to a depth of 60 inches, is greenish gray, plastic, mottled, heavy loam.

Available water capacity is high, and permeability is moderately slow. Natural fertility and the organic matter content of the surface layer are high. Depth of the root zone is limited for most farm crops by a perched water table.

Most areas of these soils are in wetland pasture and woodland. Where drained, Clyde soils are used for corn and other row crops.

Representative profile of Clyde silt loam, 0 to 3 percent slopes, in an uncultivated area, 150 yards east and 70 yards south of northwest corner of sec. 32, T. 29 N., R. 16 W.:

A1—0 to 8 inches; black (10YR 2/1) silt loam; weak moderate medium subangular blocky structure; friable; many roots; mildly alkaline; abrupt smooth boundary.

A12—8 to 12 inches; black (10YR 2/1) silt loam; moderate medium and fine subangular blocky structure; friable; many roots; mildly alkaline; clear smooth boundary.

A3—12 to 18 inches; black (10YR 2/1) silt loam; common fine prominent mottles of reddish brown (5YR 4/4); moderate medium subangular blocky structure; friable,

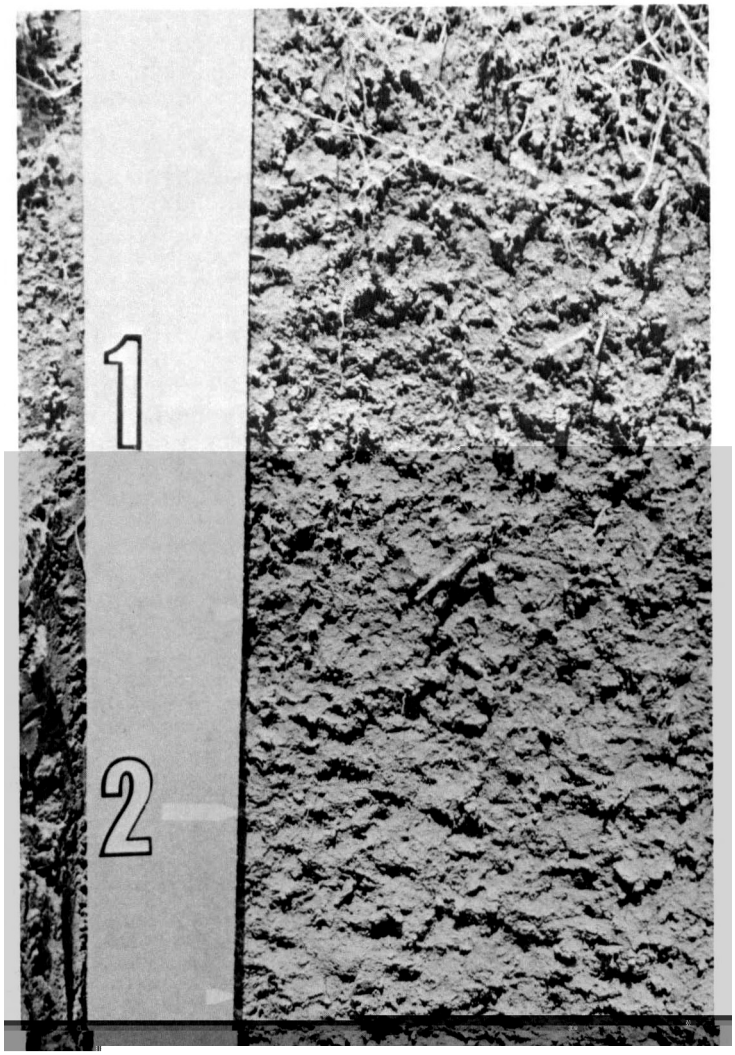


Figure 4.—Profile of Clyde silt loam. This poorly drained and very poorly drained soil is underlain by heavy loam at a depth of

loam; weak medium prismatic structure that parts to weak medium and coarse subangular blocky; very sticky; band of pebbles and about 4 percent coarse fragments by volume; mildly alkaline; clear smooth boundary.

IICg—34 to 60 inches; greenish gray (5GY 6/1) heavy loam; common fine prominent mottles of strong brown (7.5YR 5/6); massive; plastic; about 5 percent coarse fragments by volume; contains loamy bands ranging from 1 to 6 inches in thickness; mildly alkaline.

The solum ranges from 30 to 40 inches in thickness. The silty sediment is 20 to 40 inches thick. The A1 horizon is black silt loam or silty clay loam 10 to 20 inches thick.

The lower part of the Bg horizon and the Cg horizon are heavy loam or clay loam. The lower part of the Bg horizon and the Cg horizon are 0 to 5 percent coarse fragments, and they contain thin, gravelly bands. The B and C horizons are mildly alkaline.

Clyde soils are near Floyd and Auburndale soils. They are poorly drained, and they lack the brown colors in the upper part of the B horizon typical of substratum, to a depth of 60 inches, is strong brown, loose sand.

Available water capacity is low, and permeability is moderate in the loamy upper part of the profile and rapid in the sandy lower part. Natural fertility and the organic matter content of the surface layer are low.

Most areas of these soils are in hay or pasture.

In St. Croix County Cromwell soils are mapped only in complex with Amery soils.

Representative profile of Cromwell sandy loam, in an area of Amery–Cromwell sandy loams, 6 to 12 percent slopes, eroded, 110 yards south and 80 yards east of northwest corner of SW¼, sec. 9, T. 30 N., R. 19 W.:

Ap—0 to 8 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 5/3) dry; coarse and medium subangular blocky structure; friable; many roots; slightly acid; abrupt smooth boundary.

Bt—8 to 15 inches; yellowish red (5YR 4/6) heavy sandy loam; moderate coarse subangular blocky structure; friable; thin patchy clay films; common roots; medium acid; clear wavy boundary.

B31—15 to 30 inches; yellowish red (5YR 4/6) heavy loamy sand; weak coarse and me-

to 80 acres in size. They are mainly well drained and moderately well drained but a few areas are excessively drained or somewhat poorly drained to very poorly drained. Slopes are 0 to 20 percent.

Included in mapping of cut and fill areas are a few sandy and clayey areas and small areas of undisturbed sandy and loamy soils.

Available water capacity is mainly moderate but is low or high in a few areas. Natural fertility is low or medium. The organic matter content of the surface layer is low. Cut and fill areas are 0 to 70 percent coarse fragments.

Most areas are in pasture and brush or have been planted to pine tree plantations. A few areas are used as building sites. Not assigned to a capability unit or woodland group.

Dakota Series

The Dakota series consists of nearly level to sloping, well drained soils on stream terraces, outwash plains and knolls of pitted outwash plains. These soils formed in loamy sediment underlain by sand and gravel. Native vegetation was prairie grasses.

In a representative profile the surface layer is about 14 inches of loam. It is very dark brown in the upper part and very dark grayish brown in the lower part. The subsoil is about 14 inches thick. It is dark brown, friable and very friable loam in the upper 11 inches and brown, very friable sandy loam in the lower 3 inches. The substratum, to a depth of about 60 inches, is brown sand and gravel.

Available water capacity is moderate, and permeability is moderate in the subsoil and rapid in the substratum. Natural fertility is medium. The organic matter content of the surface layer is high.

These soils are used to grow corn, soybeans, and such cash crops as sweet corn, peas, or beans.

Representative profile of Dakota loam, 0 to 2 percent slopes, in a cultivated field, 220 yards east and 350 yards north of southwest corner of sec. 16, T. 29 N., R. 19 W.:

B3—25 to 28 inches; brown (7.5YR 4/4) sandy loam; weak medium subangular blocky structure; very friable; few roots; slightly acid.

C—28 to 60 inches; brown (7.5YR 4/4) sand and gravel; single grained; loose; about 15 percent coarse fragments by volume; slightly acid.

The solum thickness and depth to sand and gravel range from 20 to 40 inches. The A horizon is black, very dark brown, very dark grayish brown, or dark reddish brown and 10 to 24 inches thick.

The B horizon is loam in the upper part and sandy loam in the lower part. The C horizon is sand or sand and gravel. It is 5 to 20 percent coarse fragments. The B and C horizons are slightly acid to strongly acid.

Dakota soils are associated with Burkhardt and Pillot soils. They lack the moderately deep silt mantle characteristic of Pillot soils. They contain more clay in the B horizon and are deeper to sand and gravel than Burkhardt soils.

DaA—Dakota loam, 0 to 2 percent slopes. This soil is on stream terraces and outwash plains. Most areas are irregular in shape and range from 10 to 30 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are areas where the surface layer is sandy loam.

Runoff is very slow, and the hazard of erosion is slight.

This soil is moderately well suited to corn and such special cash crops as beans and peas. Irrigation may be feasible on large areas of this soil where vegetables or other high value crops are grown. The main concerns of management are maintaining tilth and soil structure. Capability unit IIs–1; not assigned to a woodland group.

DaB—Dakota loam, 2 to 6 percent slopes. This soil is on stream terraces and outwash plains. Most areas are irregular in shape and range from 10 to 80 acres in size.

This soil has a profile similar to the one described

more eroded than the Pillot soil, which is mainly on the concave parts of lower slopes, depressions, and drainageways.

The Dakota soil has a profile similar to the one described as representative of the series, but the surface layer is slightly thinner and lighter colored. The Pillot soil has a profile similar to the one described as representative of the series, but it contains slightly more

dium plates; friable; medium acid; abrupt wavy boundary.

B1—11 to 17 inches; yellowish brown (10YR 5/4) silt loam; common fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; few thin patchy clay films on vertical faces of peds; friable; medium acid;

with water for periods long enough to adversely affect or delay tillage. Maintaining soil tilth and soil structure is difficult.

Most areas of this soil are cultivated. The soil is moderately well suited to corn, oats, and grasses. Depth of the rooting zone is limited for most farm crops by a firm, silty clay subsoil. Controlling erosion and maintaining soil structure are important factors of good management. Capability unit IIe–6; woodland group 2o1.

DeC2—Derinda silt loam, 6 to 12 percent slopes, eroded. This soil is on areas that are peripheral to the ridgetops of the shale uplands. Most areas are long and narrow in shape and range from 5 to 15 acres in size.

This soil has a profile similar to the one described as representative of the series, but the silty mantle and surface layer are thinner and the surface layer contains more clay and is less friable.

Included with this soil in mapping are small areas where the silty mantle is less than 10 inches thick and a few areas where it is 30 to 40 inches thick. Also included are areas where layers of loamy drift are in the subsoil and a few small areas where slopes are less than 6 percent or more than 12 percent.

Runoff is medium, and the hazard of erosion is moderate. Erosion has caused tilth to deteriorate and has reduced the content of organic matter in the surface layer.

Most areas of this soil are cultivated. The soil is well shrink-swell potential of the silty clay subsoil and substratum is high.

Most areas of these soils are cultivated. Where excess water is removed, the soils are moderately well suited to row crops. Most small areas along drainageways are in wetland pasture, brush, and a few trees.

Representative profile of Derinda Variant silt loam, 1 to 6 percent slopes, in a cultivated area, 330 yards west and 30 yards south of northeast corner of SE¼, sec. 34, T. 28 N., R. 18 W.:

Ap—0 to 9 inches; very dark gray (10YR 3/1) silt loam; moderate fine and medium subangular blocky structure parting to moderate medium granular; friable; common roots; slightly acid; abrupt smooth boundary.

A2—9 to 14 inches; dark grayish brown (10YR 4/2) silt loam; common fine prominent yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/4) mottles; moderate thin and medium platy structure; firm; common roots; medium acid; clear wavy boundary.

B1—14 to 18 inches; brown (10YR 4/3) silt loam; common fine prominent yellowish red (5YR 4/6) mottles; moderate fine and medium subangular blocky structure; firm; few roots; medium acid; clear wavy boundary.

IIB2t—18 to 25 inches; olive (5Y 5/3) silty clay; many medium prominent yellowish brown

slopes. This soil is on ridges and drainageways of shale uplands.

Included with this soil in mapping are many small areas of soils along drainageways where the surface layer is thicker and darker colored than that of the Derinda Variant soil, a few areas of poorly drained soils, and a few areas where the silty mantle is more than 30 inches thick. Also included are a few areas of Derinda soils, a few areas underlain by limestone bedrock at a depth of 3 to 5 feet, and a few areas where slopes are less than 1 percent or more than 6 percent.

Runoff is slow, and the hazard of erosion is slight. This soil has a seasonal high, perched water table at a

B32—21 to 32 inches; dark brown (7.5YR 4/4) loamy sand; weak medium subangular blocky structure; very friable; few roots; medium acid; abrupt smooth boundary.

C—32 to 60 inches; dark brown (7.5YR 4/4) sand and gravel; single grained; loose; about 10 percent gravel by volume; slightly acid.

The solum ranges from 20 to 40 inches in thickness. The Ap horizon is dark reddish brown, dark brown, very dark brown, or very dark grayish brown and 10 to 24 inches thick.

The B horizon is medium acid to strongly acid, and

A12—8 to 14 inches; black (10YR 2/1) loamy sand; moderate coarse subangular blocky structure; very friable; many roots; medium acid; abrupt smooth boundary.

AC—14 to 17 inches; black (10YR 2/1) and brown (10YR 5/3) loamy sand; very weak medium subangular blocky structure; very friable; many roots; medium acid; clear wavy boundary.

C—17 to 60 inches; grayish brown (10YR 5/2) medium and coarse sand; common coarse prominent brownish yellow (10YR 6/6 and 6/8) mottles; loose; single grained; neutral.

The A horizon is black, very dark brown, or very dark grayish brown and is 10 to 20 inches thick. The surface layer and substratum are slightly acid to neutral.

Duelm soils are near Plainfield and Hubbard soils and Fluvaquents, wet. They are better drained than

Ap—0 to 8 inches; very dark brown (10YR 2/2) loamy sand; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.

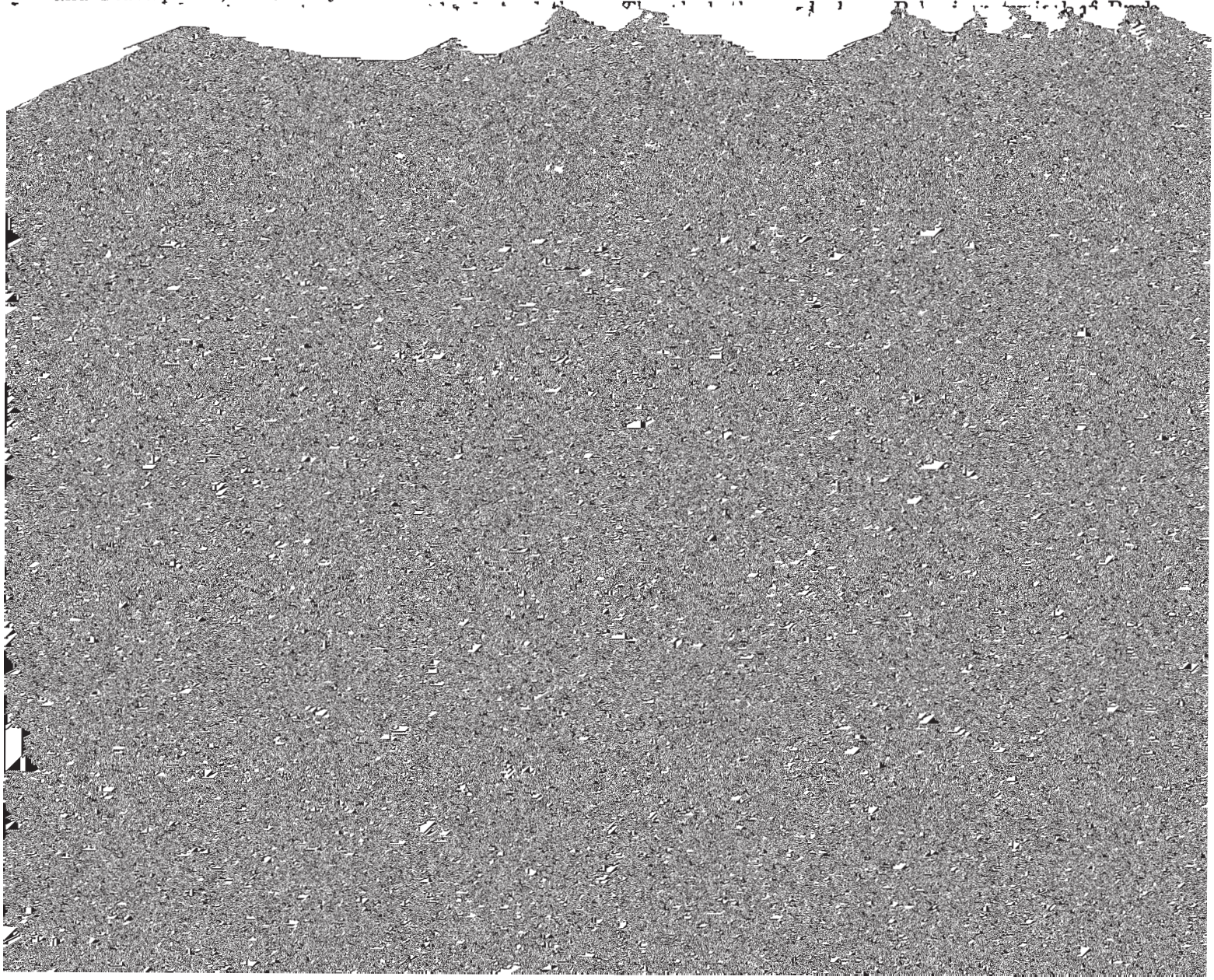
AC—8 to 15 inches; dark reddish brown (5YR 3/3) gravelly sand; very weak medium subangular blocky structure that parts to single grained where disturbed; loose; about 20 percent coarse fragments by volume; slightly acid; clear smooth boundary.

C—15 to 60 inches; strong brown (7.5YR 5/6) sand and gravel; about 35 percent coarse fragments by volume; loose; slightly acid.

The solum ranges from 12 to 24 inches in thickness. The A horizon is black or very dark brown loamy sand or sandy loam 3 to 10 inches thick.

The C horizon is 30 to 45 percent coarse fragments. The A and C horizons are strongly acid to neutral.

Emmert soils are near Burkhardt and Sattre soils.



Most areas of these soils are cultivated. A few areas are in wetland pasture or trees.

Representative profile of Floyd silt loam, 0 to 3 percent slopes, in a cultivated field, 200 yards south and 200 yards east of northwest corner of the SE¼ of sec. 24, T. 28 N., R. 17 W.:

Ap—0 to 6 inches; black (N 2/0) silt loam; moderate medium subangular blocky structure parting to weak thin plates; friable; many roots; neutral; abrupt smooth boundary.

A12—6 to 10 inches black (N 2/0) silt loam; strong medium subangular blocky structure; friable; many roots; neutral; clear wavy boundary.

A13—10 to 14 inches; black (N 2/0) heavy silt loam; weak and moderate medium granular structure; friable; many roots; neutral; clear wavy boundary.

B1—14 to 23 inches; brown and yellowish brown (10YR 4/3 and 5/6) heavy silt loam; moderate medium subangular blocky structure; friable; common roots; neutral; clear wavy boundary.

IIB21t—23 to 27 inches; yellowish brown (10YR 5/4) loam; many fine and medium distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; thick continuous clay films on surface of peds; few roots; common pebbles and cobblestones; neutral; clear wavy boundary.

IIB22tg—27 to 32 inches; grayish brown (10YR 5/2) heavy loam; many medium prominent yellowish brown (10YR 5/6) mottles; strong medium subangular blocky

moraines. Most areas are oblong and range from 5 to 60 acres in size.

Included with this soil in mapping are a few areas where gravelly bands are in the subsoil and substratum and a few areas consisting of deep silty alluvium. Also included are small areas of Clyde and Skyberg soils.

This soil has a seasonal high, perched water table at a depth of 1 to 3 feet. Runoff is slow. This soil is ponded or flooded, especially early in spring. Surface drains, water diversions and tile drainage help remove excess water and benefit plant growth. Frost late in spring and early in fall is common on this soil.

Most areas of this soil are used for corn. Where excess water is removed, the soil is well suited to most crops. Capability unit IIw–2; woodland group 4o1.

Fluvaquents

Fe—Fluvaquents consist of nearly level, somewhat poorly drained soils that are on flood plains of rivers and streams. Most areas are elongated in shape and range from 5 to 120 acres in size. Slopes are 0 to 2 percent. These soils formed in light and dark colored loamy sediment deposited by flood waters. The sediment ranges from sandy loam to silty clay loam, but in most places it is stratified silt and fine sand underlain by loose sand at a depth of 3 to 5 feet. This sediment has been deposited too recently for distinct horizons to form. Native vegetation was mostly wetland grasses and sedges and some trees such as willows and elms. These soils have a seasonal high water table at a depth of 1 to 3 feet.

Included with these soils in mapping are small areas of Duelm, Halder, Orion, Rib and Seelyeville soils, and Fluvaquents, wet; Saprists and Aquents; and Udifluvents.

black ash. These soils have a seasonal high water table at a depth of 0 to 1 foot.

Included with these soils in mapping are small areas of Duelm, Halder, Orion, Rib, and Seelyeville soils and Fluvaquents and Saprists and Aquents.

Runoff is slow, and the hazard of erosion is slight. Available water capacity, permeability, and natural fertility are too variable to rate. The organic matter content of the surface layer is moderate. Most areas are flooded frequently, especially in spring. Fresh alluvial sediment is deposited during each flood. Some places are dissected by the streams, sloughs, and old stream channels. Streambank erosion is a hazard in some places.

Most areas of these soils are in trees, brush, and marsh vegetation, and they are used for wildlife habitat. Where flooding is less frequent, a few small areas are pastured or cultivated. Capability unit Vw–14; woodland group 4w2.

Freeon Series

The Freeon series consists of gently sloping and sloping, moderately well drained soils. These soils are on low ridges and foot slopes of ground moraines. They formed in silty sediment and the underlying reddish sandy loam till. Native vegetation was mainly white pine, hard maple, and red oak. The lower part of the subsoil is saturated with water for long periods during the year.

In a representative profile the surface layer is about 8 inches of very dark grayish brown silt loam. The subsurface layer is brown silt loam about 10 inches thick. The subsoil is about 16 inches thick. The upper part is dark brown, mottled, friable silt loam; the middle part is reddish brown, mottled, friable to firm loam; and the lower part is reddish brown, mottled, firm loam. The substratum, to a depth of 60 inches, is yellowish red, mottled, firm sandy loam.

Available water capacity is high, and permeability is moderate. Natural fertility is medium. Tillage is delayed for relatively long periods in spring and after heavy rain.

Most areas of these soils are in corn, oats, and grasses.

Representative profile of Freeon silt loam, 2 to 6 percent slopes, in a cultivated area, 220 yards east and 100 yards south of northwest corner of SW¼, sec. 32, T. 30 N., R. 16 W.:

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; moderate medium subangular blocky structure; friable; common roots; slightly acid; clear smooth boundary.

A2—8 to 11 inches; brown (10YR 5/3) silt loam; moderate medium and thick platy structure; very friable; common roots; slightly acid; clear wavy boundary.

A&B—11 to 18 inches; brown (10YR 5/3) tongues of silt loam (A2); moderate medium platy structure; dark brown (10YR 4/3); slightly heavier silt loam (B21t); moderate medium subangular blocky structure; friable; common roots; slightly acid; clear wavy boundary.

IIB21t—18 to 23 inches; dark brown (7.5YR 4/4) loam; common fine and medium distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; common roots; uncoated silt and fine sand grains on faces of peds; few thin patchy clay films; common roots; about 15 percent coarse fragments by volume; strongly acid; clear wavy boundary.

IIB22t—23 to 29 inches; reddish brown (5YR 4/4) loam; common medium distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; firm; clean silt and fine sand coatings on faces of peds; few thin patchy clay films; few roots; about 15 percent coarse fragments by volume; few black (10YR 2/1) concretions; strongly acid; clear wavy boundary.

IIB3—29 to 34 inches; reddish brown (5YR 4/4) loam; common fine distinct strong brown (7.5YR 5/6) mottles and few fine prominent grayish brown (10YR 5/2) mottles; weak coarse subangular blocky structure; firm; clean silt and fine sand coatings on faces of peds; few thin patchy clay films; about 15 percent coarse fragments by volume; few black (10YR 2/1) concretions; strongly acid; gradual wavy boundary.

IIC—34 to 60 inches; yellowish red (5YR 4/6) sandy loam; common fine and medium distinct brown (10YR 5/3) and common medium prominent grayish brown (10YR 5/2) mottles; massive; firm; about 15 percent coarse fragments by volume; strongly acid.

The solum ranges from 24 to 40 inches in thickness. The silty mantle is 15 to 30 inches thick. The Ap horizon is dark grayish brown or very dark grayish brown and 6 to 9 inches thick.

The Bt horizon is loam or heavy sandy loam in the lower part. The IIC horizon is a sandy loam or light loam. The IIB and IIC horizons are 5 to 15 percent coarse fragments. The subsoil is strongly acid, and the substratum ranges from strongly acid to slightly acid.

Freeon soils are near Magnor and Santiago soils. Freeon soils are not so well drained as Santiago soils and have mottling in the B horizon which Santiago soils lack. Freeon soils lack gray mottles in the upper part of the Bt horizon which are characteristic of Magnor soils and are better drained than Magnor soils.

FnB—Freeon silt loam, 2 to 6 percent slopes. This soil is on low ridges and foot slopes of ridges. Most areas are oblong and range from 10 to 80 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are a few areas of Magnor and Santiago soils. Also included are a few areas of sandy loam and a few areas where slopes are slightly less than 2 percent or more than 6 percent.

Runoff is slow, and the hazard of erosion is slight. Tillage is delayed because this soil remains saturated

for relatively long periods in spring and after heavy rains.

This soil is well suited to corn, oats, and alfalfa. It is frequently used for corn. Controlling erosion is an im-

plains. These are sandy soils underlain by loose, fine sand. Native vegetation was oak savanna.

In a representative profile the surface layer is very dark grayish brown loamy fine sand about 6 inches

acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are areas of wet sandy soils in depressional areas where the surface layer is thicker and darker than the one in this Gotham soil. Also included are a few small areas of Plainfield and Sattre soils.

Runoff is very slow, and the hazard of erosion is slight. Soil blowing is a hazard.

Most areas of this soil are in pasture. Some areas are in pine plantations. Crop yields are generally limited by low available water capacity. If irrigated, large areas of this soil are suited for growing vegetables or other high value crops. Controlling soil blowing is an important factor of good management. Capability unit IVs–3; woodland group 3s1.

GoC—Gotham loamy fine sand, 6 to 12 percent slopes. This soil is on stream terraces and areas of pitted outwash plains. Most areas are elongated or irregular in shape and range from 10 to 20 acres in size.

This soil has a profile similar to one described as representative of the series, but the surface layer is thinner and lighter colored and the subsoil is thinner.

Included with this soil in mapping are a few areas of Plainfield soils and some small areas of wet, sandy soils in depressions that have a surface layer which is thicker and darker colored than the one in this Gotham soil.

Runoff is slow, and the hazard of erosion is slight. Soil blowing is a hazard.

Most areas of this soil are in pasture. Some areas are in pine plantations. This soil is poorly suited to row crops, oats, and alfalfa. Crop yields are generally limited by low available water capacity. Controlling erosion and soil blowing are important factors of good management. Capability unit IVs–3; woodland group 3s1.

Gravel Pits

Gp—Gravel pits consist of areas where sand and gravel or bedrock have been removed to a depth of at least several feet. These pits are in outwash, glacial [illegible] Most areas are elongated [illegible]

surface layer is brown silt loam about 3 inches thick. The subsoil is about 16 inches thick. In the upper part it is yellowish brown, friable, mottled silt loam, and in the lower part it is brown, very friable, mottled sandy clay loam and heavy sandy loam. The substratum, to a depth of about 60 inches, is strong brown sand and gravel.

Available water capacity is moderate, and permeability ranges from moderate in the upper part of the soil to rapid in the underlying sand and gravel. Natural fertility is medium. These soils have a seasonal high water table at a depth of 1 to 3 feet. Depth of the root zone is limited for most crops by a high water table in the subsoil.

Most areas of these soils are in permanent pasture and woods. Some areas are used for corn, oats, and hay.

Representative profile of Halder silt loam, 0 to 3 percent slopes, in a cultivated area, 45 yards east and 150 yards south of center of SW¼, Sec. 13, T. 30 N., R. 16 W.:

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; moderate coarse subangular blocky structure that parts to weak medium granules; friable; many roots; medium acid; abrupt smooth boundary.

A2—9 to 12 inches; brown (10YR 5/3) silt loam; common fine prominent yellowish red (5YR 4/8) mottles; weak medium and thick platy structure; very friable; common roots; medium acid; abrupt wavy boundary.

B&A—12 to 16 inches; yellowish brown (10YR 5/4) silt loam (B21t); common fine prominent yellowish red (5YR 4/8) mottles; moderate medium and fine subangular blocky structure; penetrated by brown (10YR 5/3) tongues of silt loam (A2); weak thin platy structure; friable; common roots; medium acid; clear wavy boundary.

B21t—16 to 21 inches; yellowish brown (10YR [illegible]

10 percent coarse fragments by volume; strongly acid; abrupt smooth boundary.

IIC—28 to 60 inches; strong brown (7.5YR 5/6) sand and gravel; single grained; loose; about 15 percent coarse fragments by volume; medium acid.

The solum ranges from 20 to 40 inches in thickness. The silty mantle is less than 25 inches thick. The Ap horizon is dark gray, very dark gray, dark brown, or very dark grayish brown silt loam or loam 6 to 10 inches thick.

The lower part of the B horizon is sandy clay loam, loam, or sandy loam. The C horizon is 10 to 20 percent coarse fragments.

Halder soils are near Antigo and Rib soils. Halder soils have a thinner silty mantle and are more poorly drained than Antigo soils. They are better drained and have a thinner silty mantle than Rib soils.

HaA—Halder silt loam, 0 to 3 percent slopes. This soil is in drainageways and depressions of stream terraces. Most areas are elongated or oblong and range from 10 to 30 acres in size.

Included with this soil in mapping are small areas of Rib soils and Fluvaquents. Also included are a few areas along streams where the substratum is loamy sand.

This soil has a high water table at a depth of 1 to 3 feet throughout most of the year. Runoff is slow. This soil is ponded or flooded, especially early in spring and after rains. Surface drainage helps remove runoff water. Ditches and tile drains help lower the water table. Where tile drainage is used, loose sand and silt enters tile lines unless precautions are taken to prevent this.

Most areas of this soil are used for pasture or hayland. If adequately drained, this soil is moderately well suited to corn. The main concern of management is removing excess water. Capability unit IIw–5; woodland group 3o2.

Hesch Series

and 110 yards west of center of SE¼, sec. 27, T. 28 N., R. 18 W.:

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; very friable; common roots; medium acid; abrupt smooth boundary.

A12—6 to 16 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak coarse subangular blocky structure; very friable; common roots; medium acid; clear smooth boundary.

A13—16 to 19 inches; dark brown (10YR 3/3) fine sandy loam, grayish brown (10YR 5/2) dry; weak coarse subangular blocky structure; very friable; common roots; medium acid; clear smooth boundary.

B1—19 to 22 inches; brown (10YR 4/3) fine sandy loam; moderate medium subangular blocky structure; very friable; few roots; strongly acid; clear smooth boundary.

B2t—22 to 26 inches; brown (10YR 4/3) heavy fine sandy loam; moderate coarse subangular blocky structure; very friable; dark brown (7.5YR 4/4) thin patchy clay films on surfaces of peds; few roots; strongly acid; clear smooth boundary.

B22t—26 to 34 inches; dark yellowish brown (10YR 4/4) fine sandy loam; weak coarse subangular blocky structure; very friable; dark brown (7.5YR 4/4) thin patchy clay films on surfaces of peds; few roots; strongly acid; clear wavy boundary.

C1—34 to 40 inches; strong brown (7.5YR 5/6) loamy fine sand; single grained; loose; very strongly acid; clear wavy boundary.

C2—40 to 54 inches; yellowish brown (10YR 5/4) fine sandy loam; massive, breaking to

Included with this soil in mapping are small areas of Arland, Boone, and Nickin soils. Also included are a few small areas where slopes are less than 2 percent or more than 6 percent.

Runoff is slow, and the hazard of erosion is slight.

Most areas of these soils are in pasture, woodland, or pine plantations. A few nearly level and gently sloping areas are used for corn, soybeans, and garden vegetables. Where these soils are irrigated and fertilized, they are well suited to potatoes and other special

areas are elongated or irregular in shape and range from 5 to 60 acres in size.

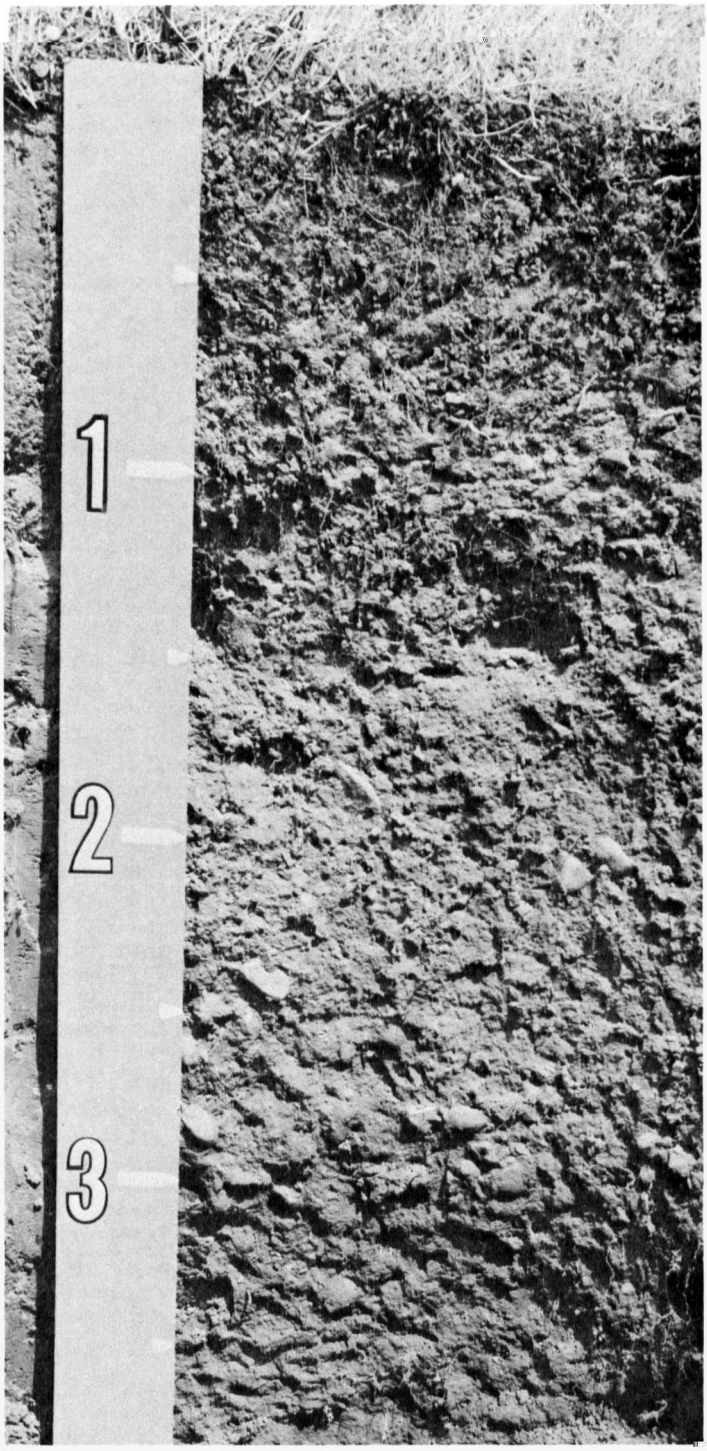
This soil has a profile similar to the one described as representative of the series, but it contains slightly

Available water capacity is very high, and permeability is moderate. Natural fertility and the organic matter content of the surface layer are high. These soils are occasionally flooded or ponded by runoff and stream

Most areas of this soil are in pasture. Where erosion and flooding are controlled, the soil is well suited to corn and other row crops. Capability unit IIw–11; woodland group 2o1.

Jewett Series

The Jewett series consists of nearly level to sloping, well drained soils in till plains, ridges, and wide drainageways of ground moraines. These soils formed in silty sediment and the underlying reddish sandy loam and loam till. Native vegetation was mainly native prairie grasses and oak savanna.



The C horizon is 0 to 15 percent coarse fragments. The subsoil is strongly acid or medium acid, and the substratum is slightly acid to strongly acid.

deteriorate and has reduced the content of organic matter in the surface layer.

Most areas of this soil are cultivated. The soil is

tled loam and dark yellowish brown, friable, mottled sandy loam. The substratum, to a depth of about 60 inches, is light yellowish brown sand and gravel.

Available water capacity is moderate, and permeability is moderate in the subsoil and rapid in the sandy substratum. Natural fertility is medium. The organic matter content of the surface layer is high. Depth of the root zone is limited for most farm crops by the wet subsoil.

Most areas of these soils are in pasture but some drained areas are cropped.

Representative profile of Lawler silt loam, 0 to 3 percent slopes, in a cultivated area, 320 yards west of the southeast corner of sec. 17, T. 28 N., R. 18 W.:

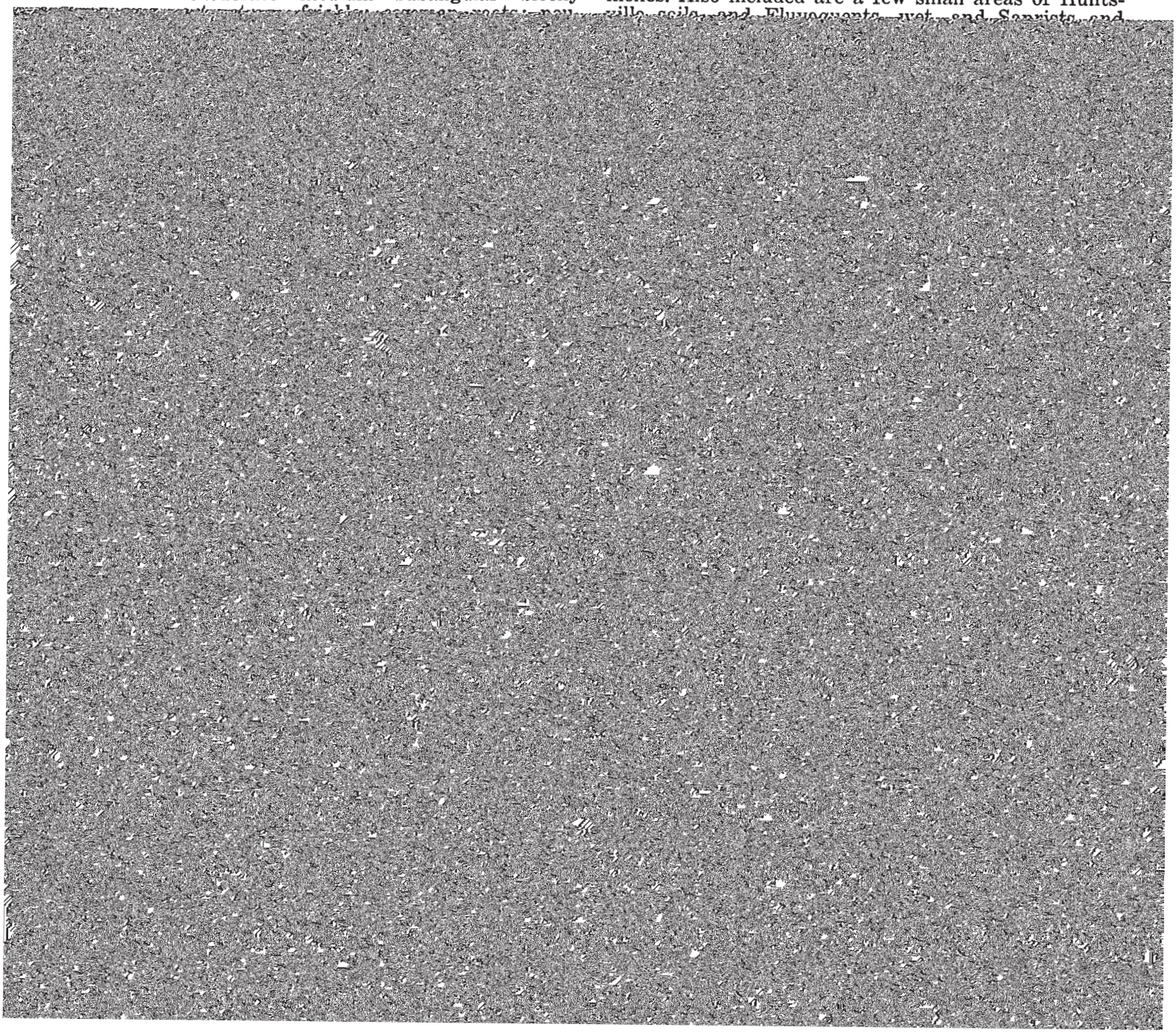
Ap—0 to 10 inches; black (10YR 2/1) silt loam; moderate medium subangular blocky [illegible]

loam. The C horizon is 5 to 15 percent coarse fragments. The B horizon is medium acid or slightly acid, and the C horizon is slightly acid or neutral.

Lawler soils are near Dakota, Halder, and Sattre soils. They are more poorly drained than Dakota soils. They are more poorly drained and have a thicker A horizon than Sattre soils. They have a thicker, darker colored A horizon than Halder soils.

LcA—Lawler silt loam, 0 to 3 percent slopes. This soil is in drainageways and depressions on stream terraces and outwash plains. Most areas are elongated or oblong and range from 10 to 30 acres in size.

Included with this soil in mapping are a few areas where the surface layer is sandy loam and areas where the soil has a depth to sand and gravel of more than 40 inches. Also included are a few small areas of Huntsville soils, and Fluvaquents, wet, and Saprists, and



silt loam; moderate medium granular structure; very friable; many roots; slightly acid; abrupt wavy boundary.

A2—4 to 10 inches; pale brown (10YR 6/3) silt loam; moderate medium and thin platy structure; friable; common roots; medium acid; clear wavy boundary.

A&B—10 to 18 inches; pale brown (10YR 6/3) tongues of silt loam (A2); weak thin platy structure; yellowish brown (10YR 5/6) silt loam (Bt); moderate medium

Where tile drainage is used, loose sand can enter tile lines unless precautions are taken to prevent this.

Most areas of this soil are used for pasture and woodland. Some areas are in corn, oats, and hay. Where excess water is removed and tilth is maintained, this soil is moderately well suited to most crops. Capability unit IIw–4; woodland group 2o2.

Nickin Series

The Nickin series consists of gently sloping to

volume; strongly acid; abrupt wavy boundary.

IIIC—34 to 60 inches; very pale brown (10YR 7/3) sand; single grained; loose; medium acid.

The solum ranges from 23 to 39 inches in thickness. In most places the silty mantle is 15 to 30 inches thick. The A horizon is black, very dark brown, or dark brown silt loam or loam 10 to 20 inches thick.

The IIB horizon is 5 to 15 percent pebbles and cobblestones. The C horizon is sand weathered from sandstone and is underlain by weakly cemented sandstone at a depth of more than 5 feet. The B horizon is slightly acid to strongly acid, and the C horizon is medium acid.

Nickin soils are near Arland, Jewett, and Pillot soils. Their B horizon contains less silt and their C horizon contains less gravel than the B and C horizons of Pillot soils. They have an A horizon that is thicker and a C horizon that contains less sand and clay than these horizons in Jewett soils. They have thicker, darker colored A horizon than Arland soils.

NcB—Nickin silt loam, 2 to 6 percent slopes. Most areas of this soil are on ridges of ground moraines that are underlain by sand weathered from sandstone bedrock. Most areas are oblong or irregular in shape and range from 10 to 60 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface layer is slightly thicker and darker colored, the silty mantle is thicker, and the subsoil is slightly thicker.

Included with this soil in mapping are some areas where the surface layer is fine sandy loam, a few small areas of Arland and Jewett soils, and areas of mod-

Controlling erosion is an important factor of good management. Capability unit IIIe–2; not assigned to a woodland group.

NnD2—Nickin loam, 12 to 20 percent slopes, eroded. This soil is on foot slopes and knolls of sandstone uplands. Most areas are elongated or round and range from 5 to 30 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface layer is slightly thinner and lighter colored, and the silty mantle and subsoil are thinner.

Included with this soil in mapping are small areas on knolls and small convex areas where the soil is severely eroded, a few areas where the surface layer is sandy loam, and a few small areas of soils that are underlain by limestone bedrock at a depth of more than 5 feet. Also included are a few small areas where slopes are less than 12 percent or more than 20 percent.

Runoff is rapid, and the hazard of erosion is severe.

Most areas of this soil are used for pasture or hayland. Some areas are wooded. This soil is poorly suited to row crops but is moderately well suited to hay and pasture. Controlling erosion is an important factor of good management. Capability unit IVe–2; not assigned to a woodland group.

Onamia Series

The Onamia series consists of gently sloping to steep, well drained soils on outwash plains and areas of pitted outwash plains. These are loamy soils underlain by sand and gravel. Native vegetation was mainly white pine, sugar maple, and red oak.

In a representative profile the surface layer is about

angular blocky structure; friable; bleached silt and very fine sand coatings on ped faces; interfingering of A2 soil material along ped faces; common roots;

Included with this soil in mapping are a few areas of Dakota and Sattre soils and a few areas where the surface layer is sandy loam. Also included are a few small areas where slopes are less than 6 percent

knolls. The Antigo soil is on foot slopes of knolls or in slight depressions and near drainageways.

The Onamia soil has a profile similar to the one described as representative of the series, but the surface layer and subsoil contain more sand in some areas or more silt in other areas. The Antigo soil has a profile similar to the one described as representative of the series, but the silty mantle and surface layer are more eroded and thinner. Some areas in depressions and drainageways have a thick, dark colored surface layer.

Included with these soils in mapping are a few wet soils in depressions and drainageways, wooded areas where the soil is not eroded, and areas of gravel and sand where the soil is severely eroded. Also included are some areas near the base of knolls where the silty sediment is thick, a few small areas of soils where most of the subsoil formed in reddish colored sandy loam and loam till underlain by sand and gravel, and a few areas where slopes are less than 12 percent or more than 25 percent.

Runoff is rapid, and the hazard of erosion is severe. In most cultivated areas, erosion of the surface layer has caused tilth to deteriorate and has reduced the content of organic matter. Coarse fragments are on the surface of severely eroded soils.

Much of this complex has been cleared and cultivated, but some extensive areas are still wooded. These soils are poorly suited to row crops but are suited to grasses and alfalfa. Some of the steeper soils are wooded or in pasture. These soils are well suited to red

tected from flooding and where excess water is removed, the soils are used for corn and other row crops.

Representative profile of Orion silt loam, 0 to 3 percent slopes, in a cultivated area, 350 yards south and 60 yards west of northeast corner of SE¼, sec. 26, T. 30 N., R. 15 W.:

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; moderate coarse and medium subangular blocky structure; very friable; common roots; neutral; abrupt smooth boundary.

C1—8 to 18 inches; dark grayish brown (10YR 4/2) silt loam; few fine prominent yellowish brown (10YR 5/6) mottles; moderate coarse subangular blocky structure parting to weak thick platy; very friable; common roots; neutral; clear wavy boundary.

C2—18 to 21 inches; very dark grayish brown (10YR 3/2) silt loam; few fine prominent reddish brown (5YR 4/4) mottles; moderate medium prismatic structure parting to moderate, coarse subangular blocky that displays thin platiness; friable; common roots; slightly acid; clear wavy boundary.

C3—21 to 24 inches; very dark grayish brown (10YR 3/2) silt loam; few medium prominent reddish brown (5YR 4/4) mottles;

Huntsville and Lawler soils, and Fluvaquents, Fluvaquents, wet, and Saprists and Aquents.

This soil is frequently flooded for brief periods, especially in spring and during periods of heavy rain. It also has a seasonal high water table at a depth of 1 to 3 feet. These wet conditions delay tillage and limit crop yields. Shallow ditches and waterways help remove runoff water. Tile drains help lower the seasonal high water table. Where tile drainage is used, loose silt enters tile lines unless precautions are taken to prevent this. Water diversions and dikes help prevent flooding. Erosion on streambanks is a severe hazard. Fencing cattle from streambanks, riprap along streambanks, and grassed waterways help control erosion.

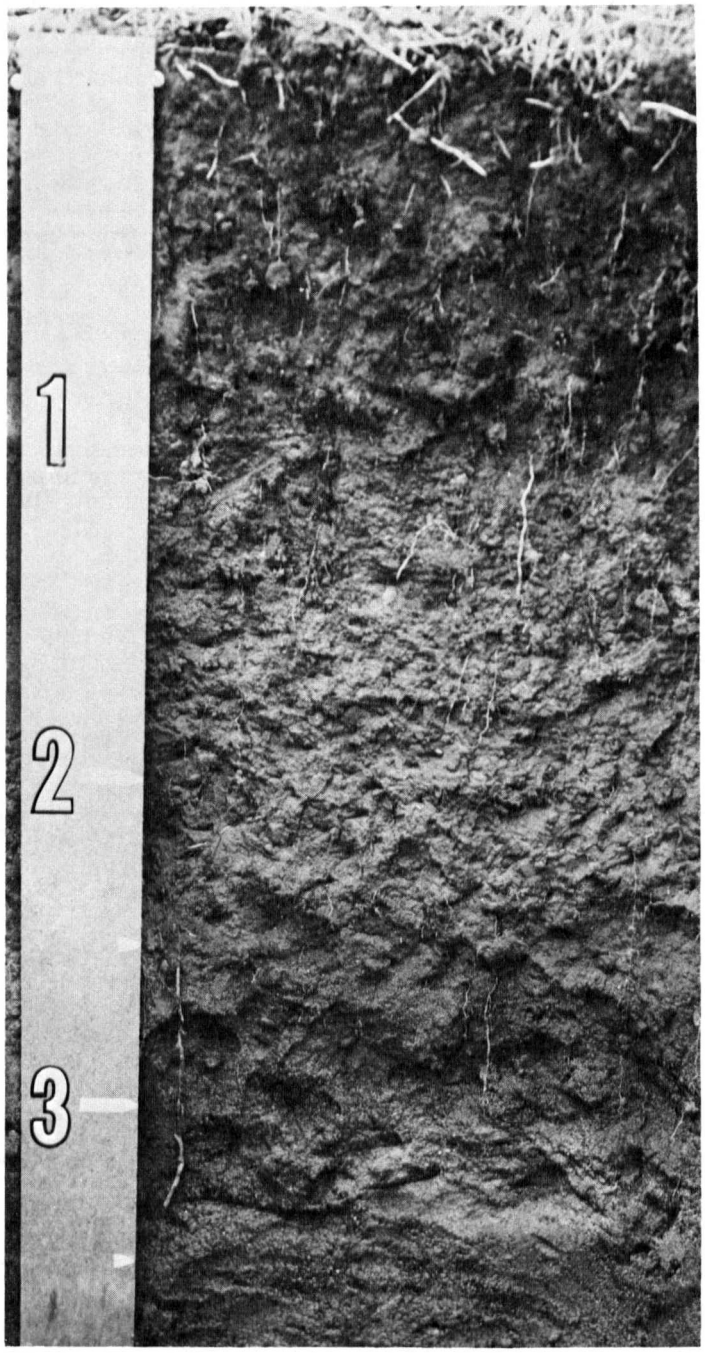
Most areas of this soil are used for corn. Where excess water is removed and the soil is protected from

silt loam; moderate medium subangular blocky structure; friable; few thin patchy clay films along root channels; common roots; very strongly acid; clear wavy boundary.

B22t—23 to 31 inches; dark yellowish brown (10YR 4/4) silt loam; moderate medium subangular blocky structure; friable; few thin patchy clay films, especially along root channels; few roots; very strongly acid; clear wavy boundary.

B3—31 to 45 inches; dark yellowish brown (10YR 4/4) silt loam; weak medium subangular blocky structure; very friable; few roots, strongly acid; clear wavy boundary.

C—45 to 60 inches; yellowish brown (10YR 5/6)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structure; friable; thin continuous clay films; slightly acid; clear wavy boundary.

B22t—25 to 34 inches; dark yellowish brown (10YR 4/4) heavy silt loam; weak coarse and medium subangular blocky structure; friable; thin patchy clay films; medium acid; gradual wavy boundary.

IIB3—34 to 37 inches; brown (7.5YR 4/4) loam; weak medium subangular blocky structure; friable; strongly acid; clear smooth boundary.

IIC—37 to 60 inches; yellowish brown (10YR 5/8) sand and gravel; single grained; loose; about 10 percent coarse fragments by volume; contains many dark colored minerals; slightly acid.

The solum ranges from 26 to 45 inches in thickness. The silty mantle is 24 to 40 inches thick. The A horizon is very dark brown or black and 10 to 18 inches thick.

The C horizon is 0 to 10 percent coarse fragments. The B horizon is slightly acid to strongly acid, and the C horizon is slightly acid to medium acid.

Pillot soils in St. Croix County contain less clay than is defined in the range of the series, but this difference does not alter their usefulness or behavior.

Pillot soils are near Dakota and Sattre soils and Jewett, sandy substratum. They have a silty mantle and contain more silt and less sand than Dakota soils. They have a thicker and darker colored A horizon and a thicker silty mantle than Sattre soils. The B horizon formed mainly in silty sediment, whereas Jewett, sandy substratum soils have B horizons typically formed in sandy loam till. Pillot soils also have a thicker, darker A horizon than Jewett, sandy substratum, soils.

PlA—Pillot silt loam, 0 to 3 percent slopes. This soil is on outwash plains and stream terraces. Most areas are oblong and range from 10 to 160 acres in size.

Included with this soil in mapping are small areas of Dakota and Sattre soils. Also included are a few areas where the depth to sand and gravel is 40 to 50 inches.

[illegible]

these soils are irrigated and fertilized, they are well suited to potatoes and other special crops.

Representative profile of Plainfield loamy sand, 6 to 12 percent slopes, in a cultivated area, 200 feet south and 50 feet west of center of NE¼ of sec. 21, T. 31 N., R. 19 W.:

Ap—0 to 8 inches; dark brown (10YR 3/3) loamy sand, pale brown (10YR 6/3) dry; weak fine and medium subangular blocky structure; very friable; common roots; slightly acid; abrupt smooth boundary.

B—8 to 24 inches; brown (7.5YR 4/4) sand; weak coarse subangular blocky structure parting to single grained; very friable; few roots; slightly acid; clear wavy boundary.

C—24 to 60 inches; strong brown (7.5YR 5/6) sand; single grained; loose; slightly acid.

The solum ranges from 18 to 34 inches in thickness. The Ap horizon is very dark grayish brown, dark brown, or dark grayish brown loamy sand or sand 6 to 10 inches thick. In some wooded areas the A1 horizon is a very dark brown or black loamy sand that is 2 to 4 inches thick. The C horizon is 0 to 10 percent coarse fragments.

Plainfield soils are near Boone, Gotham, and Hubbard soils. They have a thinner, lighter colored A horizon than Hubbard soils. Their B horizon contains slightly less silt and clay than is typical of Gotham soils. Plainfield soils are underlain by loose outwash sand, whereas Boone soils are typically underlain by weakly cemented sandstone bedrock.

PmB—Plainfield loamy sand, 2 to 6 percent slopes. This soil is on outwash plains and stream terraces. Most areas are oblong or irregular in shape and range from 10 to 40 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface layer is slightly darker and contains slightly more silt.

Included with this soil in mapping are a few small areas of Hubbard soils, a few areas where the surface

droughty and less suited to trees than slopes facing north and northeast. Controlling erosion and soil blowing are important factors of good management. Capability unit VIs–3; woodland group 3s1.

PmD—Plainfield loamy sand, 12 to 20 percent slopes. This soil is on outwash plains and stream terraces. Most areas are elongated and range from 10 to 80 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface layer and subsoil are thinner, and in places the subsoil is reddish brown.

Included with this soil in mapping are a few areas where slopes are less than 12 percent or more than 20 percent. Also included are a few wooded areas where the surface layer is thin and dark colored.

Runoff is slow, and the hazard of erosion is slight. Soil blowing is a hazard.

Most areas of this soil are in woodland, pine tree plantations, or pasture. The soil is not suited to row crops and is poorly suited to pasture. Slopes facing south and southwest are more droughty and less suited to trees than slopes facing north and northeast. Controlling erosion and soil blowing are important factors [illegible] management. Capability unit VIIs–3; woodland [illegible]

angular blocky structure; friable; thin patchy clay films and organic coatings on surface of peds; medium acid; clear smooth boundary.

B22—29 to 34 inches; dark yellowish brown (10YR 4/4) silt loam; moderate medium subangular blocky structure; friable; patchy clay films and organic coatings on surface of peds; medium acid; clear wavy boundary.

B3—34 to 38 inches; dark yellowish brown (10YR 4/4) silt loam; weak coarse subangular blocky structure; very friable; medium acid; clear wavy boundary.

C—38 to 60 inches; dark yellowish brown (10YR 4/4) silt loam; massive; friable; medium acid.

The solum ranges from 36 to 48 inches in thickness. In most places the silty mantle is more than 5 feet thick. The A horizon is very dark brown or black and 10 to 16 inches thick.

The B horizon is silt loam or heavy silt loam. The B horizon is medium acid to strongly acid, and the C horizon is strongly acid to medium acid.

Port Byron soils are near Pillot and Ritchey soils.

important factors of good management. Capability unit IIIe-1; not assigned to a woodland group.

PoD—Port Byron silt loam, 12 to 20 percent slopes. This soil is on narrow draws and foot slopes adjacent to limestone uplands. Most areas are elongated and range from 10 to 30 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are a few small areas of Ritchey and Rockton soils. Also included are a few areas where slopes are less than 12 percent or more than 20 percent.

Runoff is rapid, and the hazard of erosion is severe.

Most areas of this soil are used for pasture or hayland. The soil is moderately well suited to alfalfa and grasses and is poorly suited to corn. Controlling erosion and maintaining tilth and organic matter content are important factors of good management. Capability unit

and fine sand grains on faces of peds; common roots; strongly acid; clear wavy boundary.

IIB23t—17 to 25 inches; yellowish brown (10YR 5/4) heavy loam; few fine distinct mottles of strong brown (7.5YR 5/6); strong coarse and medium subangular blocky structure; firm; few patchy clay films on faces of peds; thin band of cobblestones and pebbles; few roots; strongly acid; gradual wavy boundary.

IIB31—25 to 33 inches; yellowish brown (10YR 5/4) heavy loam; common, medium prominent strong brown (7.5YR 5/8) and reddish yellow (7.5YR 6/8) mottles; moderate medium prismatic structure parting to weak coarse subangular blocky;

a few areas where the subsoil formed in heavy loam weathered from dolomitic limestone or kaolinitic sandstone, and a few small areas where slopes are less than 2 percent or more than 6 percent.

Runoff is slow, and the hazard of erosion is slight.

This soil is well suited to corn, oats, and alfalfa. It is frequently used for corn. Controlling erosion, especially on long slopes, is an important factor of good management. Capability unit IIe–1; woodland group 2o1.

ReC2—Renova silt loam, 6 to 12 percent slopes, eroded. This soil is on low ridges and knolls of ground moraines. Most areas are irregular in shape and range from 5 to 30 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are a few small

sandy loam; moderate medium platy structure that parts to weak very fine granules; very friable; many roots; medium acid; abrupt wavy boundary.

B1—8 to 15 inches; yellowish brown (10YR 5/6) heavy sandy loam; weak fine subangular blocky structure; very friable; uncoated silt and very fine sand grains on faces of peds; common roots; about 5 percent coarse fragments by volume; medium acid; clear wavy boundary.

B21t—15 to 27 inches; dark yellowish brown (10YR 4/4) heavy loam; strong medium subangular blocky structure; firm; thin continuous clay films and some uncoated

in the substratum and a few areas on narrow ridges, mainly in Kinnickinnic township, where the glacial drift is underlain by shale at a depth of 3 to 5 feet. Also included are a few areas where slopes are less than 4 percent or more than 12 percent.

Runoff is medium, and the hazard of erosion is moderate. Erosion has caused tilth to deteriorate and has reduced the content of organic matter in the surface layer.

This soil is suited to oats, alfalfa, and a limited amount of corn. It is frequently used for hay or pasture.

and 400 yards east of southwest corner of SE¼, sec. 30, T. 29 N., R. 16 W.:

A11—0 to 4 inches; black (10YR 2/1) silt loam; moderate medium granular structure; friable; many roots; slightly acid; abrupt smooth boundary.

A12—4 to 8 inches; black (10YR 2/1) silt loam; moderate coarse granular structure; friable; many roots; slightly acid; abrupt smooth boundary.

A3—8 to 14 inches; black (10YR 2/1) silt

loose silt and sand enter tile lines unless precautions are taken to prevent this. Also, water diversions and dikes help prevent flooding.

Most areas of this soil are used for pasture and wildlife habitat. Where adequately drained, the soil is moderately well suited to corn or other row crops. Capability unit IIw–5; woodland group 3w2.

Ritchey Series

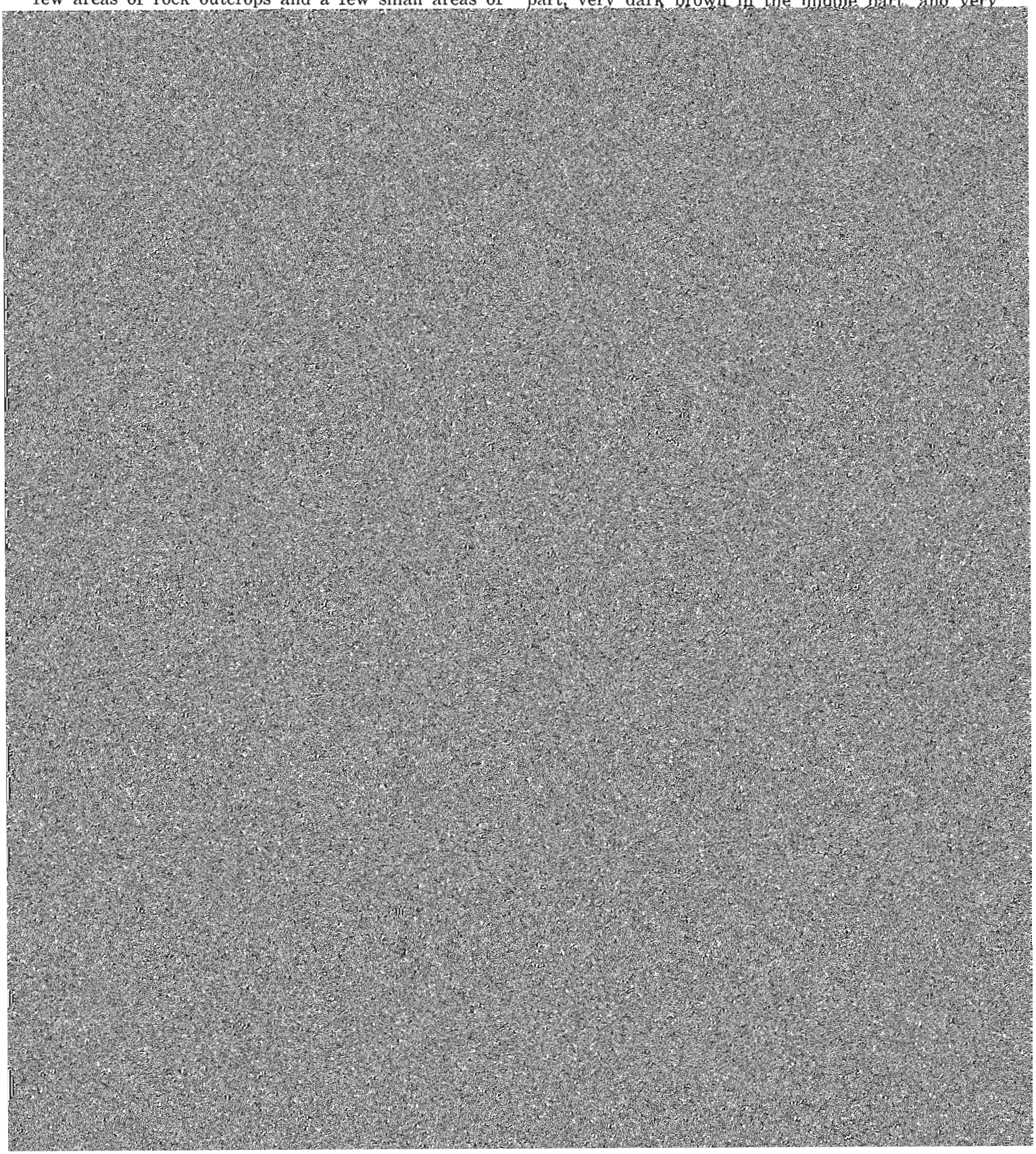
dark brown or very dark grayish brown. The Ap horizon is very dark brown to dark reddish brown.

The R horizon is dolomitic limestone bedrock that is fractured. These soils are slightly acid to medium acid to neutral in the B horizon.

Ritchey soils are near Nickin and Whalan soils. They have a thinner B horizon than Nickin and Whalan soils. Also, they are underlain by limestone, whereas Nickin soils are typically underlain by sandy materials weath-

where the subsoil formed mainly in clayey residuum weathered from limestone or shale. Also included are a few areas of rock outcrops and a few small areas of

In a representative profile the surface layer is silt loam about 14 inches thick. It is black in the upper part, very dark brown in the middle part, and very



loam underlain by fractured limestone bedrock. The silty B horizon is strongly acid to very strongly acid.

Runoff is rapid, and the hazard of erosion is severe. In most areas erosion has caused tilth to deteriorate

common roots; about 15 percent coarse fragments by volume; strongly acid; clear irregular boundary.

IIB22t—24 to 30 inches; reddish brown (5YR 4/4) heavy loam; moderate medium subangular blocky structure; friable; thin patchy

Runoff is medium, and the hazard of erosion is moderate. In most areas erosion has caused tilth to deteriorate and has reduced the content of organic matter in the surface layer.

This soil is suited to oats, alfalfa, and a limited amount of corn. Controlling erosion and maintaining

and contain more sand. Also, in many places the Antigo soil has a subsoil that formed partly in reddish sandy loam till.

Saprists and Aquents

Se—Saprists and Aquents consist of very poorly drained organic and mineral soils that are along the

and knolls of pitted outwash plains. These soils formed mainly in silty and loamy sediment underlain by sand and gravel. The native vegetation was mainly oak savanna.

In a representative profile the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsurface layer is dark grayish brown silt loam about 2 inches thick. The subsoil is about 19 inches thick. In the upper part it is dark yellowish brown, friable silt loam; in the middle part it is dark brown, friable loam; and in the lower part it is dark brown, very friable fragments. The B horizon is strongly acid or medium acid, and the C horizon is medium acid.

In mapping units ShA, ShB, and ShC2, the B horizon contains less clay than is defined as the range for the series, but this difference does not alter the usefulness or behavior of these soils.

Sattre soils are associated with Burkhardt, Dakota, and Pillot soils. They have a thinner silty mantle and surface layer than Pillot soils. They have a thinner A horizon than Dakota soils. Their solum is thicker and contains more silt and clay than that of Burkhardt

in most areas some of the subsoil has been mixed into the plow layer.

Included with this soil in mapping are areas of Sattre soils that have a surface layer of sandy loam and small areas of Burkhardt soils. Also included are a few areas

Available water capacity is very high, and permeability is moderately rapid. Natural fertility is low. Depth of the root zone is limited for most farm crops by a seasonal high water table at or near the soil surface.

Most areas of these soils are in natural vegetation.

flood waters. This sediment has been deposied too recently for distinct horizons to form. Native vegetation was mostly wetland grasses and sedges; some shrubs, such as alder and willow; and a few scattered trees such as elm. These soils have a seasonal high water table at a depth of 2 to 5 feet.

Included with Udifluvents in mapping are small areas of Fluvaquents, Fluvaquents, wet, and Saprists and Aquents, and Gotham, Hubbard, and Seelyeville soils.

Runoff is slow, and the hazard of erosion is slight. Available water capacity is low, and permeability is variable but is mostly rapid. Natural fertility and the organic matter content of the surface layer are low. Most areas of these soils are flooded frequently for brief periods, especially in spring. Fresh sandy sediment is deposited during each flood. Some places are dissected by streams, sloughs, and old stream channels. Streambank erosion is a hazard in some places.

Most areas of these soils are in trees and brush. A few areas are cultivated. These soils are suited to wildlife habitat. Capability unit VIIs–9; woodland group 3s1.

erate medium subangular blocky structure; friable; interfingerings and a few tongues of pale brown (10YR 6/3) silt loam (A2); friable; very strongly acid; common roots; clear wavy boundary.

IIB21t—16 to 25 inches; brown (10YR 5/3) clay loam; few fine distinct yellowish brown (10YR 5/6) and faint grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; very firm; few thin pale brown (10YR 6/3) silt and fine sand coatings on ped faces; common thin dark brown (10YR 3/3) clay films on faces of peds; cobbly and gravelly band; common roots; very strongly acid; clear wavy boundary.

IIB22t—25 to 30 inches; dark grayish brown (10YR 4/2) clay loam; common medium prominent yellowish brown (10YR 5/6) mottles; moderate medium subangular band; common roots; very strongly acid; blocky structure; very firm; thick nearly continuous dark brown (10YR 3/3) clay films on faces of peds; about 5 percent

where the surface layer is sandy loam. Also included are a few areas of moderately well drained soils that have a gray subsoil and a few small areas of Clyde, Floyd, and Skyberg soils. Also, in some areas near Arland soils, Vlasaty soils are underlain by sand at a depth of slightly more than 4 feet.

Runoff is slow, and the hazard of erosion is slight. Tillage is delayed because this soil remains saturated for relatively long periods in spring and after heavy rains.

This soil is well suited to corn, oats, and alfalfa. It is frequently used for corn. Controlling erosion, especially on long slopes, is an important factor of good management. Capability unit IIe–1; woodland group 2o1.

VaC2—Vlasaty silt loam, 6 to 12 percent slopes, eroded. This soil is on low ridges and knolls of ground moraines. Most areas are oblong or irregular in shape and range from 5 to 30 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and lighter colored.

Included with this soil in mapping are a few small areas where the surface layer is sandy loam. Also included are a few small areas of Clay, Floyd, and Skyberg soils and a few small areas where slopes are slightly less than 6 percent or more than 12 percent. In

the county. Most steeper soils are used for hay and pasture and some are in woods.

Representative profile of Whalan silt loam, 2 to 6 percent slopes, in a cultivated area, 200 yards south and 200 yards east of center of sec. 16, T. 28 N., R. 19 W.:

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam; weak fine and very fine subangular blocky structure; friable; common roots; slightly acid; abrupt smooth boundary.

B1—8 to 12 inches; dark brown (7.5YR 4/4) silt loam; moderate medium subangular blocky structure; friable; common roots; medium acid; clear wavy boundary.

B21t—12 to 16 inches; dark brown (7.5YR 4/4) silt loam; moderate medium subangular blocky structure; friable; thin patchy clay films; common roots; medium acid; clear wavy boundary.

B22t—16 to 20 inches; dark brown (7.5YR 4/4) gritty silt loam; moderate medium subangular blocky structure; friable; thin patchy clay films; common roots; strongly acid; clear wavy boundary.

IIB23t—20 to 30 inches; yellowish red (5YR 4/6)

areas where till in the lower part of the subsoil is not evident.

Runoff is slow, and the hazard of erosion is slight.

Most areas of this soil are used for crops. The soil is well suited to corn, oats, and alfalfa. The main concerns of management are controlling erosion and maintaining tilth and organic matter content. Capability unit IIe–2; woodland group 2o1.

Management for Crops and Pasture

About 90 percent of the land area in St. Croix County is used for crops and pasture. Corn, oats, and hay are the main crops grown and are the basis for a livestock and dairy industry. Some cash crops such as soybeans, canning peas, kidney beans, and navy beans are also grown, especially in the western and central parts of the county. About two-thirds of the soils in St. Croix

TABLE 2.—*Predicted average yields per acre of the principal crops*

[These yields are those under an improved or high level of management. Absence of a yield figure indicates that the soil is not suited to the crop, or that the crop is not ordinarily grown on that soil]

Map symbol	Soil	Corn		Oats [1]	Alfalfa-brome hay [2] (dry weight)	Native bluegrass pasture
		Grain	Silage			
		Bu	*Tons*	*Bu*	*Tons*	*Aud* [3]
AdA	Adolph silt loam, 0 to 3 percent slopes [4]	70	12.0	60		100
AlB	Amery sandy loam, 2 to 6 percent slopes	70	12.0	50	2.75	70
AlC2	Amery sandy loam, 6 to 12 percent slopes, eroded	65	11.0	45	2.5	60
AlD2	Amery sandy loam, 12 to 25 percent slopes, eroded			35	2.0	60
AmB	Amery loam, 2 to 6 percent slopes	80	13.0	70	3.5	110
AmC2	Amery loam, 6 to 12 percent slopes, eroded	75	12.5	65	3.0	100
AmD2	Amery loam, 12 to 20 percent slopes, eroded	70	12.0	60	2.5	90
AmE2	Amery loam, 20 to 30 percent slopes, eroded				2.0	70
AnC2	Amery-Cromwell sandy loams, 6 to 12 percent slopes, eroded	60	10.0	45	2.0	40
AnD2	Amery-Cromwell sandy loams, 12 to 25 percent slopes, eroded				1.75	35
AoA	Antigo silt loam, 0 to 2 percent slopes	90	15.0	80	3.5	110
AoB	Antigo silt loam, 2 to 6 percent slopes	85	14.0	80	3.5	110
ApC2	Arland sandy loam, 6 to 12 percent slopes, eroded	65	11.0	45	2.25	60
ApD2	Arland sandy loam, 12 to 25 percent slopes, eroded	60	10.0	40	2.0	60
ApF	Arland sandy loam, 25 to 35 percent slopes			35	2.0	60
AsB	Arland silt loam, 2 to 6 percent slopes	80	13.0	65	3.5	90
AsC2	Arland silt loam, 6 to 12 percent slopes, eroded	75	12.5	60	3.0	80
AuA	Auburndale silt loam, 0 to 3 percent slopes [4]	70	12.0	60	3.5	100
BnB	Boone loamy fine sand, 2 to 6 percent slopes	40	7.0	35	2.0	30
BnC	Boone loamy fine sand, 6 to 12 percent slopes				1.5	30
BnD	Boone loamy fine sand, 12 to 20 percent slopes					30
BpA	Brill silt loam, 0 to 3 percent slopes	80	13.0	80	4.0	110
BrB	Burkhardt sandy loam, 1 to 6 percent slopes	60	10.0	45	2.5	70
BrC2	Burkhardt sandy loam, 6 to 12 percent slopes, eroded	55	9.0	40	2.0	60
BxB	Burkhardt-Sattre complex, 2 to 6 percent slopes	75	12.5	55	2.75	80
BxC2	Burkhardt-Sattre complex, 6 to 12 percent slopes, eroded	70	12.0	50	2.5	70
BxD2	Burkhardt-Sattre complex, 12 to 30 percent slopes, eroded				2.0	60
CoC2	Chetek-Onamia complex, 6 to 12 percent slopes, eroded	65	11.0	45	2.25	65
CoD2	Chetek-Onamia complex, 12 to 20 percent slopes, eroded				1.75	60
CoE	Chetek-Onamia complex, 20 to 30 percent slopes					50
CyA	Clyde silt loam, 0 to 3 percent slopes [4]	85	14.0	60		120
Cz	Cut and fill areas					
DaA	Dakota loam, 0 to 2 percent slopes	80	13.0	60	3.0	90
DaB	Dakota loam, 2 to 6 percent slopes	80	13.0	60	3.0	90
DcC2	Dakota-Pillot complex, 6 to 12 percent slopes, eroded	75	12.5	55	2.75	90
DeB	Derinda silt loam, 2 to 6 percent slopes	80	13.0	75	4.25	140
DeC2	Derinda silt loam, 6 to 12 percent slopes, eroded	75	12.5	70	4.0	130

TABLE 2.—*Predicted average yields per acre of the principal crops*—Continued

Map symbol	Soil	Corn		Oats [1]	Alfalfa-brome hay [2] (dry weight)	Native bluegrass pasture
		Grain	Silage			
		Bu	*Tons*	*Bu*	*Tons*	*Aud* [3]
[illegible]	Magnor silt loam, 1 to 6 percent slopes [4]	75	12.5	70	3.5	140

nutrients in the soil, the ability of the soil to hold nutrients, the available water capacity, the kinds of crops to be grown, and the crop rotation. Where the need for lime and fertilizer is indicated in the suggestions for management, the amount of lime and the kind and amount of fertilizer to apply should be determined by soil tests. An indirect benefit from a higher level of fertility is the production of more plant litter and organic matter, which reduces erosion and promotes good soil tilth. Usually, heavy applications of lime and potassium are needed to grow alfalfa hay and pasture. Changes in soil acidity affect the availability of plant nutrients. Phosphorus and nitrogen are more readily available to plants if the soil reaction is near neutral. Generally, less lime is required to neutralize such sandy soils as Gotham and Plainfield soils than is required to neutralize silty or clayey soils; but the lime is leached out more quickly from sandy soils, so more frequent applications of lime are necessary.

Rating of the available water capacity is given to a depth of 5 feet or to bedrock in the capability unit descriptions. These ratings are defined in the Glossary and are also listed for each series in the section "Descriptions of the Soils."

As an example, assuming that alfalfa and corn require 0.30 inch of water per day during their peak use period, the number of days that a given soil will support these crops without rainfall can be determined. Thus, the soils that have a high available water capacity, between 9 and 12 inches, will support these crops for 30 to 40 days without rain, if the moisture content of the soils is at field capacity at the beginning of this period. In contrast, soils that have a low available water capacity, between 3 and 6 inches, will support these crops for only 10 to 20 days without rain under similar conditions.

The available water capacity is very important in determining levels of fertilization and population of plants where no irrigation is planned. A high level of fertilization is generally not justified on soils that have very low or low available water capacity, because crop growth is limited by the available water capacity. In addition, the soils that have very low and low available water capacity are coarse textured or have a thin solum. Excessive amounts of nitrate fertilizer added to these soils may be quickly leached from the soil and contaminate surface or ground water.

from runoff from adjacent areas. Soils on flood plains need protection from flooding.

Adolph, Halder, Lawler, Orion, and Rib soils respond well to both surface and tile drainage. Duelm soils generally are not suited to tile drainage unless precautions are taken to keep sand from entering the tile lines. These soils respond well to surface and open-ditch drainage. There is a danger of over-draining sandy soils such as those of the Duelm series, resulting in a droughty condition. Organic soils such as those of the Seelyeville series respond well to both tile and open-ditch drainage, but there is a danger of frost damage to crops grown on this soil.

When organic soils are drained there are several hazards. One of these is subsidence. Subsidence is the loss of surface elevation and is approximately ½ to 1 inch per year in Wisconsin. The subsidence potential is high for Seelyeville soils.

Subsidence of organic soils after drainage is attributed mainly to four factors: loss of buoyancy caused by ground water, consolidation, compaction, and biochemical activity. Elevation loss caused by the first three factors is initial subsidence and is normally accomplished in about three years after the water table is lowered. Initial subsidence of organic soils typically results in a one-half reduction in thickness of the organic materials above the water table.

After initial subsidence, shrinkage continues at a fairly uniform rate because of biochemical oxidation of the organic materials. This is termed continued subsidence and progresses until mineral material or the water table is reached. The rate of continued subsidence depends on the depth to the water table and increases as depth increases. Subsidence of organic soils can be stopped by maintaining the water level at the surface. It can be slowed by maintaining the water level as high as possible for the land use.

Controlling erosion.—Many of the soils in the county are moderately eroded. Examples are sloping and moderately steep Amery and Santiago soils. Most of the soil lost by erosion is the result of sheet and rill erosion, although some gullying also occurs.

Practices that help to control erosion are terracing, using water diversions and grassed waterways, strip-cropping, contour tilling, growing sod crops or cover crops in rotations, and mulching with crop residue.

Grassed waterways provide a sod cover in natural

moderately slow or slow permeability. These soils are more susceptible to ponding and erosion than other glaciated areas of the county. Water diversions and seepage. Tillage is generally not practical, and renovation is not feasible. Such soils are generally kept in Kentucky bluegrass, reed canarygrass, or bromegrass.

Subclasses are further divided into groups called capability units. These are groups of soils that are so much alike that they are suited to the same crops and

CAPABILITY UNIT IIe-2

This unit consists of gently sloping soils that are well drained. These are silty and loamy soils that are under

drainage can be used to remove surface water and prevent ponding.

Where drained and protected from flooding, this soil is moderately well suited to corn, small grain, and other crops. If properly drained and fertilized, and if minimum tillage is used to return crop residue, row crops can be grown year after year without soil tilth deteriorating and without organic matter content seriously

Where adequately drained, this soil is moderately well suited to corn, small grain, and alfalfa. Undrained areas are suited to pasture but are occasionally used for corn and other row crops.

CAPABILITY UNIT IIw-4

Magnor silt loam, 1 to 6 percent slopes, is the only soil in this unit. It is a somewhat poorly drained, loamy

Areas of somewhat poorly drained soils can be used for limited crop production, but areas of poorly drained soils are not suited to crops unless they are drained. Where adequately drained, these soils are moderately well suited to corn, small grain, and hay crops. Undrained soils are well suited to pasture but are occasionally used for row crops.

CAPABILITY UNIT IIw-11

Huntsville silt loam, 0 to 3 percent slopes, is the only soil in this unit. It is a well drained and moderately well drained, silty soil.

Permeability is moderate, and available water capacity is very high. The lower part of this soil is saturated with water for relatively long periods throughout the year. This soil also receives runoff from adjacent areas and is flooded by stream overflow. Ponding and flooding delay tillage for short periods, espe-

from entering and clogging tile lines. Cultivation at proper moisture content, minimum tillage, and good crop residue management help maintain good tilth and soil structure.

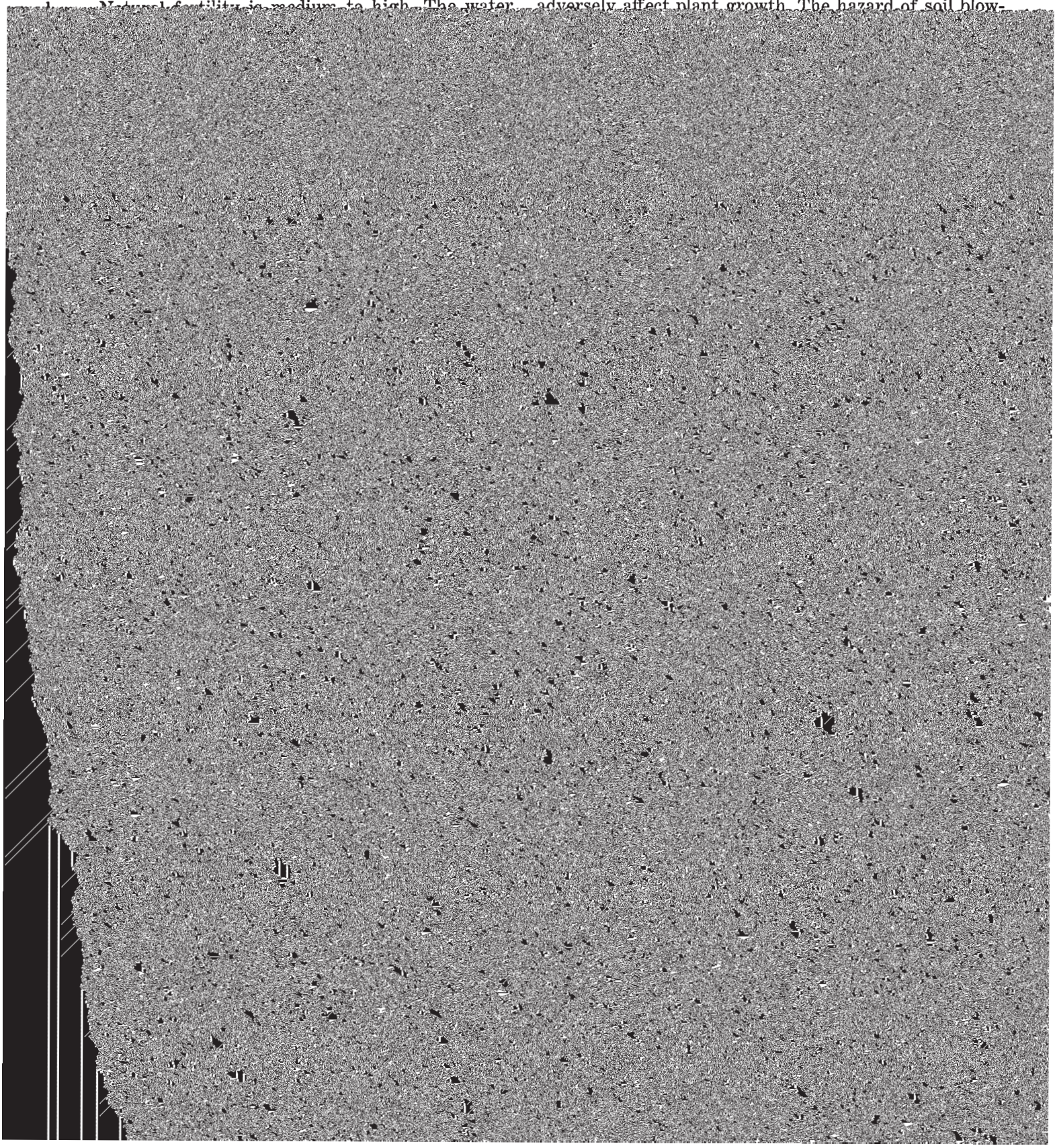
Where these soils are drained and protected from flooding and streambank erosion, they are moderately well suited to corn and other crops commonly grown. Undrained areas are suited to pasture but are occasionally used for row crops.

CAPABILITY UNIT IIs-1

This unit consists of nearly level and gently sloping soils that are well drained. These are silty and loamy soils that are underlain by sand or sand and gravel.

Permeability is moderate in the subsoil and rapid in the substratum. Available water capacity is moderate in most soils but it is low in a few soils that have a surface layer of loam. Natural fertility is medium. Runoff is

from rapid to moderately slow in the substratum. Available water capacity is moderate in most soils but is low in a few areas where the soil has a surface layer of



city is moderate. Natural fertility is low or medium. The water table is deep, so the soils of this unit are not saturated with water for long enough periods to adversely affect plant growth. The hazard of soil blow-

crop residue help control erosion and maintain good tilth, soil structure, and fertility.

These soils are moderately well suited to grasses and alfalfa or pasture. They are also suited to a limited amount of such row crops as corn and soybeans.

CAPABILITY UNIT IIIw-3

Auburndale silt loam, 0 to 3 percent slopes, is the only soil in this unit. It is a poorly drained, silty soil that is underlain by sandy loam till.

CAPABILITY UNIT IVe-2

This unit consists mainly of moderately steep soils that are well drained. They are loamy and silty soils that are underlain by soft sandstone, loamy sand, and sandy loam till, sand and gravel, or limestone.

Permeability is moderate in the subsoil and ranges from moderately slow to rapid in the substratum. Available water capacity is mainly moderate. The soils of this unit are not saturated with water for periods long enough to adversely affect plant growth. Natural fertility is medium. Runoff is rapid, and the hazard of

excessively drained and well drained. These are sandy soils that are underlain by loamy sediments or loamy soils that are underlain by sand in some places.

Permeability is mainly moderate but in many places it ranges from rapid to moderately slow as depth of the soil increases. The available water capacity is moderate in all soils in this unit except in a few areas where the soil has a sandy substratum; in these areas available water capacity is low. Natural fertility ranges from medium to low. The soils of this unit are not saturated with water for periods long enough to adversely affect plant growth. Soil blowing is a hazard on some soils. Runoff is slow or medium, and the hazard of erosion is slight or moderate. Many areas that have been cultivated have lost as much as 4 inches of the original surface layer through erosion.

Such conservation practices as crop rotations that consist mainly of sod cover crops, contour farming

Diversions and surface drainage help remove surface water and help prevent ponding, but drainage is difficult because outlets are not well developed. This soil forms major drains in the ground moraine. The drains are long and narrow, but channels are too small and too blocked to adequately handle the runoff water.

Where drained and protected from flooding, this soil is suited to corn and other row crops. Undrained areas are not suited to row crops or cultivation, but they are suited to wetland pasture and wildlife habitat.

CAPABILITY UNIT IVw-5

Duelm loamy sand is the only soil in this unit. This is a somewhat poorly drained sandy soil that is underlain by sand. Slopes are 0 to 2 percent.

Permeability is rapid, and available water capacity is low. Unless this soil is drained, the substratum is saturated by ground water throughout the year. This

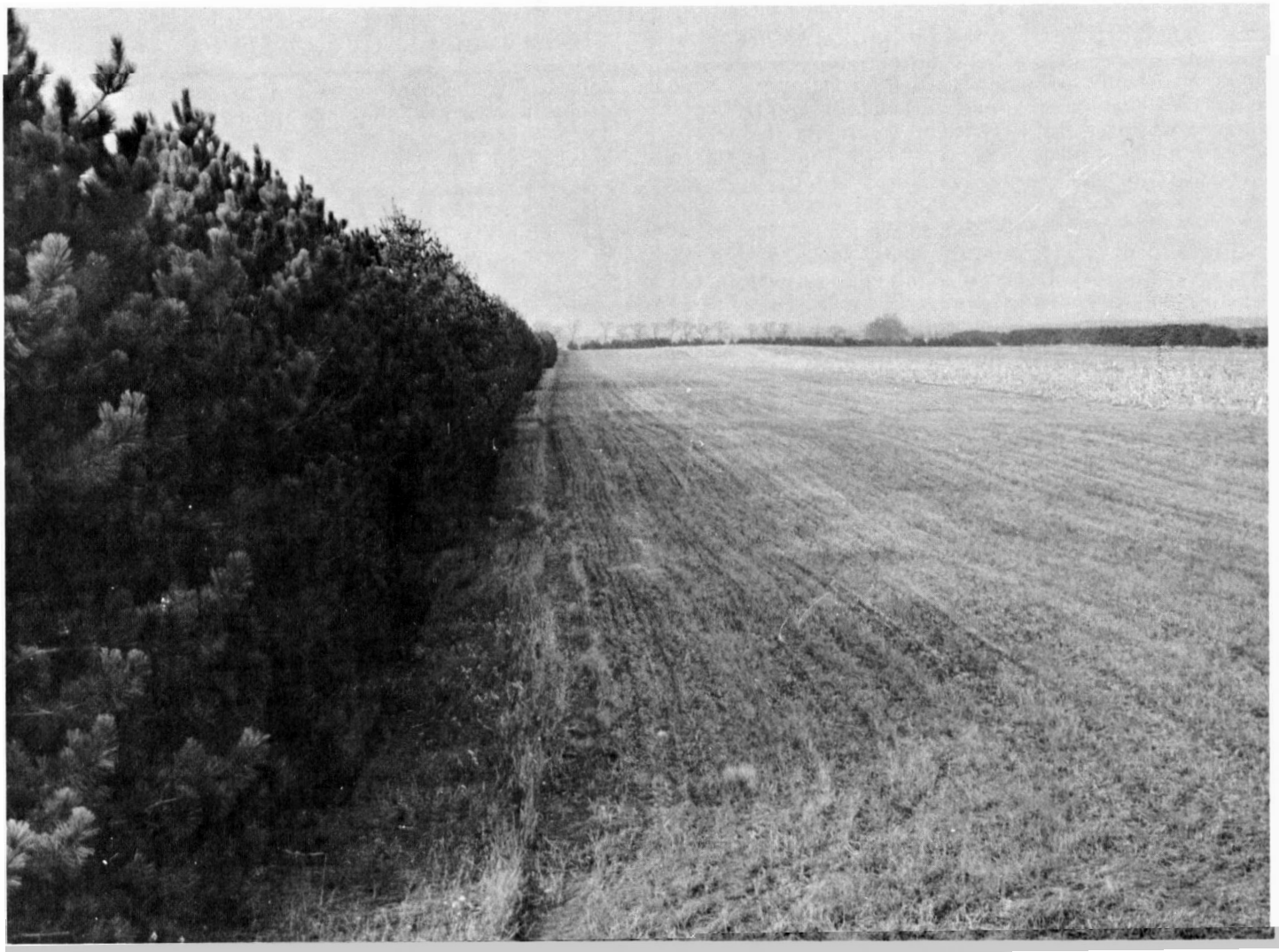


Figure 8.—**Ten year old red pine windbreak growing on nearly level Hubbard soil. Soil blowing is a hazard in cultivated areas of these and other sandy, droughty soils.**

ing. Where drained, this soil is subject to soil blowing, burning, and subsidence. If the water table is lowered excessively, this soil is subject to rapid subsidence.

Where properly drained and protected from flooding erosion is slight. The soils are droughty; they are subject to soil blowing.

Such conservation practices as crop rotations that consist of some sod cover crops, contour farming, strip-

If properly managed, the soils in this unit are suited to a cropping system that includes row crops, small grain, and hay. Planting early in spring, before the soil has a chance to dry, is best on these soils. Later plantings, especially of small seeded crops, have a poor chance of survival. The nearly level and gently sloping soils are suited to irrigation. If irrigated, they are suited to more intensive crop production. These soils are suited to pasture.

CAPABILITY UNIT Vw-14

Fluvaquents, wet, are the only soils in this unit. These nearly level, poorly drained, and very poorly drained soils are on flood plains. The meandering stream channels, oxbows, and sloughs, and the hazard of flooding limit the use of these soils. Slopes are 0 to 2 percent.

Permeability, natural fertility, and available water capacity are too variable to rate. Texture varies from sand to silt loam. Unless the soils are drained, ground water is at or near the surface throughout the year.

Drainage and protection from flooding are generally impractical. Many areas of these soils are wooded or in pasture. The soils are poorly suited to pasture. They are better suited to woodland or wetland wildlife habitat.

CAPABILITY UNIT VIe-1

Amery loam, 20 to 30 percent slopes, eroded, is the only soil in this unit. It is a steep, well drained, loamy soil that is underlain by sandy loam till.

Permeability is moderate, and available water capacity is moderate. This soil is not saturated with water for periods long enough to adversely affect plant growth. Natural fertility is low or medium. Runoff is very rapid, and the hazard of erosion is very severe.

Pasture and hayfields are difficult to renovate. Controlled grazing, renovation, and fertilization help maintain adequate plant cover and control erosion.

Because of the very severe hazard of erosion, this soil is generally not suited to cultivated crops. If properly managed, it is suited to pasture. The soil is used mostly for pasture, woodland, and wildlife habitat.

CAPABILITY UNIT VIe-3

This unit consists of moderately steep and steep soils that are somewhat excessively drained and well drained. These are loamy soils that are underlain by dolomitic limestone or by sand and gravel, generally at a depth of less than 20 inches.

Permeability is moderate and moderately rapid in the subsoil and the substratum but is rapid where the sub-

Controlled grazing, renovation, and fertilization help maintain adequate sod cover and control erosion.

Because of the severe hazard of erosion, the shallow root zone, and the low available water capacity, these soils are generally not suited to cultivated crops. If properly managed, they are suited to hay and pasture. They are also well suited to woodland and wildlife habitat.

CAPABILITY UNIT VIe-4

This unit consists of moderately steep and steep soils that are somewhat excessively drained and well drained. These are loamy soils that are underlain mainly by sandy loam till that is mixed with sand and gravel in some areas.

Permeability is generally moderate but ranges to rapid in some areas that are underlain by sand and gravel. Available water capacity is moderate in all soils in this unit except in a few small areas where the soil has a sandy substratum; in these areas available water capacity is low. This soil is not saturated with water for periods long enough to affect plant growth. Natural fertility is medium or low. Runoff is rapid or very rapid, and the hazard of erosion is severe or very severe.

Pasture and hayfields are difficult to renovate. Controlled grazing, renovation, and fertilization help maintain adequate sod cover and control erosion.

Because of the severe hazard of erosion, these soils are generally not suited to cultivated crops. If properly managed, they are suited to hay and pasture. They are also well suited to woodland and wildlife habitat.

CAPABILITY UNIT VIs-3

This unit consists of sloping soils that are excessively drained. These are sandy soils that are underlain by sand or by soft sandstone.

Permeability ranges from very rapid to moderately rapid, and available water capacity is low. These soils are not saturated with water for periods long enough to adversely affect plant growth. Natural fertility is low. Runoff is slow, and the hazard of erosion is slight. The hazard of soil blowing is severe.

Establishing plant cover is difficult. Planting pasture and hay early in spring, before the soil has a chance to dry, is best on these soils. Later plantings have a poor chance of survival. Controlled grazing, renovation, and fertilization help maintain plant cover and control erosion and soil blowing. Pollution of ground water by leaching of fertilizer elements, especially nitrates, is a hazard in these sandy soils.

Because of low available water capacity and the severe hazard of soil blowing, these soils are generally

soils in this unit are not saturated with water for periods long enough to adversely affect plant growth. Natural fertility is low or medium. Runoff is very rapid, and the hazard of erosion is very severe. The topsoil is thin, and in some areas that have been overgrazed the soil is eroded. Controlled grazing helps maintain plant cover and control erosion.

Because of the very severe hazard of erosion this soil is not suited to commercial crop production. It is poorly suited to pasture because establishing and maintaining good grassland is difficult. The soil is suited mainly to woodland and wildlife habitat.

CAPABILITY UNIT VIIe-3

This unit consists of steep and very steep soils that are somewhat excessively drained and well drained. These are loamy soils that are underlain by sand and

This soil is mostly suited to woodland and wildlife habitat.

CAPABILITY UNIT VIIe-5

Emmert loamy sand, 12 to 35 percent slopes, is the only soil in this unit. It is an excessively drained sandy soil that is underlain by sand and gravel at a depth of less than 20 inches. Some areas of this soil are gravelly.

Permeability is very rapid, and available water capacity is very low. This soil is not saturated with water for periods long enough to adversely affect plant growth. Natural fertility is low. Runoff is medium or rapid, and the hazard of erosion is moderate.

Some areas of this soil that have been overgrazed are eroded. Controlling grazing and topdressing with fertilizer help maintain plant cover and control erosion.

Because of the very low available water capacity, the

sediment, potholes for use by waterfowl and other wildlife can be formed by blasting.

Predicted yields

Table 2 gives predicted average yields per acre for the main crops grown in St. Croix County. Predictions are based on results obtained by the agricultural experiment station on experimental test plots and on observations made by soil scientists and other agricultural workers who are familiar with the soils (*4*). All yields are based on averages obtained over a long period of time and assume an average amount of rainfall. By using improved crop varieties and management, higher yields than those shown in the table are being obtained by many farmers. This trend can be expected to continue. This table will continue to have value as the general level of crop yields increases, because it also gives an idea of the relative productivity of the soils. It must be remembered, however, that improvement in technology in the future may affect some soils more than others. Also, some soils that have low to medium yields because they have low available water capacity may be well suited to intensive production of specialty crops if irrigated.

The yields of oats refer to oats seeded wtih a legume-grass mixture. Yields of oats higher than those shown in the table result in a poor stand of grass-legume mixture. Yields for alfalfa-brome hay in table 2 refer to those from well established, first-year and second-year stands. Yields of native bluegrass pasture are commonly grown on many soils that are too strongly sloping for renovation or for row crops.

The management needed to obtain the yields shown in table 2 is considerably above average for the county. Under this level of management, acid soils are limed to about pH 6.5, according to recommendations resulting from soil tests. Fertilizer is also applied according to

***Figure 9.*—Thinning a pine plantation grown on Boone soils. These trees are used for fence posts, poles, or pulpwood.**

In a 1968 inventory of the forest resources, 50,000 acres, or about 11 percent of the land area, was in commercial woodland (fig. 9). The woodland is about 55 percent oak and hickory; 20 percent sugar maple; 13 percent aspen and white birch; 4 percent conifers; 4 percent elm, ash, and cottonwood; and 4 percent is not stocked (*30*).

Woodland groups

The soils of St. Croix County have been placed in

conversions of average site index into volumetric growth and yield are based on recognized site index curves for red oak (*22*), aspen (*13*), sugar maple (*7*)

apply to the descriptions of all the woodland groups in St. Croix County.

Equipment limitations are rated on the basis of soil

TABLE 3.—*Woodland*

Woodland groups and map symbols [1]	Potential productivity of the soils				Trees to select for planting	Equipment limitations	Erosion hazard	Seedling mortality
	Kinds of trees	Average site index	Number of plots	Yearly growth per acre				

TABLE 3.—*Woodland*—Continued

Woodland groups and map symbols [1]	Potential productivity of the soils				Trees to select for planting	Equipment limitations	Erosion hazard	Seedling mortality
	Kinds of trees	Average site index	Number of plots	Yearly growth per acre				
				Fbm				
Group 3d1: BrB, BrC2, BxB, BxC2, CoC2, RnB, RnC2.	Red oak [2]	55	([3])	160	Red pine, jack pine, and eastern red-cedar.	Slight	Slight	Moderate.
	Jack pine	55	([3])	180				
Group 3d2: BxD2, CoD2, CoE, RnD2, RoE.	Red oak [2]	55	([3])	160	Red pine, jack pine, and eastern red-cedar.	Moderate	Severe	Moderate.
	Jack pine	55	([3])	80				
Group 3s1: BnB, BnC, GoB, GoC, HrB, HsB, HsC, PmB, PmC, Ud.	Black oak	51	4	130	Red pine, jack pine, and eastern red-cedar.	Slight	Slight	Moderate.
	Northern pin oak	56	2	110				
	White pine	59	2	400				
	Jack pine	58	2	95				
Group 3s2: Du	Jack pine	55	([3])	75	Eastern white pine, red pine, and red maple.	Slight	Slight	Moderate.
	Aspen	60	([3])	150				
	Red maple	55	([3])	----------				

TABLE 3.—*Woodland*—Continued

Woodland groups and map symbols [1]	Potential productivity of the soils				Trees to select for planting	Equipment limitations	Erosion hazard	Seedling mortality
	Kinds of trees	Average site index	Number of plots	Yearly growth per acre				
				Fbm				
Group 6w1: Se	Not suited for							

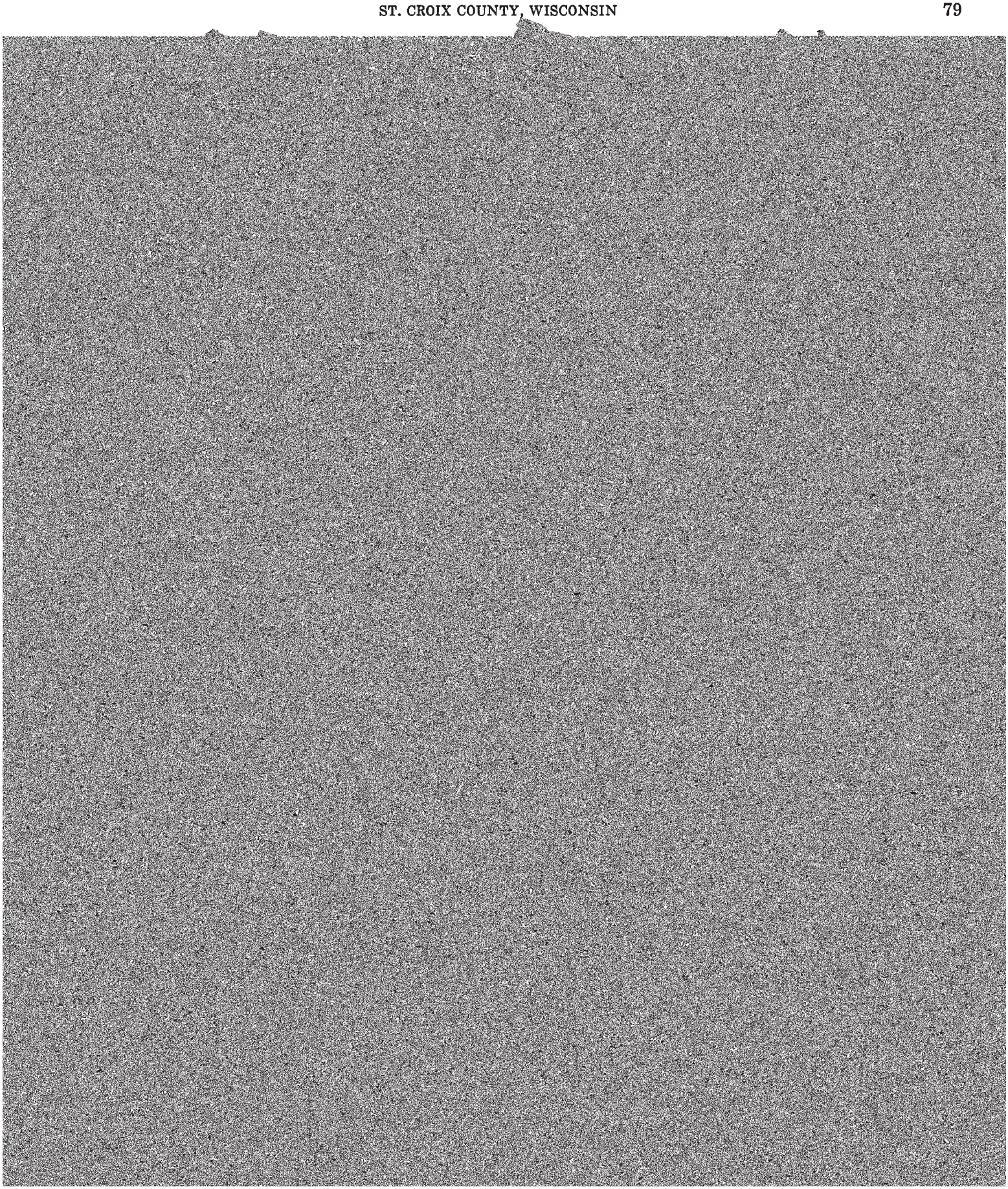


TABLE 5.—*Shrubs and vines suited to the soils*—Continued

Tree and shrub group and map symbols	Common name	Type of plant	Potential height	Plants suitable for— Landscaping	Hedge, screen, or windbreak	Wildlife food and cover	Roadside planting	Ground cover
			Ft					
Group 2. Shallow to deep, mainly moderately well drained to excessively drained, medium and coarse textured soils that have moderate to very low available water capacity: BnB, BnC, BnD, BrB, BrC2, BxB, BxC2, BxD2, CoC2, CoD2, CoE, DkB, EmE, GoB, GoC, HrB, PmB, PmC, PmD, RnB, RnC2, RnD2, RoE, Ud.	Arborvitae	Shrub	3–7	X	X	X		
	Barberry, Japanese	Shrub	6	X	X	X		
	Bayberry or wax-myrtle.	Shrub	5–9	X		X		X
	Bittersweet	Vine		X		X	X	X
	Blackberry, dewberry, blackcap raspberry.	Bramble	1–5			X	X	X
	Chokeberry, black	Shrub	1–3	X		X	X	X
	Cotoneaster	Shrub	4–8	X	X	X		
	Crabapple	Shrub	10–25	X	X	X	X	
	Currant, alpine	Shrub	6–7	X	X			
	Dogwood, gray	Shrub	6–10			X	X	
	Filbert (hazelnut)	Shrub	5–8			X	X	
	Forsythia	Shrub	4–8	X				
	Grape, wild	Vine				X	X	X
	Hawthorn or thornapple.	Shrub	5–15			X	X	
	Honeysuckle	Shrub	6–12	X	X	X		
	Juniper, creeping	Shrub	1–2	X		X	X	X
	Juniper, Pfitzer	Shrub	8–10	X		X		
	Lilac	Shrub	8–10	X	X		X	
	Maple, Amur	Shrub	1	X	X			
	Mockorange	Shrub	6–9	X	X			
	Myrtle or periwinkle	Vine	1	X			X	X
	Ninebark, common	Shrub	6–9	X	X		X	
	Olive, autumn	Shrub	10–15	X	X	X		
	Peashrub, Siberian	Shrub	10–15		X	X	X	
	Pine, mugho	Shrub	6–9	X		X		
	Plum, American	Shrub	10–15			X	X	
	Privet, Amur	Shrub	10		X	X		
	Privet, Regels border	Shrub	6–9		X	X		
	Redcedar, eastern	Shrub	6–9		X	X	X	
	Russian-olive	Shrub	15+	X	X	X		
	Snowberry	Shrub	3–4	X		X	X	X
	Spirea, Anthony Waterer.	Shrub	2–3	X				
	Spirea, Vanhoutte	Shrub	5–6	X	X			
	Sumac, fragrant	Shrub	3	X		X	X	X
	Sumac, smooth	Shrub	6–10			X	X	
	Sumac, staghorn	Shrub	10–15			X	X	
	Viburnum, blackhaw	Shrub	8–10		X	X	X	
	Viburnum, nannyberry	Shrub	9–12		X	X	X	
	Viburnum, Rafinesque	Shrub	2–4			X	X	
	Viburnum, wayfaring-tree.	Shrub	4–9	X		X	X	
	Virginia creeper	Vine				X	X	X
	Willows, shrubby types including pussy willow.	Shrub	2–8	X	X	X	X	
Group 3. Mainly somewhat poorly drained to very poorly drained mineral soils: AdA, AuA, CyA, DfB, Du, FdA, Fe, Fm, HaA, LcA, MaB, OrA, RhA, SrA.	Arborvitae	Shrub	3–7	X	X	X		
	Bayberry or wax-myrtle.	Shrub	5–9	X		X		X
	Dogwood, gray	Shrub	6–10			X	X	
	Dogwood, pagoda	Shrub	10–15			X	X	
	Dogwood, redosier	Shrub	3–9					
	Dogwood, roundleaf	Shrub	3–9			X	X	X
	Dogwood, silky	Shrub	6–10		X	X	X	
	Elder, American	Shrub	3–10			X	X	X
	Hawthorn or thornapple.	Shrub	5–15			X	X	
	Honeysuckle	Shrub	6–12	X	X	X		
	Ninebark, common	Shrub	6–9	X	X		X	
	Olive, autumn	Shrub	10–15	X	X	X		
	Plum, American	Shrub	10–15			X	X	

TABLE 5.—*Shrubs and vines suited to the soils*—Continued

Tree and shrub group and map symbols	Common name	Type of plant	Potential height	Plants suitable for— Landscaping	Hedge, screen, or windbreak	Wildlife food and cover	Roadside planting	Ground cover
			Ft					
	Group 3—con.							
	Russian-olive	Shrub	15+	X	X	X		
	Spirea narrowleaf	Shrub	3–4				X	
	Spirea, Vanhoutte	Shrub	5–6	X	X			
	Viburnum, American cranberrybush.	Shrub	7–9	X	X	X	X	
	Viburnum, mapleleaf	Shrub	3–5			X	X	
	Viburnum, nannyberry	Shrub	9–12		X	X	X	
	Viburnum, wayfaring-tree.	Shrub	4–9	X		X	X	
	Willows, shrubby types including pussy willow.	Shrub	2–8	X	X	X	X	
	Winterberry, common	Shrub	6–9			X	X	
Group 4. Very poorly drained organic soils: Sm.	Arborvitae	Shrub	3–7	X	X	X		
	Dogwood, redosier	Shrub	3–9					
	Dogwood, roundleaf	Shrub	3–9			X	X	X
	Dogwood, silky	Shrub	6–10		X	X	X	
	Elder, American	Shrub	3–10			X	X	X
	Honeysuckle	Shrub	6–12	X	X	X		
	Ninebark, common	Shrub	6–9	X	X		X	
	Spirea, narrowleaf	Shrub	3–4				X	
	Viburnum, American cranberrybush.	Shrub	7–9	X	X	X	X	
	Viburnum, mapleleaf	Shrub	3–5			X	X	
	Viburnum, nannyberry	Shrub	9–12		X	X	X	
	Viburnum, wayfaring-tree.	Shrub	4–9	X		X	X	
	Willows, shrubby types including pussy willow.	Shrub	2–8	X	X	X	X	
	Winterberry, common	Shrub	6–9			X	X	

trees as oaks, maples, cherry, and nut trees furnish mast, fruit, seeds, dens, cover, and browse for wildlife. Coniferous trees that are more than eight feet tall furnish seeds, fruit, browse, and cover for wildlife. Examples are pines, firs, spruce, tamarack, and cedar.

Wetland plants for food and cover include forbs, grasses, sedges, aquatic plants, and woody plants that grow well in wet areas. They furnish fruit, seeds, browse, and cover for wildlife that live in wet areas and on or near open water. Examples are smartweed, canarygrass, sedges, arrowhead, alder, and willow. These plants grow well in type 1, 2, and 6 wetlands as defined in U.S. Department of Interior Circular 39 (*23*). Type 1 wetlands are seasonally flooded basins and nearly level areas that are covered with water or saturated with water during seasonal wet periods but are generally relatively dry during much of the growing season. Type 2 wetlands include fresh meadows that are generally not covered by water during the growing season but are saturated within a few inches of the soil surface. Type 6 wetlands consist of shrub swamp areas in which the soil is generally saturated during the growing season.

Shallow water areas are areas where water is less than 5 feet deep. They are natural or artificial water areas formed by dug-out areas or low embankments, or both. Common plants are cattails, bulrushes, sedges, and reeds. Shallow water areas in St. Croix County are type 3 and 4 wetlands. Type 3 wetlands are shallow marshes where the soil is saturated or covered by as much as 6 inches of water during the growing season. Type 4 wetlands are deep marshes that are covered by 6 inches to about 3 feet of water during the growing season.

Deep water areas are more than 5 feet deep. They are naturally formed or are dug. Common plants are coontail, waterlilies, milfoil, and waterweed. The deep water areas consist of ponds, lakes and type 5 wetlands. Type 5 wetlands are open freshwater areas that include shallow ponds and reservoirs or wet areas where water is less than 10 feet deep.

In 1938 and 1967 these types of wetland covered the following acreages in St. Croix County.

	1938	1967
Type 2	2,796	1,749
Types 3, 5	721	428
Type 6	3,337	1,500
Type 7	4,458	11,423
Total	11,312	15,100

Table 7 lists the important kinds of wildlife in St. Croix County and rates the importance of the various

Paths and trails are used for local and cross country

TABLE 6.—*Suitability of the*

Wildlife groups and map symbols [1]	Grain and seed crops	Grasses and legumes
Group 1. Moderately well drained to somewhat excessively drained soils that are loamy throughout and are not subject to flooding: AlB, AlC2, AlD2, AmB, AmC2, AmD2, AmE2, AnC2, AnD2, AoA, AoB, ApC2, ApD2, ApF, AsB, AsC2, BpA, FnB, FoB, FoC2, JeA, JeB, JeC2, JsA, JsB, OmB, OmC2, OnC2, OnD2, OtB, OtC, OtD2, ReB, ReC2, RgC2, RgD2, SaB, SaC2 ScC2, ScD2, ShA, ShB, ShC2 SlA, SlB, WhB, WhC2, WhD2.	Good where slope is 0 to 6 percent, fair where slope is 6 to 12 percent, poor where slope is more than 12 percent; water erosion is a hazard.	Good where slope is 0 to 12 percent, fair where slope is 12 to 20 percent, poor where slope is more than 20 percent.
Group 2. Moderately well drained silty soils that have a silt loam, clay loam, or silty clay loam subsoil and are not subject to flooding: DeB, DeC2, VaB, VaC2.	Good where slope is 0 to 6 percent, fair where slope is 6 to 12 percent, unsuited where slope is more than 12 percent.	Good where slope is 0 to 12 percent, fair where slope is 12 to 20 percent, unsuited where slope is more than 20 percent.
Group 3. Somewhat excessively drained to excessively drained soils that are sandy throughout and are droughty: BnB, BnC, BnD, EmE, GoB, GoC, HrB, PmB, PmC, PmD.	Fair: water erosion is a hazard.	Good ----------
Group 4. Mainly soils that are thin over sand and gravel or dolomitic limestone and are droughty: BrB, BrC2, BxB, BxC2, BxD2, CoC2, CoD2, CoE, RnB, RnC2, RnD2, RoE.	Fair where slope is 0 to 6 percent, poor where slope is more than 6 percent; water erosion is a hazard.	Good where slope is 0 to 12 percent, fair where slope is 12 to 20 percent, poor where slope is more than 20 percent.
Group 5. Well drained and somewhat excessively drained soils that have a thick dark colored surface layer and are loamy or sandy throughout: DaA, DaB, DcC2, DkB, HeB, HeC2, HeD2, HsB, HsC, NcB, NcC2, NnD2, PlA, PoB, PoC, PoD, RpB, RpC2, RpD2.	Poor where slope is 0 to 6 percent; unsuited where slope is more than 6 percent; droughty; soil blowing is a hazard.	Fair ----------
Group 6. Somewhat poorly drained and moderately well drained soils: DfB, Du, FdA, Fe, HaA, LcA, MaB, OrA, SrA, Ud.	Good where soil has been drained; fair where soil is undrained and wet.	Good where soil has been drained; fair where soil is undrained and wet; few plants are suitable.
Group 7. Very poorly drained and poorly drained soils: AdA, AuA, CyA, Fm, RhA, Se.	Good where soil has been drained; very poor where soil is undrained and wet.	Fair where soil has been drained; poor where soil is undrained and wet.
Group 8. Very poorly drained organic soils: Sm.	Fair where soil has been drained; unsuited where soil is undrained and wet.	Fair where soil has been drained; unsuited where soil is undrained and wet; few plants are suitable.
Group 9. Well drained and moderately well drained silty soils that are subject to flooding: HuA.	Good ----------	Good ----------
Group 10. Well drained shallow soils over limestone and exposures of lime-	Poor: water erosion is a hazard; shallow to	Poor where slope is more than 20 percent;

soils for wildlife habitat

Wild herbaceous upland plants	Woody plants		Wetland plants for food and cover	Shallow and deep water developments
	Hardwood trees and shrubs	Coniferous trees		
Good where slope is 0 to 20 percent, fair where slope is more than 20 percent	Good where slope is 0 to 20 percent, fair where slope is more than 20 percent	Good where slope is 0 to 20 percent, fair where slope is more than 20 percent	Poor where slope is 0 to 2 percent, unsuited where slope is more than 2 percent	Poor where slope is 0 to 2 percent, unsuited where slope is more than 2

TABLE 7.—*Relative value of elements of wildlife habitat*

[The numeral 1 means that the element of habitat is of little value for the survival of that kind of wildlife; 2 means that it is of Dashes mean that the element of habitat

Kinds of wildlife	Grain and seed crops		Grasses and legumes	
	Harvested	Not harvested	Harvested	Not harvested
Migratory waterfowl:				
Ducks	3	3	1	3
Geese	4	5	4	1
Upland game birds:				
Hungarian partridge	4	4	3	4
Pheasant	4	4	----	5
Quail	4	4	2	4
Woodcock	----	----	1	3
Mammals:				
Rabbits, cottontail	3	4	3	5
Raccoon	3	4	----	1
Squirrels, fox and gray	3	4	----	1
Deer	3	4	3	3
Beaver	----	----	----	----
Fox, red [1]	2	3	2	3
Mink [1]	----	----	----	----
Muskrat	1	1	----	----

[1] Some carnivorous animals are not strictly dependent on these elements.

parts of this survey, can be used to make interpretations in addition to those given in tables 9 and 10, and it also can be used to make other useful maps.

This information, however, does not eliminate need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 5 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have special meaning to soil scientists. The Glossary defines many of these items commonly used in soil science.

Classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system used by the SCS engineers, Department of Defense, and others, and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO).

The Unified system is used to classify soils according to engineering uses for building material or for the support of structures other than highways (*2*). Soils are classified according to particle size distribution, [illegible] limit, and organic matter con-

basis of the plasticity index. Nonplastic classes are ML, MH, OL, and OH; plastic classes are CL and CH. There is one class of highly organic soils, Pt. Dual classifications used for a specific range of particle sizes are SP–SM, SW–SM, SP–SC, SW–SC, GP–GM, GW–GM, GP–GC, and GW–GC. For a specific range of liquid limits and plasticity indices, the dual classifications of CL–ML, SC–SM, and GC–GM are used. For borderline cases, usually both possible classifications are listed.

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance (*1*). In this system, a soil is placed in one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are divided as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The AASHTO classification for tested soils, with group index numbers in parentheses, is shown in table 11; the

TABLE 8.—*Recreational limitations*

Recreation groups and map symbols [1]	Playgrounds and intensive play areas	Picnic grounds and extensive play areas
Group 1. Nearly level to very steep, somewhat excessively drained and well	Slight where slope is 0 to 2 percent, moderate where slope is 2 to 6 percent,	Slight where slope is 0 to 6 percent, moderate where slope is 6 to 12 percent,

of the soils

Camp areas (tent and trailer)	Paths and trails	Golf course fairways
Slight where slope is 0 to 6 percent, moderate where slope is 6 to 12 percent, severe where slope is more than 12 percent; surface slippery and soft when wet; erodible slopes.	Slight where slope is 0 to 12 percent, moderate where slope is 12 to 20 percent, severe where slope is more than 20 percent; erodible slopes; muddy and slippery when wet.	Slight where slope is 0 to 6 percent, moderate where slope is 6 to 12 percent, severe where slope is more than 12 percent; erodible slopes.
Moderate where slope is 0 to 12 percent, severe where slope is more than 12 percent; erodibility; droughtiness; vegetation difficult to maintain.	Moderate where slope is 0 to 20 percent, severe where slope is more than 20 percent; erodibility; poor stability on slopes; paths and trails difficult to maintain; surfacing may be needed.	Moderate where slope is 0 to 12 percent; severe where slope is more than 12 percent; erodibility; droughtiness; good turf difficult to maintain.
Slight where slope is 2 to 6 percent, moderate where slope is 6 to 12 percent or where permeability is moderately slow, severe where slope is more than 12 percent or where the soil is more than 50 percent coarse fragments.	Slight where slope is 2 to 12 percent, moderate where slope is 12 to 20 percent, severe where slope is more than 20 percent or where the soil is more than 50 percent coarse fragments.	Slight where slope is 2 to 6 percent, moderate where slope is 6 to 12 percent or permeability is moderately slow, severe where slope is more than 12 percent or where the soil is more than 50 percent coarse fragments.
Moderate: moderately slow permeability; silty; slippery when wet.	Moderate: moderately slow permeability; slippery when wet.	Moderate: slope is 2 to 12 percent; moderately slow permeability.
Moderate where moderately well drained, severe where somewhat poorly drained; subject to occasional flooding.	Slight where moderately well drained, moderate where somewhat poorly drained; seasonal high perched water table.	Slight where slope is 0 to 6 percent and where the soil is moderately well drained, moderate where slope is 6 to 12 percent or where the soil is somewhat poorly drained; seasonal high perched water table.
Severe: subject to flooding; poor trafficability when wet.	Severe: subject to flooding; poor trafficability when wet.	Severe: subject to flooding; turf easily damaged when wet.

measures for steel and more resistant concrete should be used to reduce damage.

Another soil property significant to engineering use is subsidence. Subsidence is settlement of organic soils when drained or of soils containing semifluid mineral [illegible] the organic soils are subject to subsidence, if drained. These are Seelyeville soils and the Saprists part of Saprists and Aquents. Subsidence of these soils is approximately ½ to 1 inch per year, if drained. A more complete discussion of subsidence is given in the sub-

TABLE 9.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils for referring to other series that appear in the first

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification		Coarse fragment greater than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHTO	
	Ft	*Ft*	*In*				*Pct*
Adolph: AdA	>5	[2,3] 0–1	0–14	Silt loam	CL	A–4, A–6, or A–7	----------
			14–23	Silt loam	CL	A–4 or A–6	----------
			23–60	Sandy loam	SM, SC, or SC–SM	A–2 or A–4	0–10
*Amery: AlB, AlC2, AlD2, AmB, AmC2, AmD2, AmE2, AnC2, AnD2. For Cromwell parts of these units, see Cromwell series.	>5	>5	0–12	Loam or sandy loam.	ML, SM, CL–ML, or SM–SC	A–4 or A–2–4	----------
			12–31	Sandy loam	SC–SM or SM	A–2–4 or A–4	5–10
			31–60	Sandy loam	SC–SM or SM	A–2–4 or A–4	5–10
Antigo: AoA, AoB	>5	>5	0–18	Silt loam	ML, CL, CL–ML	A–4	----------
			18–29	Silt loam and loam	CL	A–6 or A–7	----------
			29–33	Sandy loam	SC, SC–SM, or SM	A–2	----------
			33–60	Sand and gravel	SP, SW, SW–SM, or SP–SM	A–1	0–3
Arland: ApC2, ApD2, ApF	2–3 1/3	>5	0–8	Sandy loam	SM, SC–SM, or SC	A–4	----------
			8–24	Sandy loam	SM, SC–SM, or SC	A–2 or A–4	10–20
			24–60	Soft sandstone [5]	SP, SP–SM, or SM	A–3 or A–2	10–20
AsB, AsC2	2–3 1/3	>5	0–11	Silt loam	ML, CL–ML, or CL	A–4	0
			11–26	Silt loam and loam	CL–ML or CL	A–4 or A–6	0–10
			26–35	Sandy loam	SM or SC–SM	A–2 or A–4	5–15
			35–60	Soft sandstone [5]	SP or SP–SM	A–3	5–15
Auburndale: AuA	>5	[2,3] 0–1	0–13	Silt loam	ML, CL, or CL–ML	A–4	0
			13–36	Silt loam	CL	A–4 or A–6	0
			36–60	Sandy loam	SC or SC–SM	A–4 or A–6	5–10
Boone: BnB, BnC, BnD	2–3 1/3	>5	0–3	Loamy fine sand	SM	A–2	0
			3–24	Fine sand	SM	A–2	0
			24–60	Soft sandstone and fine sand.[5]	SP, SP–SM, SM	A–3 or A–2	0
Brill: BpA	>5	3–5	0–16	Silt loam	ML, CL–ML, or CL	A–4	0
			16–26	Silt loam	CL	A–6	0
			26–30	Loam	SC or CL	A–4 or A–6	0
			30–60	Sand and gravel	SP	A–1 or A–3	0–10
*Burkhardt: BrB, BrC2, BxB, BxC2, BxD2. For Sattre parts of these units, see Sattre series.	>5	>5	0–12	Sandy loam	SM	A–2–4	0
			12–16	Sandy loam	SM	A–2–4 or A–4	0
			16–60	Sand and gravel	SP or SW	A–1	0–15
Chetek: CoC2, CoD2, CoE. Mapped only in complex with Onamia soils.	>5	>5	0–6	Sandy loam	SM	A–2	0
			6–16	Sandy loam	SM	A–2 or A–4	0
			16–60	Sand and gravel	SP or SW	A–1	0–15

significant to engineering

in such mapping units may have different properties and limitations, and for this reason it is necessary to follow the instructions column of this table. The symbol > means greater than]

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction [1]	Shrink-swell potential	Corrosivity of—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
				Pct		*In per hr*	*In per in of soil*	*pH*			
100	95–100	90–100	85–95	30–50	10–25	0.6–2.0	0.22–0.24	5.6–6.0	Low	High	Moderate.
100	95–100	90–100	85–95	20–30	8–15	0.2–0.6	0.20–0.22	6.1–6.5	Moderate	High	Low.
85–95	75–90	55–70	30–40	10–20	2–10	0.2–0.6	0.11–0.13	6.1–7.3	Low	High	Low.
100	100	65–95	30–75	10–30	3–7	0.6–2.0	0.12–0.22	6.6–7.3	Low	Low	Low.
85–100	75–95	70–80	30–45	10–20	2–6	0.6–2.0	0.12–0.14	5.6–7.3	Low	Moderate	High.
85–100	75–95	75–85	30–45	10–20	2–6	0.6–2.0	0.11–0.13	5.6–6.5	Low	Low	High.
100	100	90–100	75–85	20–30	3–10	0.6–2.0	0.22–0.24	5.6–6.0	Low	Low	Moderate.
100	100	80–90	75–85	30–45	15–25	0.6–2.0	0.20–0.22	5.1–5.5	Moderate	Low	Moderate.
85–100	85–95	60–70	25–35	10–20	2–6	2.0–6.0	0.12–0.14	5.1–5.5	Low	Low	High.
75–90	40–85	25–50	2–10	--------	NP	>20.0	0.02–0.04	5.1–5.5	Low	Low	High.
95–100	95–100	70–85	40–50	10–20	2–10	2.0–6.0	0.16–0.18	4.5–5.5	Low	Low	High.
85–100	80–95	50–70	25–40	10–20	2–10	2.0–6.0	0.15–0.17	4.5–5.5	Low	Low	High.
95–100	95–100	75–95	3–15	--------	NP	0.6–2.0	0.05–0.07	5.1–6.5	Low	Low	High.
95–100	95–100	80–95	70–80	20–30	3–10	0.6–2.0	0.22–0.24	5.1–7.3	Low	Low	Low.
90–100	80–100	80–95	55–75	25–35	5–15	0.6–2.0	0.17–0.22	5.1–6.0	Low to moderate.	Low	Moderate.
90–100	80–95	50–70	25–40	10–20	1–5	2.0–6.0	0.12–0.14	4.5–5.5	Low	Low	High.
90–100	90–100	75–95	3–10	--------	NP	0.6–2.0	0.05–0.07	5.1–6.5	Low	Low	High.
100	100	100–95	85–95	20–30	2–10	0.6–2.0	0.22–0.24	5.1–6.5	Low	High	Moderate.
100	100	100–95	80–95	20–35	10–20	0.2–0.6	0.20–0.22	4.5–5.5	Moderate	High	High.
85–90	75–95	60–80	35–50	10–20	5–12	0.2–0.6	0.11–0.13	6.1–7.3	Low	High	Low.
100	100	75–90	20–30	--------	NP	>20.0	0.10–0.12	4.5–6.5	Low	Low	High.
100	100	50–90	15–30	--------	NP	>20.0	0.10–0.12	4.5–5.5	Low	Low	High.
90–100	90–100	65–75	3–15	--------	NP	2.0–6.0	0.06–0.10	4.5–5.5	Low	Low	High.
100	100	90–100	70–90	20–30	3–10	0.6–2.0	0.22–0.24	5.6–7.3	Low	Low	Low.
90–100	90–100	80–90	75–85	30–40	15–25	0.6–2.0	0.20–0.22	4.5–5.0	Moderate	Moderate	High.
85–95	85–95	75–85	40–60	20–30	8–15	0.6–2.0	0.17–0.19	5.1–5.5	Low	Moderate	Moderate.
85–90	75–85	35–55	1–5	--------	NP	6.0–20	0.02–0.04	5.6–6.0	Low	Low	Moderate.
95–100	95–100	60–70	25–35	29	NP	2.0–6.0	0.13–0.15	5.1–6.5	Low	Low	High.
95–100	85–95	60–80	30–50	15–25	1–4	2.0–6.0	0.12–0.14	5.1–6.0	Low	Low	High.
75–85	60–75	20–50	1–5	--------	NP	6.0–20	0.02–0.04	5.6–6.5	Low	Low	Moderate.
95–100	95–100	60–70	25–35	>26	NP	2.0–6.0	0.13–0.15	5.1–6.0	Low	Low	High.
95–100	80–95	60–70	30–45	10–22	1–4	2.0–6.0	0.12–0.19	5.1–6.0	Low	Low	High.
75–85	65–85	20–50	1–5	--------	NP	6.0–20	0.02–0.04	5.6–6.5	Low	Low	Moderate.

TABLE 9.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification		Coarse fragment greater than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHTO	
	Ft	*Ft*	*In*				*Pct*
Clyde: CyA	>5	[2,3] 0–1	0–18	Silt loam	CL–ML or CL	A–2 or A–6	0
			18–28	Silt loam	CL	A–6 or A–7	0
			28–60	Heavy loam	CL	A–6	0–5
Cromwell: Mapped only in complex with Amery soils.	>5	>5	0–30	Sandy loam and loamy sand.	SM or SM–SC	A–2 or A–4	0
			30–60	Sand and gravel and loamy sand.	SP, SP–SM, or SM	A–2 or A–3	0–10
Cut and fill areas: Cz. Too variable to be rated.							
*Dakota: DaA, DaB, DcC2. For Pillot part	>5	>5	0–14	Loam	ML	A–4	0
			14–28	Loam	ML, CL–ML, or CL	A–4 or A–6	0

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction [1]	Shrink-swell potential	Corrosivity of—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
				Pct		*In per hr*	*In per in of soil*	*pH*			
95–100	95–100	85–95	75–85	25–35	5–20	0.6–2.0	0.22–0.24	7.4–7.8	Low	High	Low.
95–100	95–100	90–100	80–90	35–45	15–25	0.2–2.0	0.20–0.22	7.4–7.8	Moderate	High	Low.
90–100	85–95	75–85	55–65	30–40	15–25	0.2–0.6	0.17–0.19	7.4–7.8	Moderate	High	Low.
95–100	75–100	60–90	25–50	10–30	2–5	0.6–2.0	0.11–0.15	5.1–6.0	Low	Low	Moderate.
90–100	70–100	50–75	0–15	>15	NP	6.0–20	0.05–0.07	5.1–6.0	Low	Low	Moderate.
95–100	90–100	85–95	55–65	20–30	1–4	0.6–2.0	0.20–0.22	6.1–6.5	Low	Low	Low.
95–100	90–100	85–95	55–70	20–30	4–15	0.6–2.0	0.17–0.19	5.1–6.5	Low	Low	Moderate.
85–100	80–90	35–65	0–4	-------	NP	6.0–20	0.02–0.04	5.1–6.5	Low	Low	Moderate.
95–100	75–100	85–95	75–85	20–35	4–14	0.2–0.6	0.22–0.24	6.1–6.5	Low	Moderate	Moderate.
95–100	95–100	90–100	80–90	30–40	11–20	0.2–2.0	0.20–0.22	5.6–7.3	Moderate	Moderate	Moderate.
85–100	85–100	95–100	85–100	55–65	30–40	0.6–0.2	0.10–0.12	5.6–7.3	High	High	Low.
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100	100	90–100	70–90	20–30	3–10	0.6–2.0	0.22–0.24	5.6–6.5	Low	High	Moderate.
100	95–100	95–100	90–100	45–65	30–40	0.06–0.20	0.10–0.13	6.6–7.8	High	High	Low.
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95–100	95–100	65–75	25–35	10–19	1–4	2.0–6.0	0.12–0.15	5.6–6.0	Low	Low	Moderate.
90–100	90–100	50–70	15–30	-------	NP	6.0–20	0.09–0.11	5.1–6.0	Low	Low	Moderate.
90–100	70–100	25–40	0–4	-------	NP	6.0–20	0.02–0.04	5.6–6.5	Low	Low	Moderate.
95–100	95–100	45–60	15–30	-------	NP	6.0–20	0.10–0.12	6.1–7.3	Low	Low	Moderate.
95–100	95–100	40–60	0–5	-------	NP	6.0–20	0.05–0.07	6.1–7.3	Low	Low	Low.
80–90	65–75	40–55	20–30	16–24	2–5	2–6.0	0.06–0.10	5.1–7.3	Low	Low	Moderate.
50–70	45–60	10–25	0–4	-------	NP	>20.0	0.02–0.04	5.1–7.3	Low	Low	Moderate.
100	100	80–95	75–85	25–35	5–20	0.6–2.0	0.22–0.24	6.6–7.3	Low	High	Low.
95–100	95–100	90–100	80–90	35–45	15–25	0.6–2.0	0.20–0.22	6.6–7.3	Moderate	High	Low.
90–95	85–95	75–85	50–65	30–40	11–20	0.2–0.6	0.17–0.19	6.6–7.8	Moderate	High	Low.
90–95	85–95	85–95	70–80	30–45	15–25	0.2–0.6	0.14–0.16	6.6–7.8	Moderate	High	Low.
100	100	90–95	70–80	20–30	2–4	0.6–2.0	0.22–0.24	6.1–6.5	Low	Moderate	Low.
95–100	75–100	75–85	40–60	15–30	7–15	0.6–2.0	0.17–0.19	5.1–5.5	Moderate	Moderate	Moderate.
95–100	75–95	70–85	25–40	15–20	2–6	0.6–2.0	0.10–0.14	5.1–6.5	Low	Moderate	Moderate.
95–100	95–100	85–95	75–90	20–30	2–4	0.6–2.0	0.22–0.24	5.6–6.0	Low	Moderate	Moderate.
85–100	80–95	75–85	50–65	20–30	10–20	0.6–2.0	0.17–0.19	4.5–5.5	Moderate	Moderate	Moderate.
90–100	85–100	80–95	60–80	35–45	15–25	0.2–0.6	0.14–0.16	5.6–6.0	Moderate	High	Moderate.

TABLE 9.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification		Coarse fragment greater than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHTO	
	Ft	*Ft*	*In*				*Pct*
Gotham: GoB, GoC--	>5	>5	0–30	Loamy fine sand ----	SM	A–2	0
			30–60	Fine sand with [illegible]	SP, SP-SM, SM, or [illegible]	A–2 or A–3	0

significant to engineering—Continued

Percentage less than 3 inches passing sieve—								Liquid	Plas-		Available		Shrink-	Corrosivity of—	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 9.—*Estimated soil properties*

Soil series and map symbols	Depth to— Bedrock	Depth to— Seasonal high water table	Depth from surface	USDA texture	Classification Unified	Classification AASHTO	Coarse fragment greater than 3 inches
	Ft	*Ft*	*In*				*Pct*
*Onamia: OmB, OmC2, OnC2, OnD2. For Antigo parts of these units, see Antigo series.	>5	>5	0–7	Loam	CL–ML, CL	A–4	0
			7–28	Loam	SC or CL	A–4 or A–6	0
			28–32	Sandy loam	SM or SC–SM	A–2 or A–4	0
			32–60	Sand and gravel	SP or SP–SM	A–1 or A–3	0–10
Orion: OrA	>5	[3] 1–3	0–60	Silt loam	ML or CL–ML	A–4	0
Otterholt: OtB, OtC, OtD2.	>5	>5	0–16	Silt loam	CL–ML or CL	A–4	0
			16–45	Silt loam	CL	A–4 or A–6	0
			45–60	Silt loam	CL–ML or CL	A–4 or A–6	0
Pillot: PlA	>5	>5	0–15	Silt loam	CL–ML or CL	A–4 or A–6	0
			15–37	Silt loam	CL	A–6 or A–7	0
			37–60	Sand and gravel	SP	A–1 or A–3	0–5
Plainfield: PmB, PmC, PmD.	>5	>5	0–8	Loamy sand	SM	A–2	0
			8–60	Sand	SP	A–3	0
Port Byron: PoB, PoC, PoD.	>5	>5	0–60	Silt loam	CL	A–4 or A–6	0
Renova: ReB, ReC2	>5	>5	0–9	Silt loam	ML	A–4	0
			9–17	Silt loam	CL	A–6	0
			17–60	Heavy loam	CL	A–6	0–5
Renova Variant: RgC2, RgD2.	>5	>5	0–6	Loam	ML	A–4	0
			6–15	Sandy loam	SC or CL	A–4 or A–6	0–5
			15–34	Loam	CL	A–4 or A–6	0–10
			34–60	Sandy loam and loamy sand.	SM	A–2	0–10
Rib: RhA	>5	[3] 0–1	0–14	Silt loam	ML, CL–ML, or CL	A–4	0
			14–25	Silt loam	CL	A–4 or A–6	0
			25–30	Loam	ML or CL	A–4	0
			30–60	Sand and gravel	SP or SP–SM	A–1 or A–3	0–3

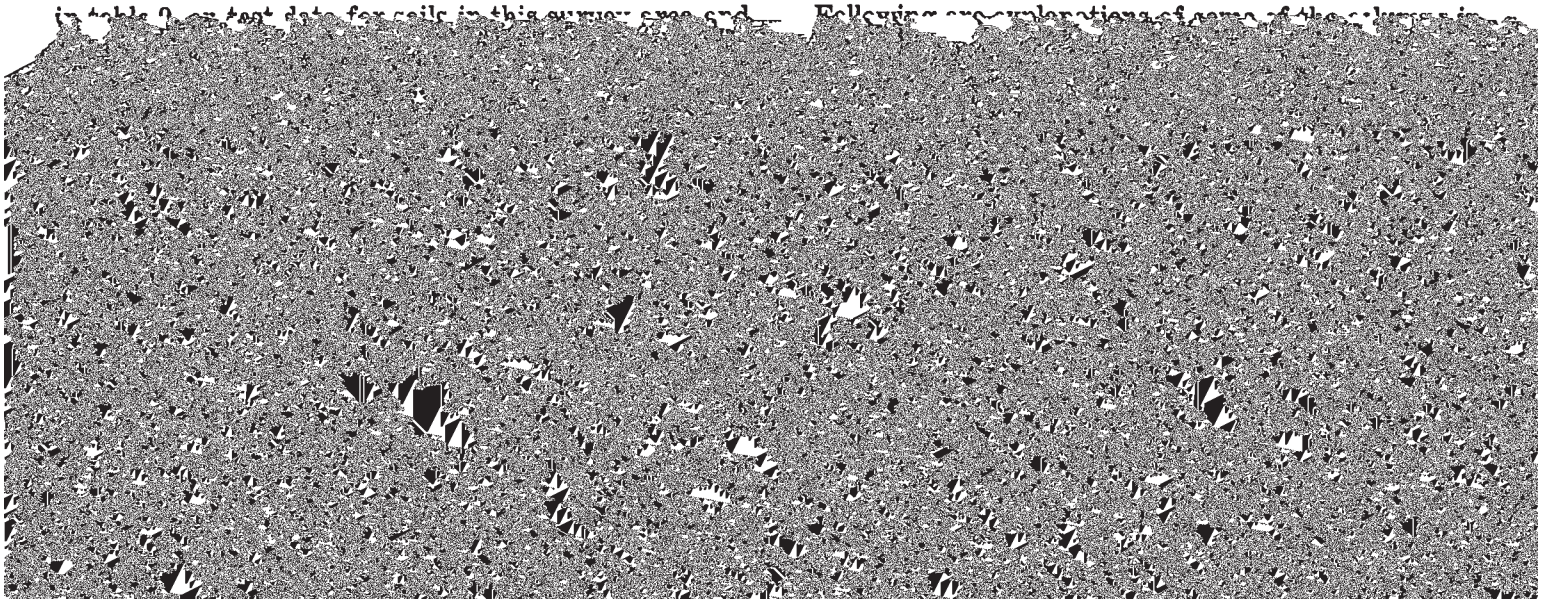
significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction [1]	Shrink-swell potential	Corrosivity of—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
				Pct		*In per hr*	*In per in of soil*	*pH*			
95–100	90–95	80–90	50–70	20–30	5–10	0.6–2.0	0.20–0.22	5.6–6.5	Low	Low	Moderate.

TABLE 9.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification		Coarse fragment greater than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHTO	
	Ft	*Ft*	*In*				*Pct*
Sattre: ShA, ShB, ShC2, SlA, SlB.	>5	>5	0–17	Silt loam or loam	ML	A–4	0
			17–30	Loam	SC–SM, SC, CL–ML, or CL	A–4 or A–6	0
			30–60	Sand and gravel	SP	A–1 or A–3	0–5
Seelyeville: Sm	>5	[2,3] 1–3	0–55	Muck	Pt	----------	0
			55–60	Sand	SP, SP–SM, or SM	A–2 or A–3	0
Skyberg: SrA	>5	[2,3] 0–1	0–18	Silt loam	ML or CL	A–4 or A–6	0
			18–32	Heavy loam	CL	A–6 or A–7	0–5
			32–60	Heavy loam	CL	A–6	0–5
Udifluvents: Ud Too variable to be rated.	>5	[3] 2–5					
Vlasaty: VaB, VaC2	>5	[2] 3–5	0–16	Silt loam	CL–ML or CL	A–4 or A–6	0
			16–42	Clay loam	CL	A–6	0–5
			42–60	Clay loam	CL	A–6 or A–7	0–5
Whalan: WhB, WhC2, WhD2.	1 2/3–3 1/3	>5	0–20	Silt loam	CL–ML or CL	A–4	0
			20–30	Loam	SC or CL	A–6	0–10
			30–34	Clay loam	CL	A–6 or A–7	0–5
			34	Limestone	----------	----------	----------

[1] In many areas the pH value of the surface layer is higher than the value given because of liming practices used in farming.
[2] Seasonally perched high water table.
[3] Soils are subject to flooding, ponding or occasional overflow of short duration.



significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction [1]	Shrink-swell potential	Corrosivity of—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
				Pct		*In per hr*	*In per in of soil*	*pH*			
95–100	95–100	85–95	75–85	25–35	2–8	0.6–2.0	0.22–0.24	5.1–6.0	Low	Low	Moderate.
85–95	80–95	70–85	40–60	20–30	5–15	0.6–2.0	0.15–0.17	5.1–6.0	Low	Low	Moderate.
80–100	75–85	35–65	0–5	--------	NP	6.0–20	0.02–0.05	5.6–6.0	Low	Low	Moderate.
--------	--------	--------	--------	--------	--------	2.0–6.0	0.25–0.35	5.6–6.5	--------	Moderate	Moderate.
95–100	95–100	50–70	4–15	--------	NP	6.0–20	0.02–0.04	5.6–7.3	Low	Moderate	Low.
100	100	90–100	85–95	30–40	6–15	0.6–2.0	0.22–0.24	4.5–6.0	Moderate	High	High to moderate.
95–100	90–100	80–95	55–75	30–45	15–25	0.2–0.6	0.18–0.20	4.5–5.5	Moderate	High	High to moderate.
95–100	90–100	85–95	60–75	30–40	15–25	0.2–0.6	0.18–0.20	6.1–7.3	Moderate	High	Low.
100	100	95–100	85–95	25–35	5–15	0.6–2.0	0.22–0.24	5.6–6.5	Low	Moderate	Low to high.
95–100	90–100	85–95	55–70	30–40	11–25	0.2–0.6	0.14–0.16	4.5–5.5	Moderate	High	High.
95–100	90–100	85–95	55–70	35–45	15–30	0.2–0.6	0.14–0.16	7.4–8.4	Moderate	High	Low.
100	100	90–100	80–90	20–30	5–10	0.6–2.0	0.22–0.24	4.5–6.5	Low	Low	Moderate.
75–95	75–95	65–85	40–60	25–35	11–20	0.6–2.0	0.17–0.19	4.5–6.0	Low	Low	Moderate to high.
95–100	85–95	80–95	60–75	35–45	15–30	0.2–0.6	0.15–0.19	5.6–6.0	Moderate	Moderate	Moderate.

[4] NP means nonplastic.
[5] Soft sandstone (weakly cemented) parting to loose sand when dug with spade but in a few places strongly cemented bedrock is at depths ranging from 4 to 6 feet.

permeability, organic matter, and slope; and if the floor needs to be leveled, depth to bedrock becomes important. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified Soil Classi-

properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

TABLE 10.—*Interpretations of*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. fully the instructions for referring to other series

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Trench type sanitary landfill [1]	Local roads and streets
Adolph: AdA	Severe: high water table; floods.	Severe: high water table.	Severe: high water table; floods.	Severe: high water table; floods.	Severe: high water table; floods.	Severe: high water table; susceptible to frost action; floods.
*Amery: AlB, AmB	Moderate: moderate permeability.	Moderate: moderate permeability; slope.	Slight	Slight	Slight	Moderate: susceptible to frost action; low shear strength.
AlC2, AmC2, AnC2 For Cromwell part of AnC2, see Cromwell series.	Moderate: moderate permeability; slope.	Severe: slope	Moderate: slope.	Moderate: slope.	Slight	Moderate: slope; susceptible to frost action; low shear strength.
AlD2, AmD2, AmE2, AnD2. For Cromwell part of AnD2, see Cromwell series.	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Moderate where slope is 12 to 20 percent; severe where slope is more than 20 percent.	Severe: slope
Antigo: AoA, AoB	Slight [3]	Severe: very rapid permeability in substratum.	Severe: sidewall instability of substratum.	Slight	Severe: very rapid permeability in substratum.	Moderate: susceptible to frost action; low shear strength in upper part of soil.
Arland: AsB	Moderate: sandstone bedrock at 24 to 40 inch depth.[5]	Severe: sandstone bedrock at 24 to 40 inch depth; slope; moderate permeability.	Moderate: sandstone bedrock at 24 to 40 inch depth.[6]	Moderate: sandstone bedrock at 24 to 40 inch depth.	Severe: seepage possible in substratum; sandstone bedrock at 24 to 40 inch depth.	Slight
ApC2, AsC2	Moderate: sandstone bedrock at 24 to 40 inch depth; slope.[5]	Severe: sandstone bedrock at 24 to 40 inch depth; slope; moderate permeability.	Moderate: sandstone bedrock at 24 to 40 inch depth.[6]	Moderate: sandstone bedrock at 24 to 40 inch depth; slope.	Severe: seepage possible in substratum; sandstone bedrock at 24 to 40 inch depth.	Moderate: slope.
ApD2	Severe: slope	Severe: sandstone bedrock at 24	Severe: slope	Severe: slope	Severe: seepage possible in substratum; sand-	Severe: slope

engineering properties of the soils

The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow care-
that appear in the first column of this table]

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Poor: high water table; susceptible to frost action.	Unsuited	Poor: high water table.	Moderately slow permeability; high water table; floods.	Piping hazard	Very poorly drained; floods.	High available water capacity; high water table; floods.	Slopes are 0 to 3 percent; high water table; some stones; floods.
Fair: susceptible to frost action.	Poor: fines [2]	Good	Moderate permeability.	Medium to low shear strength.	Natural drainage is adequate.	Moderate available water capacity; moderately rapid water intake rate.	Slopes are 2 to 6 percent; small stones; sandy loams have hazard of soil blowing.
Fair: susceptible to frost action.	Poor: fines [2]	Fair: slope	Moderate permeability.	Medium to low shear strength.	Natural drainage is adequate.	Moderate available water capacity; moderately rapid water intake rate; slope.	Slopes are 6 to 12 percent; small stones; sandy loams have hazard of soil blowing.
Fair where slope is 12 to 20 percent; poor where slope is more than 20 percent; susceptible to frost action.	Poor: fines [2]	Poor: slope	Moderate permeability; slope.	Medium to low shear strength.	Natural drainage is adequate	Moderate available water capacity; moderately rapid water intake rate; slope.	Slopes are 12 to 30 percent; small stones; sandy loams have hazard of soil blowing.
Fair: sus-	Good	Good	Very rapid	Low shear	Natural	Moderate	Slopes are 0 to

TABLE 10.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Trench type sanitary landfill [1]	Local roads and streets
Arland—cont:						
ApF	Severe: slope	Severe: sandstone bedrock at 24 to 40 inch depth; [6] slope; moderate permeability.	Severe: slope	Severe: slope	Severe: slope	Severe: slope
Auburndale: AuA	Severe: high water table; floods.	Severe: high water table; floods.	Severe: high water table; floods.	Severe: high water table; floods.	Severe: high water table; floods.	Severe: high water table; floods; susceptible to frost action.
Boone:						
BnB	Moderate: sandstone bedrock at 24 to 40 inch depth.[6]	Severe: very rapid permeability; sandstone bedrock at 24 to 40 inch depth.[6]	Severe: sidewall instability.[6]	Moderate: sandstone bedrock at 24 to 40 inch depth.[6]	Severe: very rapid permeability; sandstone bedrock at 24 to 40 inch depth.[6]	Slight [6]
BnC	Moderate: sandstone bedrock at 24 to 40 inch depth; slope.[6]	Severe: very rapid permeability; sandstone bedrock at 24 to 40 inch depth.[6]	Severe: sidewall instability.[6]	Moderate: sandstone bedrock at 24 to 40 inch depth; slope.	Severe: very rapid permeability; sandstone bedrock at 24 to 40 inch depth.[6]	Moderate: slope.[6]
BnD	Severe: slope [6]	Severe: very rapid permeability; slope; sandstone bedrock at 24 to 40 inch depth.	Severe: sidewall instability; slope.[6]	Severe: slope.[6]	Severe: very rapid permeability; sandstone bedrock at 24 to 40 inch depth.[6]	Severe: slope.[6]
Brill: BpA	Severe: seasonal high water table.[8]	Severe: rapid permeability in substratum.	Severe: sidewall instability of substratum.	Moderate: seasonal high water table.	Severe: rapid permeability in the substratum.	Severe: susceptible to frost action; low shear strength.

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Poor: slope	Poor: excess fines.	Poor: slope	Moderate permeability; sandstone bedrock at 24 to 40 inch depth; slope.	Medium to low shear strength; thin layer.	Natural drainage is adequate.	Moderate available water capacity; slope.	Slopes are 25 to 35 percent; stones common; sandstone bedrock at 24 to 40 inch depth.
Poor: high water table; susceptible to frost action.	Unsuited	Poor: high water table.	Moderately slow permeability; high water table; floods.	Medium to low permeability of compacted material; piping hazard.	Poorly drained; moderately slow permeability; floods.	High available water capacity; high water table; floods.	Slopes are 0 to 3 percent; high water table; floods.
Good for sand.[6] Poor for gravel.	Good [6]	Poor: sandy	Very rapid permeability; sandstone bedrock at 24 to 40 inch depth.	High permeability of compacted material; high permeability; medium to high piping hazard.[6]	Excessively drained.	Low available water capacity; rapid water intake rate; soil blowing hazard.	Slopes are 2 to 6 percent; sandy; difficult to vegetate and stabilize; soil blowing hazard; sandstone bedrock at 24 to 40 inch depth.[6]
Good for sand.[6] Poor for gravel.	Good [6]	Poor: sandy	Very rapid permeability; sandstone bedrock at 24 to 40 inch depth; slope.[6]	High permeability of compacted material; medium to high piping hazard.[6]	Excessively drained.	Low available water capacity; rapid water intake rate; soil blowing hazard; slope.	Slopes are 6 to 12 percent; sandy; difficult to vegetate and stabilize; soil blowing hazard; sandstone bedrock at 24 to 40 inch depth.[6]
Fair: slope [6]	Good [6]	Poor: sandy; slope.	Very rapid permeability; sandstone bedrock at 24 to 40 inch depth; slope.[6]	High permeability of compacted material; medium to high piping hazard.[6]	Excessively drained.	Low available water capacity; rapid water intake rate; soil blowing hazard; slope.	Slopes are 12 to 20 percent; sandy; difficult to vegetate and stabilize; soil blowing hazard; sandstone bedrock at 24 to 40 inch depth.[6]
Fair: susceptible to frost action; low shear strength.	Good	Good	Rapid permeability in substratum; seasonal high water table at depths below 3 feet.	Medium to low permeability of compacted material in subsoil; high permeability of compacted material in substratum.	Moderately well drained.	Moderate available water capacity; moderate water intake rate; seasonal high water table.	Slopes are 0 to 3 percent; sand and gravel in substratum; seasonal high water table.

TABLE 10.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Trench type sanitary landfill [1]	Local roads and streets
*Burkhardt:						
BrB, BxB	Slight [3]	Severe: rapid permeability	Severe: side-wall insta-	Slight	Severe: rapid permeability	Slight

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and	Topsoil	Pond reservoir	Dikes, levees, and other	Drainage for	[illegible]	Terraces and

TABLE 10.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Trench type sanitary landfill [1]	Local roads and streets
Chetek—cont:						
CoE For Onamia part of CoE, see Onamia series.	Severe: slope [3]	Severe: rapid permeability in substratum; slope.	Severe: sidewall instability; slope.	Severe: slope	Severe: rapid permeability in substratum; slope.	Severe: slope
Clyde: CyA	Severe: high water table; floods.	Severe: high water table; floods.	Severe: high water table; floods.	Severe: high water table; floods.	Severe: clayey; difficult to work; high water table; floods; seasonal high perched water table.	Severe: high water table; floods; low shear strength.
Cromwell Mapped only in complexes with Amery soils.	Moderate where slope is 6 to 12 percent; severe where slope is more than 12 percent.[3]	Severe: rapid permeability in substratum; slope.	Severe: sidewall instability in substratum.	Moderate where slope is 6 to 12 percent; severe where slope is more than 12 percent.	Severe: rapid permeability in substratum.	Moderate where slope is 6 to 12 percent; severe where slope is more than 12 percent.
Cut and fill areas: Cz. Too variable to rate.						
*Dakota:						
DaA, DaB	Slight [3]	Severe: rapid permeability in substratum.	Severe: sidewall instability of substratum.	Slight	Severe: rapid permeability in substratum; slope.	Slight
DcC2 For Pillot part of DcC2, see Pillot series.	Moderate: slope.[3]	Severe: rapid permeability in substratum; slope.	Severe: sidewall instability of substratum.	Moderate: slope.	Severe: rapid permeability in substratum.	Moderate: slope.

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Poor: slope	Good	Poor: slope	Rapid permeability in substratum; slope.	High permeability of compacted material; medium to high piping hazard; thin layer.	Somewhat excessively drained.	Low available water capacity; moderately rapid water intake rate; soil blowing hazard; slope.	Slopes are 20 to 30 percent; shallow to sand and gravel; difficult to vegetate and stabilize; complex slopes; stones.
Poor: high water table; low shear strength.	Unsuited	Poor: high water table.	Moderately slow permeability.	Low permeability of compacted material; medium to low shear strength.	Moderately well drained; slow permeability; seasonal high perched water table.	High available water capacity; slow permeability; seasonal high perched water table; slope.	Slopes are 0 to 3 percent; heavy loam substratum; seasonal high perched water table.
Good	Good for sand; fair for gravel; excess fines.	Fair; thin layer.	Rapid permeability in substratum.	High permeability of compacted material in substratum; medium to high piping hazard.	Natural drainage is adequate.	Low available water capacity; moderately rapid water intake rate; slope.	Slopes are 6 to 25 percent; sand and gravel substratum; stones difficult to vegetate and stabilize.
Fair: susceptible to frost action.	Good for sand; poor to unsuited for gravel; excess fines.	Fair: thin layer.	Rapid permeability in substratum.	Medium to low permeability of compacted material in subsoil; high permeability of compacted material in substratum.	Natural drainage is adequate.	Moderate available water capacity; moderate water intake rate; slope.	Slopes are 6 to 12 percent; sand and gravel substratum; stones.
Fair: susceptible to frost action.[4]	Good for sand; poor to unsuited for gravel; excess fines.	Fair: thin layer.	Rapid permeability in substratum.	Medium to low permeability of compacted material in subsoil; high permeability of compacted material in substratum.	Natural drainage is adequate.	Moderate available water capacity; moderate water intake rate; slope.	Slopes are 6 to 12 percent; sand and gravel substratum; stones.
Poor: low shear strength; shale bedrock at 20 to	Unsuited	Fair: shallow; reclamation of borrow pit difficult.	Slow permeability; shale bedrock at 20 to 40 inch depth; frag-	Medium to low permeability of compacted material; medium to	Moderately well drained; slow permeability; seasonal high	Moderate available water capacity; slow permeability	Slopes are 2 to 6 percent; clay shale bedrock substratum;

TABLE 10.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank	Sewage	Shallow	Dwellings with	Trench type	Local roads

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Poor: low shear strength; shale bedrock at 20 to 40 inch depth; fragmented limestone bedrock at 4 to 6 foot. depth.	Unsuited	Fair: shallow; reclamation of borrow pit difficult; slope.	Slow permeability; shale bedrock at 20 to 40 inch depth; fragmented limestone bedrock at 4 to 6 foot depth; seasonal high perched water table.	Medium to low permeability of compacted material; medium to low shear strength; shale bedrock at 20 to 40 inch depth.	Moderately well drained; slow permeability; seasonal high perched water table.	Moderate available water capacity; slow permeability; seasonal high perched water table; slope.	Slopes are 6 to 12 percent; clay shale bedrock substratum; seasonal high perched water table.
Poor: high shrink-swell potential; susceptible to frost action; seasonal high perched water table; shale bedrock at 20 to 40 inch depth.	Unsuited	Fair; thin layer.	Slow permeability; seasonal high perched water table; shale bedrock at 20 to 40 inch depth.	Low permeability of compacted material; medium to low shear strength; substratum has high shrink-swell potential; shale bedrock at 20 to 40 inch depth.	Somewhat poorly drained; slow permeability.	Moderate available water capacity; slow water intake rate; seasonal high perched water table; slope.	Slopes are 1 to 6 percent; shale bedrock substratum; seasonal high perched water table.
Good	Fair for sand; excess fines; unsuited for gravel.	Good	Rapid permeability in substratum.	Medium to low permeability of compacted material in subsoil; high permeability of compacted material in substratum.	Somewhat excessively drained.	Low available water capacity; moderately rapid water intake rate; slope.	Slopes are 2 to 6 percent; sand substratum; soil blowing hazard.
Fair: seasonal high water table.	Fair for sand; excess fines; seasonal high water table hinders excavation; unsuited for gravel.	Poor: sandy	Rapid permeability; seasonal high water table; floods.	High permeability of compacted material in subsoil; high permeability of compacted material in substratum.	Somewhat poorly drained; floods.	Low available water capacity; rapid water intake rate; seasonal high water table; floods.	Slopes are 2 percent; sandy; seasonal high water table; floods.
Fair to poor; slope.	Good for sand and gravel.	Poor: sandy; slope; thin layer.	Very rapid permeability; slope.	High permeability of compacted material; medium to high piping hazard.	Excessively drained.	Very low available water capacity; rapid water intake rate; slope.	Slopes are 12 to 35 percent; shallow to sand and gravel; difficult to vegetate and stabilize.
Poor: susceptible to frost action.	Unsuited	Good	Moderately slow permeability; seasonal high perched water table; floods.	Medium to low permeability of compacted material; medium shear strength; medium piping hazard.	Somewhat poorly drained; moderately slow permeability; floods.	High available water capacity; slow water intake rate; seasonal high perched water table; floods.	Slopes are 0 to 3 percent; heavy loam substratum; seasonal high perched water table; floods.

TABLE 10.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Trench type sanitary landfill [1]	Local roads and streets
Fluvaquents: Fe	Severe: occasional flooding; seasonal high water table.	Severe: occasional flooding; seasonal high water table.	Severe: occasional flooding; seasonal high water table.	Severe: occasional flooding; seasonal high water table.	Severe: occasional flooding; seasonal high water table.	Severe: occasional flooding; susceptible to frost action.
Fluvaquents, wet: Fm	Severe: high water table; frequent flooding.	Severe: high water table; frequent flooding.	Severe: high water table; frequent flooding.	Severe: high water table; frequent flooding.	Severe: high water table; frequent flooding.	Severe: high water table; frequent flooding; susceptible to frost action.
Freeon:						
FnB	Severe: seasonal high perched water table.	Moderate: moderate permeability; seasonal high perched water table; slope.	Moderate: seasonal high perched water table.	Moderate: seasonal high perched water table.	Severe: seasonal high perched water table.	Moderate: susceptible to frost action; moderate shrink-swell potential.
FoB	Severe: moderately slow permeability; seasonal high perched water table.	Moderate: slope.	Moderate: seasonal high perched water table.	Moderate: seasonal high perched water table; moderate shrink-swell potential.	Severe: seasonal high perched water table.	Severe: susceptible to frost action; low shear strength.
FoC2	Severe: moderately slow permeability; seasonal high perched water table.	Severe: slope	Moderate: seasonal high perched water table; slope.	Moderate: seasonal high perched water table; moderate shrink-swell potential; slope.	Severe: seasonal high perched water table.	Severe: susceptible to frost action; low shear strength.
Gotham						
GoB	Slight [3]	Severe: rapid permeability.	Severe: sidewall instability.	Slight	Severe: rapid permeability; sandy.	Slight

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Poor: susceptible to frost action; seasonal high water table.	Unsuited	Too variable to rate.	Variable permeability; seasonal high water table; floods.	Medium to low shear strength; medium to high piping hazard.	Somewhat poorly drained; floods; variable permeability.	Moderate to high available water capacity; seasonal high water table; occasional flooding.	Slopes are 0 to 2 percent; seasonal high water table; occasional flooding.
Poor: high water table; susceptible to frost action.	Unsuited	Too variable to rate; high water table.	Variable permeability; high water table; frequent flooding.	Medium to low permeability of compacted material; low shear strength; piping hazard.	Poorly drained and very poorly drained; frequent flooding; variable permeability.	Moderate water intake rate; high water table; floods.	Slopes are 0 to 2 percent; high water table; floods.
Fair: susceptible to frost action; moderate shrink-swell potential.	Unsuited	Good	Moderate permeability; seasonal high perched water table.	Medium to low permeability of compacted material; medium to low shear strength; piping hazard.	Moderately well drained.	High available water capacity; moderate water intake rate; seasonal high perched water table; slope.	Slopes are 2 to 6 percent; seasonal high perched water table; some stones.
Poor: susceptible to frost action; low shear strength.	Unsuited	Good	Moderately slow permeability; seasonal high perched water table.	Low permeability of compacted material; medium to low shear strength.	Moderately well drained.	Very high available water capacity; slow water intake rate; seasonal high perched water table; slope.	Slopes are 2 to 6 percent; clay loam substratum; seasonal high perched water table; some stones.
Poor: susceptible to frost action; low shear strength.	Unsuited	Fair: slope	Moderately slow permeability; seasonal high perched water table.	Low permeability of compacted material; medium to low shear strength.	Moderately well drained.	Very high available water capacity; slow water intake rate; seasonal high perched water table; slope.	Slopes are 2 to 12 percent; clay loam substratum; seasonal high perched water table; some stones.
Good	Fair or poor for sand: fines; unsuited for gravel.[3]	Poor: sandy	Rapid permeability.	Medium permeability of compacted material in subsoil; high permeability of compacted material in substratum; medium to high piping hazard.	Somewhat excessively drained.	Low available water capacity; rapid water intake rate; slope.	Slopes are 2 to 6 percent; sandy; difficult to vegetate and stabilize; soil blowing hazard.

TABLE 10.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption	Sewage lagoons	Shallow excavations	Dwellings with basements	Trench type sanitary	Local roads and streets

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Good	Fair or poor for sand: fines; unsuited for gravel.[3]	Poor: sandy	Rapid permeability.	Medium permeability of compacted material in subsoil; high permeability of compacted material in substratum; medium to high piping hazard.	Somewhat excessively drained.	Low available water capacity; rapid water intake rate; slope.	Slopes are 6 to 12 percent; sandy; difficult to vegetate and stabilize; soil blowing hazard.
Fair: seasonal high water table; low shear strength in subsoil; susceptible to frost action.	Good for sand: seasonal high water table hinders excavation; poor for gravel.	Good	Rapid permeability in substratum; seasonal high water table; floods.	Medium to low permeability of compacted material in subsoil; high permeability of compacted material in substratum.	Somewhat poorly drained; floods.	Moderate available water capacity; moderate water intake rate; seasonal high water table; floods.	Slopes are 0 to 3 percent; sand and gravel substratum; seasonal high water table; floods.
Fair: reclamation of borrow area difficult.[6]	Poor for sand: fines; unsuited for gravel.[3, 6]	Good	Moderately rapid and moderate permeability.	Medium to low permeability of compacted material; medium shear strength; medium to high piping hazard.[6]	Well drained	Moderate available water capacity; moderately rapid water intake rate; slope.	Slopes are 2 to 6 percent.
Fair: reclamation of borrow area difficult.[6]	Fair for sand: fines; unsuited for gravel.[3, 6]	Fair: slope	Moderately rapid and moderate permeability.	Medium to low permeability of compacted material; medium shear strength; medium to high piping hazard.[6]	Well drained	Moderate available water capacity; moderately rapid water intake rate; slope.	Slopes are 6 to 12 percent; erosion hazard.[6]
Fair: reclamation of borrow area difficult.[6]	Fair for sand: fines; unsuited for gravel.[3, 6]	Poor: slope	Moderately rapid permeability in subsoil; moderate permeability in substratum; moderately steep.[6]	Medium to low permeability of compacted material; low to high piping hazard.[6]	Well drained	Moderate available water capacity; moderately rapid water intake rate; slope.	Slopes are 12 to 20 percent; erosion hazard.[6]
Good	Good: poorly graded sand; unsuited for gravel.	Poor: sandy	Rapid permeability.	Medium to low permeability of compacted material; medium shear strength in subsoil; high permeability of compacted material in substratum.	Somewhat excessively drained.	Low available water capacity; rapid water intake rate; slope.	Slopes are 0 to 6 percent; sandy; difficult to vegetate and stabilize; soil blowing hazard.

TABLE 10.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Trench type sanitary landfill [1]	Local roads and streets
Hubbard, loamy substratum:						
HuB	Severe to mod-	Severe: rapid	Severe:	Slight	Severe:	Slight

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Fair: low shear strength in substratum.	Poor for sand: fines in substratum; unsuited for gravel.[2]	Poor: sandy	Permeability ranges from rapid in subsoil to moderate or moderately slow in substratum.	Medium to low permeability of compacted material; low to high piping hazard.	Somewhat excessively drained.	Moderate available water capacity; rapid water intake rate; slope.	Slopes are 0 to 6 percent; sandy; difficult to vegetate and stabilize; soil blowing hazard.
Fair: low shear strength in substratum.	Poor for sand: fines in substratum; unsuited for gravel.[2]	Poor: sandy	Permeability ranges from rapid in subsoil to moderate or moderately slow in substratum.	Medium to low permeability of compacted material; low shear strength; high piping hazard.	Somewhat excessively drained.	Moderate available water capacity; rapid water intake rate; slope.	Slopes are 6 to 12 percent; sandy; difficult to vegetate and stabilize; soil blowing hazard.
Poor: susceptible to frost action; low shear strength.	Unsuited	Good	Moderate permeability; occasional flooding; seasonal high water table in places.	Medium to low permeability of compacted material; low shear strength and piping hazard.	Well drained and moderately well drained.	Very high available water capacity; moderate water intake rate; occasional flooding.	Slopes are 0 to 3 percent; seasonal high water tables in places; occasional flooding and situation of channels.
Fair: susceptible to frost action.	Poor: fines[2]	Good	Moderate permeability.	Medium to low permeability of compacted material, shear strength and piping hazard.	Natural drainage is adequate.	High available water capacity; moderate water intake rate; slope.	Slopes are 0 to 6 percent; some stones.
Fair: susceptible to frost action.	Poor: fines[2]	Fair: slope	Moderate permeability.	Medium to low permeability of compacted material; shear strength and piping hazard.	Natural drainage is adequate.	High available water capacity; moderate water intake rate; slope.	Slopes are 6 to 12 percent; some stones.
Fair: moderate frost action potential.[6]	Good	Good	Rapid permeability in substratum.	Medium to low permeability in subsoil; high permeability in substratum.	Natural drainage is adequate.	Moderate available water capacity; moderate water intake rate; slope.	Slopes are 0 to 6 percent; sand and gravel substratum.
Fair: seasonal high water table; low shear strength in subsoil material.	Fair: seasonal high water table hinders excavation.	Good	Rapid permeability in substratum; seasonal high water table; floods.	Medium to low permeability of compacted material in subsoil; high permeability of compacted material in substratum.	Somewhat poorly drained; floods.	Moderate available water capacity; moderate water intake rate; seasonal high water table; floods.	Slopes are 0 to 3 percent; sand and gravel substratum; seasonal high water table; floods.

TABLE 10.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Trench type sanitary landfill [1]	Local roads and streets
Magnor: MaB	Severe: seasonal high perched water table; floods.	Moderate: slope.	Severe: seasonal high perched water table; floods.	Severe: seasonal high perched water table; floods.	Severe: seasonal high perched water table; floods.	Severe: high frost action potential; floods.
Nickin: NcB	Slight	Severe: Moderate to moderately rapid permeability.	Moderate: sidewall instability of substratum.	Slight	Severe: moderate to moderately rapid permeability.[6]	Moderate: susceptible to frost action.
[illegible]	Moderate: [illegible]	Severe: [illegible]	Moderate: [illegible]	Moderate: [illegible]	Severe: [illegible]	Moderate: [illegible]

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Poor: seasonal high perched water table; susceptible to frost action.	Unsuited	Good	Moderately slow permeability; seasonal high perched water table; floods.	Medium to low permeability of compacted material; medium to low shear strength; medium to low piping hazard.	Seasonal high water table; floods; moderately slow permeability.	High available water capacity; moderate water intake rate; seasonal high perched water table; slope; floods.	Slopes are 1 to 6 percent; seasonal high perched water table; floods; some stones.
Fair: susceptible to frost action; low shear strength.	Fair for sand: fines; unsuited for gravel.[2]	Good	Moderate and moderately rapid permeability.	Medium to low permeability of compacted material; medium shear strength; medium to high piping hazard.	Natural drainage is adequate.	Moderate available water capacity; moderate water intake rate; slope.	Slopes are 2 to 6 percent; sand substratum.
Fair: susceptible to frost action; low shear strength.[6]	Fair for sand: fines; unsuited for gravel.[2]	Fair: slope	Moderate and moderately rapid permeability.	Medium to low permeability of compacted material; medium shear strength; medium to high piping hazard.	Natural drainage is adequate.	Moderate available water capacity; moderate water intake rate; slope.	Slopes are 6 to 12 percent; sand substratum.
Fair: susceptible to frost action; slope; low shear strength.[6]	Fair for sand: fines; unsuited for gravel.[2]	Poor: slope	Moderate and moderately slow permeability.	Medium to low permeability of compacted material; medium shear strength; medium to	Natural drainage is adequate.	Moderate available water capacity; moderate water intake rate; slope.	Slopes are 12 to 20 percent; sand substratum.

TABLE 10.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Trench type sanitary landfill[1]	Local roads and streets
Orion: OrA	Severe: occasional flooding; seasonal high water table.	Severe: seasonal high water table.	Severe: occasional flooding; seasonal high water table.	Severe: occasional flooding; seasonal high water table.	Severe: occasional flooding; seasonal high water table.	Severe: occasional flooding; susceptible to frost action.
Otterholt: OtB	Moderate: moderate permeability.	Moderate: moderate permeability; slope.	Slight	Slight	Slight	Severe: susceptible to frost action.
OtC	Moderate: moderate permeability; slope.	Severe: slope	Moderate: slope.	Moderate: slope.	Slight	Severe: susceptible to frost action.
OtD2	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.	Severe: susceptible to frost action.
Pillot: PlA	Slight[3]	Severe: rapid permeability in substratum.	Severe: sidewall instability of substratum.	Slight	Severe: rapid permeability in substratum.	Moderate: susceptible to frost action; low shear strength in upper part of soil.[4]
Plainfield: PmB	Slight[3]	Severe: rapid permeability.	Severe: sidewall instability.	Slight	Severe: rapid permeability; sandy.	Slight
PmC	Moderate: slope.[3]	Severe: rapid permeability; slope.	Severe: sidewall instability.	Moderate: slope.	Severe: rapid permeability; sandy.	Moderate: slope.

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Poor: susceptible to frost action.	Unsuited	Good	Moderate permeability; seasonal high water table; occasional flooding.	Medium to low permeability of compacted material; low shear strength; high piping hazard.	Somewhat poorly drained.	Very high available water capacity; occasional flooding; seasonal high water table.	Slopes are 0 to 3 percent; seasonal high water table; occasional flooding and siltation of channels.
Poor: susceptible to frost action.	Unsuited	Good	Moderate permeability.	Medium to low permeability of compacted material; medium to low shear strength; medium to high piping hazard.	Natural drainage is adequate.	Very high available water capacity; moderate water intake rate.	Slopes are 2 to 6 percent; deep silt loam.
Poor: susceptible to frost action.	Unsuited	Fair: slope	Moderate permeability.	Medium to low permeability of compacted material; medium to low shear strength; medium to high piping hazard.	Natural drainage is adequate.	Very high available water capacity; moderate water intake rate; slope.	Slopes are 6 to 12 percent; deep silt loam.
Poor: susceptible to frost action.	Unsuited	Poor: slope	Moderate permeability; slope.	Medium to low permeability of compacted material; medium to low shear strength; medium to high piping hazard.	Natural drainage is adequate.	Very high available water capacity; moderate water intake rate; slope.	Slopes are 12 to 20 percent; deep silt loam.
Fair: susceptible to frost action; low shear strength in upper part of soil.[4]	Good	Good	Rapid permeability in substratum.	Medium to low permeability of compacted material in subsoil; high permeability of compacted material in substratum.	Natural drainage is adequate.	Moderate available water capacity; moderate water intake rate.	Slopes are 0 to 3 percent; sand and gravel substratum at 24 to 40 inch depth.
Good	Good: poorly graded sand; little or no gravel.	Poor: sandy	Rapid permeability.	High permeability of compacted material; medium to high piping hazard.	Natural drainage is excessive.	Low available water capacity; rapid water intake rate.	Slopes are 2 to 6 percent; sandy; difficult to vegetate and stabilize; soil blowing hazard.
Good	Good: poorly graded sand; little or no gravel.	Poor: sandy	Rapid permeability.	High permeability of compacted material; medium to high piping hazard.	Natural drainage is excessive.	Low available water capacity; rapid water intake rate; slope.	Slopes are 6 to 12 percent; sandy; difficult to vegetate and stabilize; soil blowing hazard.

TABLE 10.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Trench type sanitary landfill [1]	Local roads and streets
Plainfield—Cont.:						
PmD	Severe: slope [8]	Severe: rapid permeability; slope.	Severe: sidewall instability; slope.	Severe: slope	Severe: rapid permeability: sandy.	Severe: slope
Port Byron:						
PoB	Moderate: moderate permeability.	Moderate: moderate permeability; slope.	Slight	Slight	Slight	Severe: susceptible to frost action.
PoC	Moderate: moderate permeability; slope.	Severe: slope	Moderate: slope.	Moderate: slope.	Slight	Severe: susceptible to frost action.
PoD	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.	Severe: susceptible to frost action.
Renova:						
ReB	Severe: moderately slow permeability.	Moderate: slope.	Slight	Slight	Slight	Moderate: moderate shrink-swell potential; susceptible to frost action.
ReC2	Severe: moderately slow permeability.	Severe: slope	Moderate: slope.	Moderate: slope.	Slight	Moderate: moderate shrink-swell potential; susceptible to frost action.

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Fair: slope	Good: poorly graded sand; little or no gravel.	Poor: sandy; slope.	Rapid permeability; slope.	High permeability of compacted material; medium to high piping hazard.	Natural drainage is excessive.	Low available water capacity; rapid water intake rate; slope.	Slopes are 12 to 20 percent; sandy; difficult to vegetate and stabilize; soil blowing hazard.
Poor: susceptible to frost action.	Unsuited	Good	Moderate permeability.	Medium to low permeability of compacted material; medium to low shear strength; medium to high piping hazard.	Natural drainage is adequate.	Very high available water capacity; moderate water intake rate; slope.	Slopes are 2 to 6 percent; deep silt loam.
Poor: susceptible to frost action.	Unsuited	Fair: slope	Moderate permeability.	Medium to low permeability of compacted material; medium to low shear strength; medium to high piping hazard.	Natural drainage is adequate	Very high available water capacity; moderate water intake rate; slope.	Slopes are 6 to 12 percent; deep silt loam.
Poor: susceptible to frost action.	Unsuited	Poor: slope	Moderate permeability; slope.	Medium to low permeability of compacted material; medium to low shear strength; medium to high piping hazard.	Natural drainage is adequate.	Very high available water capacity; moderate water intake rate; slope.	Slopes are 12 to 20 percent; deep silt loam.
Fair: moderate shrink-swell potential; susceptible to frost action.	Unsuited	Good	Moderately slow permeability in substratum.	Low permeability of compacted material; medium to low shear strength; medium to low piping hazard.	Natural drainage is adequate.	High available water capacity; moderate water intake rate; slope.	Slopes are 2 to 6 percent; heavy loam subsoil.
Fair: moderate shrink-swell potential; susceptible to frost action.	Unsuited	Fair: slope	Moderately slow permeability in substratum.	Low permeability of compacted material; medium to low shear strength; medium to low piping hazard.	Natural drainage is adequate.	High available water capacity; moderate water intake rate; slope.	Slopes are 6 to 12 percent; heavy loam subsoil.

TABLE 10.—Interpretations of engineering

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Fair: susceptible to frost action; medium shear strength.	Fair to poor for sand; fines in some places; unsuited for gravel.	Fair: slope; thin layer.	Moderate to moderately rapid permeability in substratum.	Low permeability of compacted material in subsoil; low to high permeability of compacted material in substratum.	Natural drainage is adequate.	Moderate to high available water capacity; moderate water intake rate; slope.	Slopes are 4 to 12 percent; loamy and sandy substratum.

TABLE 10.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Trench type sanitary landfill [1]	Local roads and streets
Rockton—cont:						
RpD2	Severe: limestone bedrock at 20 to 40 inch depth; slope.	Severe: limestone bedrock at 20 to 40 inch depth; slope.	Severe: limestone bedrock at 20 to 40 inch depth; slope.	Severe: limestone bedrock at 20 to 40 inch depth; slope.	Severe: limestone bedrock at 20 to 40 inch depth.	Severe: low shear strength; slope.
*Santiago:						
SaB	Moderate: moderate permeability.	Moderate: moderate permeability; slope.	Slight	Slight	Slight	Moderate: susceptible to frost action; medium shear strength.
SaC2, ScC2 For Antigo part of ScC2, see Antigo series.	Moderate: moderate permeability; slope.	Severe: slope	Moderate: slope.	Moderate: slope.	Slight	Moderate: susceptible to frost action; medium shear strength.
ScD2 For Antigo part of ScD2, see Antigo series.	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.	Severe: slope
Saprists and Aquents: Se.	Severe: high water table; floods.	Severe: high water table; floods.	Severe: high water table; floods.	Severe: high water table; floods.	Severe: high water table; floods.	Severe: susceptible to frost action; high water table; floods; low shear strength.

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
	Sand and		Road [illegible]	Dikes, levees,	Drainage for		[illegible]

TABLE 10.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Trench type sanitary landfill [1]	Local roads and streets
Seelyeville: Sm	Severe: high water table; floods.	Severe: high water table; organic soils; floods.	Severe: high water table; organic soils; floods.	Severe: high water table; organic soils; floods.	Severe: high water table; floods; moderately rapid permeability.	Severe: high water table; susceptible to frost action; floods; organic soils.
Skyberg: SrA	Severe: seasonal high perched water table: moderately slow permeability.	Slight	Severe: seasonal high perched water table.	Severe: seasonal high perched water table.	Severe: seasonal high perched water table.	Severe: susceptible to frost action; low shear strength.
Udifluvents: Ud	Severe: occasional flooding; seasonal high water table.	Severe: occasional flooding; seasonal high water table; rapid permeability.	Severe: occasional flooding; seasonal high water table.	Severe: occasional flooding; seasonal high water table.	Severe: occasional flooding; seasonal high water table; sandy.	Severe: occasional flooding.
Vlasaty: VaB	Severe: moderately slow permeability; seasonal high perched water table.	Moderate: slope.	Moderate: seasonal high perched water table.	Moderate: seasonal high perched water table; moderate shrink-swell potential.	Severe: seasonal high perched water table.	Severe: susceptible to frost action.
VaC2	Severe: moderately slow permeability; seasonal high perched water table.	Severe: slope.	Moderate: seasonal high perched water table; slope.	Moderate: seasonal high perched water table; moderate shrink-swell potential.	Severe: seasonal high perched water table.	Severe: susceptible to frost action.
Whalen: WhB	Severe: limestone bedrock at 20 to 40 inch depth.	Severe: limestone bedrock at 20 to 40 inch depth.	Severe: limestone bedrock at 20 to 40 inch depth.	Severe: limestone bedrock at 20 to 40 inch depth.	Severe: limestone bedrock at 20 to 40 inch depth.	Severe: low shear strength.

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Poor: high water table; organic soils; susceptible to frost action.	Unsuited	Poor: high water table; oxidizes rapidly.	Moderately rapid permeability; high water table.	Organic soils; compressible; hard to pack; not suited for embankments.	Very poorly drained; frequent flooding; moderately rapid permeability.	Very high available water capacity; rapid water intake rate; high water table; blowing hazard.	Slopes are 0 to 2 percent; unstable organic material; highly erodible high water table.
Poor: susceptible to frost action; low shear strength.	Unsuited	Fair: thin layer.	Moderately slow permeability.	Low permeability of compacted material; low to medium shear strength; low to medium piping hazard.	Somewhat poorly drained; moderately slow permeability.	High available water capacity; moderately slow water intake rate.	Slopes are 0 to 3 percent; firm heavy loam subsoil; seasonal high perched water table.
Fair: seasonal high water table; susceptible to frost action.	Fair: stratified sand; unsuited for gravel.	Poor: sandy	Variable; mostly rapid permeability; seasonal high water table.	High permeability of compacted material; medium to high piping hazard.	Moderately well drained and somewhat poorly drained.	Low available water capacity; rapid water intake rate; seasonal high water table; occasional flooding.	Slopes are 0 to 2 percent; seasonal high water table; sandy; occasional flooding.
Poor: susceptible to frost action; low shear strength.	Unsuited	Fair: thin layer.	Moderately slow permeability; seasonal high perched water table.	Low permeability of compacted material; low to medium shear strength;	Moderately well drained.	High available water capacity; moderately slow water intake rate; seasonal high	Slopes are 2 to 6 percent; very firm; clay loam substratum; seasonal

TABLE 10.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Trench type sanitary landfill [1]	Local roads and streets

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and other embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Poor: low shear strength; thin layer;	Unsuited -----	Fair: slope; thin layer.	Moderate permeability; limestone bedrock at	Medium to low permeability of compacted material;	Natural drainage is adequate.	Moderate available water capacity; moderate	Slopes are 6 to 12 percent; limestone bedrock at

TABLE 11.—*Engineering*

[Tests performed by Wisconsin Department of

Soil name and location	Parent material	Depth	Moisture density [1]		Mechanical analysis [2]	
			Maximum dry density	Optimum moisture	Percentage less than 3 inches passing sieve—	
					1 in	¾ in
		In	*Lb per cu ft*	*Pct*		
Amery loam: SW¼SW¼ sec. 23, T. 29 N., R. 15 W. (Modal profile)	Loamy material over sandy loam glacial till.	10–27	127	10	100	98
		30–50	126	10	100	99
Antigo silt loam: SW¼SE¼ sec. 25, T. 30 N., R. 19 W. (Lower part of subsoil contains slightly	Silty sediment over glacial sand and gravel.	18–25	----------	----------	----------	----------
		34–60	----------	----------	98	96

test data

Transportation, Division of Highways]

Mechanical analysis [2]—Continued								Liquid limit [3]	Plasticity index [4]	Classification	
Percentage less than 3 inches passing sieve—Continued					Percentage smaller than—					AASHTO [5]	Unified
⅜ in	No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	0.05 mm	0.005 mm	0.002 mm				
								Pct			
96	94	91	76	35	29	11	8	19	4	A-2-4(0)	SC-SM
98	96	91	79	39	34	13	9	19	4	A-4(1)	SC-SM
--------	--------	100	92	79	74	27	24	34.8	16.2	A-6(10)	CL
93	89	81	29	2	2	2	2	--------	[6] NP	A-1-b(0)	SP
--------	--------	100	69	32	30	11	7	25.5	NP	A-2-4(0)	SM
--------	100	95	69	32	31	12	8	20.8	3.3	A-2-4(0)	SM
87	78	67	30	1	1	1	1	--------	NP	A-1-b(0)	SP
--------	--------	100	92	80	78	35	29	52.8	26.2	A-7-6(17)	CH
--------	--------	100	94	87	84	32	24	41.5	20.4	A-7-6(12)	CL
96	94	91	81	59	56	29	24	37.4	20.2	A-6(9)	CL
--------	--------	100	97	85	84	55	50	55	32	A-7-6(19)	CH
--------	--------	100	99	97	96	73	63	63	33	A-7-6(20)	CH
68	55	39	19	4	3	1	1	--------	NP	A-1-a(0)	SP
80	66	49	21	4	4	2	1	--------	NP	A-1-a(0)	SP
95	94	92	82	57	53	22	17	27.4	10	A-4-(4)	CL
95	93	91	77	30	27	15	12	17.4	3	A-2-4(0)	SM
90	89	88	76	48	45	23	20	33.4	18.1	A-6(5)	SC
95	94	92	78	34	30	15	12	20.0	6.7	A-2-4(0)	SC-SM
97	93	81	67	38	35	18	15	34.4	18.4	A-6(3)	SC
97	95	92	81	42	38	17	12	18.8	6.6	A-4(1)	SC-SM
98	97	97	87	52	48	20	17	28.2	11.7	A-6(4)	CL
--------	--------	100	99	9	7	3	3	--------	NP	A-3(0)	SP-SM
--------	--------	100	94	74	70	17	9	26	5	A-4(8)	CL-ML
95	93	90	75	39	35	17	13	26	11	A-6(1)	SC
99	97	91	78	41	36	18	15	26	13	A-6(2)	SC
--------	--------	100	93	63	59	42	28	36	19	A-6(9)	CL
--------	--------	100	95	64	60	35	30	36	21	A-6(10)	CL
--------	--------	100	90	64	61	36	31	44.8	27.9	A-7-6(14)	CL
--------	--------	100	93	69	64	36	29	40.3	24.8	A-6(13)	CL
--------	--------	100	93	64	62	35	31	36	19	A-6(9)	CL
--------	--------	100	91	62	60	36	30	40	23	A-6(10)	CL
--------	99	98	90	69	64	--------	33	--------	--------	--------	--------
--------	--------	99	90	69	63	--------	32	--------	--------	--------	--------

TABLE 11.—*Engineering*

Soil name and location	Parent material	Depth	Moisture density [1]		Mechanical analysis [2]	
			Maximum dry density	Optimum moisture	Percentage less than 3 inches passing sieve—	
					1 in	¾ in
		In	*Lb per cu ft*	*Pct*		
Whalen silt loam: NW¼SE¼ sec. 16, T. 28 N., R. 19 W. (Modal profile)	Loess, loamy glacial till, and clayey residium over limestone bedrock.	20–30	----------	----------	86	82
		30–34	----------	----------	---------	---------

[1] Based on AASHTO Designation T99–57, Method A (*1*).
[2] Mechanical analysis according to the AASHTO Designation T88–57 (*1*). Results by this procedure may differ somewhat from the results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by hydrometer method, and the various grain-size fractions are calculated on the basis of all material up to and including that of 3 inches in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from the calculation of grain-size fraction. The mechanical analysis data used in this table are not suitable for use in naming textural classes of soil.

plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. It may be much or little, but some time is always required for differentiation of soil horizons. Usually, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

It is now thought that a combination of basic or simple processes proceed in all soils and is responsible for horizon differentiation. All of these processes are at least potential processes in every soil. These processes can be considered under four main headings that generally do not act alone. These headings are *gains, losses, transfers,* and *transformations.* Some of these changes promote horizon differentiation and others retard or offset horizon differentiation. The balance among changes determines the nature of the soil at any given spot.

The results of these soil-forming processes can be briefly summarized using Santiago soils as an illustration. The parent materials of these soils were sandy loam till and windblown silt loam. The silt loam was deposited over the till, probably during and after the glacial period. The high position on the landscape and the porous nature of the underlying till contributed to the characteristics that make these soils well drained, processes were accelerated as more litter accumulated and produced a greater volume of organic residue and acids. Basic minerals and iron in the soil material were gradually dissolved and moved downward by percolating waters. As water continued to move downward through the soil, suspended particles of clay along with iron and other dissolved minerals also were translocated from the upper part of the soil and deposited in the middle part. Thus, the middle part of subsoil contains more clay and iron than upper and lower parts of the Santiago soils.

As a result of these soil-forming processes, the Santiago soils now have a thin, dark colored silt loam surface layer; a thick, leached, light colored subsurface layer; and a subsoil that is mainly reddish brown heavy loam. The substratum is unweathered, sandy loam glacial till that has changed but little since it was deposited by the glacier.

Processes that took place in the formation of Santiago soils were *gains* of organic matter in the surface layer, *loss* of clay from the upper part of the soil and subsequent *transfer* to the lower part of the profile, and *transformation* of iron compounds in the lower subsoil. In varying degrees all these processes are occurring in all soils of the survey area. In St. Croix County, the kinds of parent material and relief, or topography, have, to a great extent, determined the kinds of processes that have been dominant in the formation of all the soils, and they have thus caused differences among the soils. Factors that have contributed to the formation of

test data—Continued

Mechanical analysis [2]—Continued								Liquid limit [3]	Plasticity index [4]	Classification	
Percentage less than 3 inches passing sieve—Continued				Percentage smaller than—						AASHTO [5]	Unified

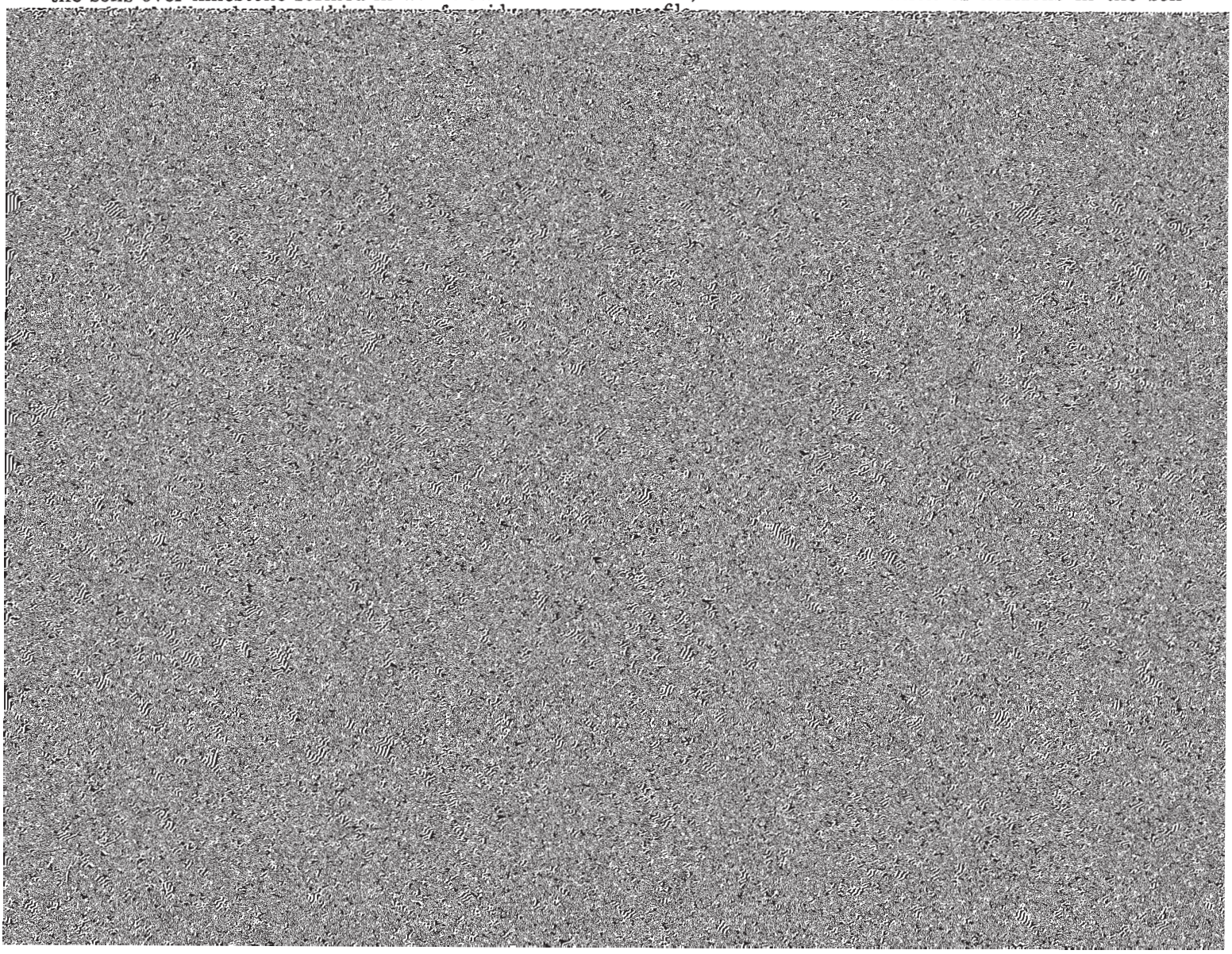
more than 50 inches of organic material over mineral soil material. The Saprists part of Saprists and Aquents also formed in organic material.

Alluvial and colluvial deposits are also relatively important parent materials in the county. Most of these deposits are of recent origin, and the soils that formed in them do not have distinct horizons. These materials range from silty to sandy in texture and are deposited on stream bottoms and foot slopes by stream floods or local wash of soil materials from higher positions on the landscape. Huntsville and Orion soils and Fluvaquents and Fluvaquents, wet, formed in alluvial and colluvial deposits.

Residuum from weathered bedrock is another parent material in the county. The three kinds of bedrock are dolomitic limestone, sandstone, and shale. Limestone weathers to a clayey residuum that is firm and plastic. This layer is thin or lacking in most places in St. Croix County. Much of residuum was removed by the glacier and since glaciation there has not been sufficient time for further weathering. In most places in the county the soils over limestone formed in windblown silt loam southwestern parts of St. Croix County. In most places, these layers are only 48 to 60 inches thick and are underlain by fragmented dolomitic limestone. This shale weathers to an olive and olive gray clay which is neutral to moderately alkaline below the solum. Derinda and Derinda Variant soils formed in residuum from weathered shale. They are on the ridgetops of shale uplands and have slow permeability.

Relief and drainage

The hills, valleys, ridges, and plains of St. Croix County are results of the work of rains, rivers, winds, glacial ice, and glacial meltwater over long periods of time. Where bedrock controls the topography, the resistance or lack of resistance of the underlying rocks has determined the relief. Relief, in turn, influences soil formation by controlling drainage, runoff, and other direct or indirect effects of water, including erosion. In many places the relief of a given soil can be correlated closely with the drainage; the thickness and organic matter content of the A1 horizon; the thickness of the solum; and the differentiation of horizons in the soil



thinner dark colored surface layer and are generally more acid than those formed under grass. Pillot soils formed under grass and have a thick, dark colored surface layer. Soils that formed under grass accumulate more organic matter and retain it longer than soils that formed under trees. The humus contributes to their darker color. Soils that formed in places where the vegetation is a mixture of trees and grasses generally have characteristics of both woodland and prairie soils.

Climate

Climate affects soil formation through the moisture and heat that it contributes to an environment. It has a direct effect on the weathering of rocks and the alteration of parent material through the mechanical action of freezing and thawing and the chemical action generated by the leaching of water. Climate has an indirect effect through its influence on plant and animal life.

Differences in climate within the survey area are too small to have any great effect on differences in the soils. The area is within a climatic zone, however, where both prairie vegetation and woodland vegetation are competing for dominance in the soil-plant regime. Pillot and Port Byron soils are representative of soils that formed under grassland vegetation. They have a thick, dark colored surface layer. Renova, Santiago, and Vlasaty soils formed under woodland vegetation and lack the thick, dark colored surface layer.

Time

Time has had some effect on differences among the soils of the survey area. Soils of the alluvial plains, for example, do not have distinct horizons because the soil material has not been in place long enough for the soil-forming processes to take full effect. Well drained soils that formed in glacial till and in windblown silt loam, on the other hand, have well-defined horizons as the result of processes that have been active for thousands of years. In some soils along natural drainageways, such as Huntsville and Orion soils, new material is added to the surface from time to time and covers an older soil. It has not been in place long enough for distinct horizons to have formed.

Man's activities have been so important that he is often referred to as the sixth soil-forming factor. During the past 125 years, man has influenced the soils to a marked extend by disturbing and altering the natural soil-forming processes. He has greatly altered the original condition of many soils by clearing, burning, and cultivating. He has contributed to accelerated erosion by repeatedly removing plant cover from terraces and uplands. He has often contributed to loss of organic matter through overcultivation and has reduced the infiltration rate. He has changed the loose, porous surface layer to clods through overcultivation and the use of heavy equipment.

Where good management and suitable crop rotations have been used, the soil has not been harmed and crop yields have gradually increased. Additions of animal manure and the growth of grasses such as bromegrass have increased the organic matter content of the surface layer and upper part of the subsoil beyond the level of that in virgin woodland soils.

Man has altered the natural acidity of the soils by liming. The lime has not only improved plant growth but has created a more favorable environment for soil bacteria. The increased bacterial action, in turn, has hastened the decomposition of organic matter that darkens the cultivated part of many soils.

Man has also applied fertilizer to increase the supply of plant nutrients. He has grown alfalfa, which uses its long taproot to transfer calcium and other plant food elements from the lower subsoil and substratum to the surface.

Man has improved drainage by constructing waterways and building water control structures. Drainage of wetlands has permitted cultivation of many high-potential soils but has contributed to a general lowering of the water table throughout the area.

Evidence of other effects of man's activity can be seen in areas where the surface layer is now mostly brown subsoil. This soil loss is also evidenced by the over-thickened surface layer on foot slopes and along natural drainageways, where sediment, washed from the surrounding soils, is 2 to 3 feet or more thick. Included in mapping the Floyd and Orion soils are areas that formed in sediment overlying older, buried soils.

Other changes caused by man's manipulation of the soil and landscape include the tendency towards more flash flooding where woodland cover is removed from the more sloping soils of the watershed; rapid filling of lakes and reservoirs with sediment; contamination of ground water with sewage effluent and fertilizer elements, especially nitrates; and the general effect of pesticides on soil organisms and ground water. All of man's activities affect the soil in some way, but some of the changes will not be evident for many years.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Because this system is under continual study, readers interested in developments of the current system should search the latest literature available (*24, 28*).

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for

classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. The same property or subdivisions of this property may be used in several different categories. In table 12, the soil series of St. Croix County are placed in four categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. Three exceptions to this are the Entisols, Histosols, and Vertisols which occur in many different climates. Each order is named with a word of three or four syllables ending in *sol* (Moll-i-sol).

SUBORDER. Each order is subdivided into suborders using those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders are more narrowly defined than are the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of a water table at a shallow depth, soil climate, the accumulation of clay, iron, or organic carbon in the upper solum, cracking of soils caused by a decrease in soil moisture, and fine stratification. The names of suborders have two syllables. The last syllable indicates the order. An example is *Aquoll* (Aqu, meaning water or wet, and *oll*, from Mollisol).

GREAT GROUP. Soil suborders are separated into great groups on the basis of unformity in the kinds and sequence of soil horizons and features. The horizons used to make separations are those in which clay, carbonates, and other constituents have accumulated or have been removed; and those that have pans that interfere with growth of roots, movement of water, or both. Some features used are soil acidity, soil climate, soil composition, and soil color. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Haplaquoll (*Hapl*, meaning simple horizons, *aqu* for wetness, or water, and *oll*, from Mollisols).

SUBGROUP. Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and others called intergrades that have properties of the group and also one or more properties of another great group, suborder, or order. Other subgroups may have soil properties unlike those of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Haplaquolls (a typical Haplaquoll).

FAMILY. Soil families are separated within a subgroup primarily on the basis of properties important to the growth of plants or to the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature,

Environmental Factors Affecting Soil Use

This section gives information about the main natural and cultural features that affect the use and management of the soils of St. Croix County. It briefly explains those features that affect the existing and potential use of soils for farming and other purposes.

Relief and Drainage

St. Croix County is about 85 percent uplands, 14 percent wetlands, and 1 percent water. Cedar Lake and Bass Lake and the Willow and St. Croix Rivers are all in the western half of the county and make up about 90 percent of the surface water acreage. Generally, drainage is to the southwest toward the Mississippi River. Most of the county is underlain by dolomitic limestone that dips to the south and southwest at a low angle of approximately 9 feet to the mile. The action of erosion on the tilted limestone has produced an east and northeast facing cuesta that extends along the eastern border of the county. It is low and irregular and gradually disappears toward the north, presumably beneath a thick cover of glacial drift. Toward the southern edge of the county, its height is about 200 feet. Traveling west over the cuesta, the land levels out to a large plain consisting mostly of ground moraine and stream terraces. About 65 percent of the soils in the county are nearly level or gently sloping, about 20 percent are sloping, and 15 percent are moderately steep to very steep.

Most of the nearly level and gently sloping soils are on ground moraines and stream terraces throughout the county. A few sloping soils are scattered throughout the county, but most are closely associated with the moderately steep to very steep soils. Generally the moderately steep to very steep soils are located as follows: the cuesta along the eastern and southeastern border of the county; north of River Falls where isolated outliers of limestone bedrock form buttes and narrow ridges; and north and east of Hudson where an end moraine and pitted outwash areas have complex topography consisting of narrow ridges, hills, and depressions.

Geology and Underlying Material

Most of the landscape of St. Croix County consists of glacial drift underlain by dolomitic limestone. The limestone bedrock crops out in a few areas throughout the county, mainly on the buttes and narrow ridges north of River Falls, along streambanks, and along the eastern and southeastern border of the county. There are a number of quarries in these outcrops, for example, the large quarry near Wilson in Springfield

TABLE 12.—*Classification of the soils*

Series	Family	Subgroup	Order
Adolph [1]	Coarse-loamy, mixed, frigid	Typic Haplaquolls	Mollisols

example, there is a danger of ground water pollution from unfiltered septic tank effluent moving down these crevices in soils underlain by limestone at a depth of less than 40 inches. These soils have severe limitations for soil absorption filter fields and for other uses where the ability of the soil to act as a filter is the prime consideration of use. There is also a danger of ground water contamination through sinkholes in the underlying limestone. The rate of water movement through these sinkholes varies from year to year because soil

nonfarm uses. The well drained soils underlain by sandy loam or light loam till have long, uniform slopes and are well suited to such erosion control practices as stripcropping, terraces, and diversions.

Glacial outwash is stratified sand and gravel that was deposited by glacial meltwaters. These materials are desirable for roadbuilding and making concrete. Extensive areas of glacial outwash are mainly in the western part of the county. Along the Apple and Willow Rivers and near River Falls are large areas of nearly

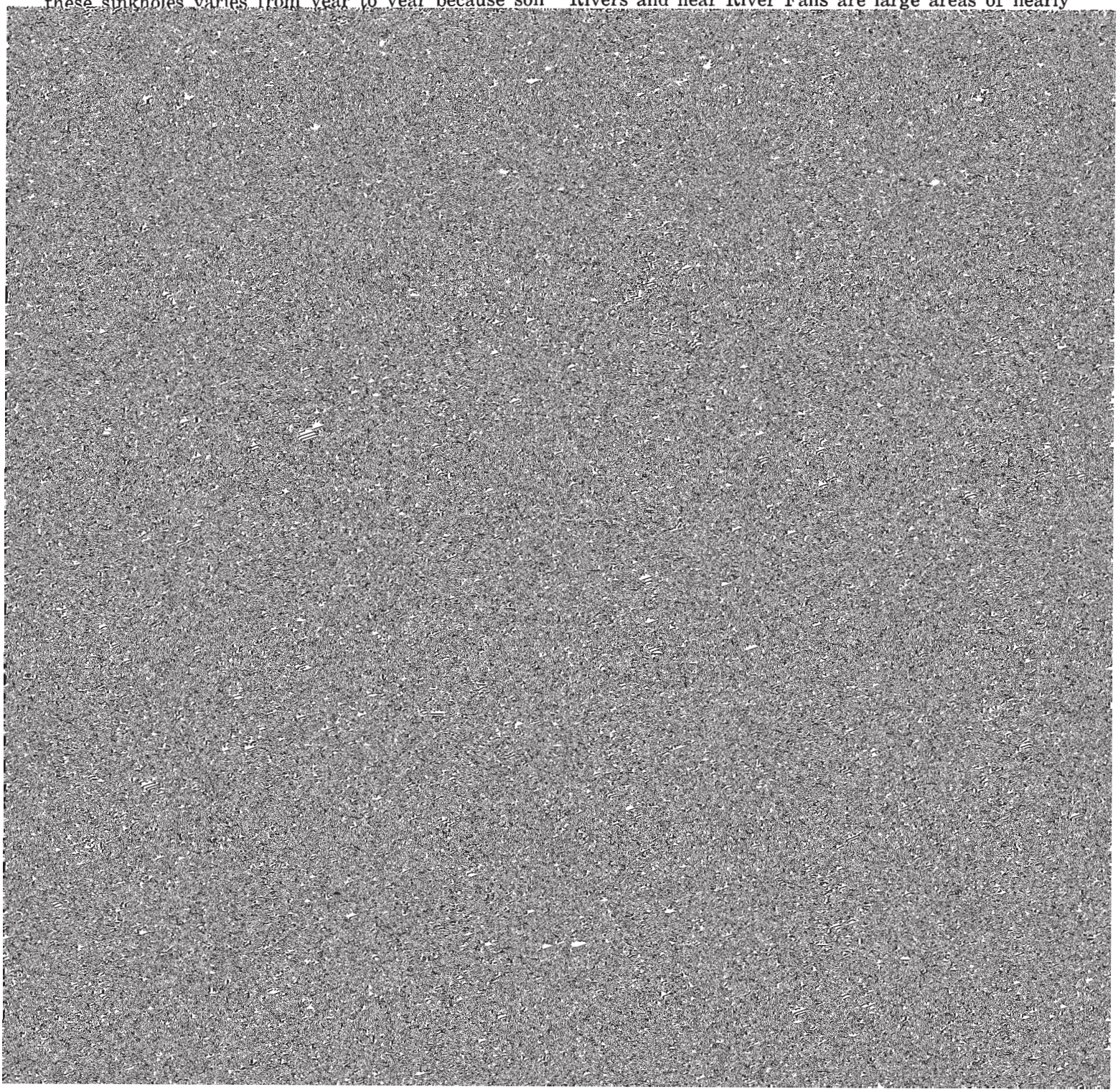


TABLE 13.—*Probabilities of last freezing temperature in spring and first in fall*

[All data from River Falls, Wisconsin, based on records from 1930 to 1959]

Probability	Dates for given probability and temperature				
	32° F or lower	28° F or lower	24° F or lower	20° F or lower	16° F or lower
Spring:					
20 percent chance after	May 24	May 15	May 1	April 22	April 6
40 percent chance after	May 17	May 8	April 23	April 14	March 29
60 percent chance after	May 11	May 1	April 17	April 7	March 23
80 percent chance after	May 5	April 24	April 10	March 31	March 15
Fall:					
20 percent chance before	September 16	September 27	October 7	October 19	October 28
40 percent chance before	September 23	October 5	October 14	October 27	November 5
60 percent chance before	September 29	October 11	October 21	November 3	November 11

ing season, defined as the number of days between the Prairie du Chien dolomite and partly in the upper part

are food processing and manufacturing of wood products, furniture, refrigerator equipment, machinery, metal products, and plastics. Most of the industry is in the communities of Baldwin, Hudson, and New Richmond. The industrial base of St. Croix County has grown significantly in the past decade. Future growth is very likely because of the urban spread from the Minneapolis-St. Paul metropolitan area. Construction of Interstate Highway 94 through the county made this increase in growth more rapid.

St. Croix County is primarily an agricultural area. Many businesses that service and sell farm machinery and other farm supplies are distributed throughout the

(14) Gevorkiantz, S. R. 1956. Site index curves for balsam fir in the Lake States. Lake States For. Exp. Stn. Tech. Note 465.
(15) Gevorkiantz, S. R. 1957. Site index curves for white cedar in the Lake States. Lake States For. Exp. Stn. Tech. Note 472.
(16) Gevorkiantz, S. R. 1957. Site index curves for white pine in the Lake States. Lake States For. Exp. Stn. Tech. Note 483.
(17) Gevorkiantz, S. R. 1957. Site index curves for red pine in the Lake States. Lake States For. Exp. Stn. Tech. Note 484.
(18) Gevorkiantz, S. R. 1957. Site index curves for red oak in the Lake States. Lake States For. Exp. Stn. Tech. Note 485.
(19) Gevorkiantz, S. R. 1957. Site index curves for tamarack

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Climax vegetation. The stabilized plant community on a par-

monly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

permanent if no appreciable change is expected and its character is the result of ecological factors alone.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock

tissue. Plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from the air and water.

Organic matter. A general term for plant and animal material, in or on the soil, in all stages of decomposition. Readily

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained (each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Succession (ecology). The progressive development of vegetation toward its highest ecological expression, or the climax vegetation; replacement of one plant community by another.

Surface layer. A term used in nontechnical soil descriptions for one or more layers above the subsoil. Includes A horizon; has no depth limit.

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 it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

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 a soil or soil material consisting of particles well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

GUIDE TO MAPPING UNITS

[For a full description of a mapping unit, read both the description of the mapping unit and the description of

Map symbol	Mapping unit	Described on page	Capability unit	Woodland group	Wildlife group	Recreation group	Tree and shrub group
			Symbol	Symbol	Number	Number	Number
CoC2	Chetek-Onamia complex, 6 to 12 percent slopes, eroded	21	IVe-3	3d1	4	1	2
CoD2	Chetek-Onamia complex, 12 to 20 percent slopes, eroded	21	VIe-3	3d2	4	1	2
CoE	Chetek-Onamia complex, 20 to 30 percent slopes	21	VIIe-3	3d2	4	1	2
CyA	Clyde silt loam, 0 to 3 percent slopes	23	IIw-1	4w2	7	6	3
Cz	Cut and fill areas	23	------	---	---	1	---
DaA	Dakota loam, 0 to 2 percent slopes	24	IIs-1	---	5	1	1
DaB	Dakota loam, 2 to 6 percent slopes	24	IIe-2	---	5	1	1
DcC2	Dakota-Pillot complex, 6 to 12 percent slopes, eroded	24	IIIe-2	---	5	1	1
DeB	Derinda silt loam, 2 to 6 percent slopes	25	IIe-6	2o1	2	4	1
DeC2	Derinda silt loam, 6 to 12 percent slopes, eroded	26	IIIe-6	2o1	2	4	1
DfB	Derinda Variant silt loam, 1 to 6 percent slopes	26	IIw-3	3o2	6	5	3

Map symbol	Mapping unit	Described on page	Capability unit	Woodland group	Wildlife group	Recreation group	Tree and shrub group
			Symbol	Symbol	Number	Number	Number
JeC2	Jewett silt loam, 6 to 12 percent slopes, eroded	37	IIIe-1	2o1	1	1	1
JsA	Jewett silt loam, sandy substratum, 0 to 2 percent slopes	37	IIs-1	2o1	1	1	1
JsB	Jewett silt loam, sandy substratum, 2 to 6 percent slopes	37	IIe-2	2o1	1	1	1
LcA	Lawler silt loam, 0 to 3 percent slopes	38	IIw-5	4o1	6	5	3
MaB	Magnor silt loam, 1 to 6 percent slopes	39	IIw-4	2o2	6	5	3
NcB	Nickin silt loam, 2 to 6 percent slopes	40	IIe-2	---	5	1	1
NcC2	Nickin silt loam, 6 to 12 percent slopes, eroded	40	IIIe-2	---	5	1	1
NnD2	Nickin loam, 12 to 20 percent slopes, eroded	40	IVe-2	---	5	1	1
OmB	Onamia loam, 2 to 6 percent slopes	41	IIe-2	2o1	1	1	1
OmC2	Onamia loam, 6 to 12 percent slopes, eroded	41	IIIe-2	2o1	1	1	1
OnC2	Onamia-Antigo complex, 6 to 12 percent slopes, eroded	41	IIIe-2	2o1	1	1	1
OnD2	Onamia-Antigo complex, 12 to 25 percent slopes, eroded	41	IVe-2	2r1	1	1	1
Ora	Orion silt loam, 0 to 3 percent slopes	42	IIw-13	3o2	6	5	3
OtB	Otterholt silt loam, 2 to 6 percent slopes	43	IIe-1	1o1	1	1	1
OtC	Otterholt silt loam, 6 to 12 percent slopes	43	IIIe-1	1o1	1	1	1
OtD2	Otterholt silt loam, 12 to 20 percent slopes, eroded	44	IVe-1	1r1	1	1	1
PlA	Pillot silt loam, 0 to 3 percent slopes	45	IIs-1	---	5	1	1
PmB	Plainfield loamy sand, 2 to 6 percent slopes	45	IVs-3	3s1	3	2	2
PmC	Plainfield loamy sand, 6 to 12 percent slopes	45	VIs-3	3s1	3	2	2
PmD	Plainfield loamy sand, 12 to 20 percent slopes	46	VIIs-3	3s3	3	2	2
PoB	Port Byron silt loam, 2 to 6 percent slopes	46	IIe-1	---	5	1	1
PoC	Port Byron silt loam, 6 to 12 percent slopes	46	IIIe-1	---	5	1	1
PoD	Port Byron silt loam, 12 to 20 percent slopes	47	IVe-1	---	5	1	1
ReB	Renova silt loam, 2 to 6 percent slopes	47	IIe-1	2o1	1	4	1
ReC2	Renova silt loam, 6 to 12 percent slopes, eroded	48	IIIe-1	2o1	1	4	1
RgC2	Renova Variant loam, 4 to 12 percent slopes, eroded	48	IIIe-2	2o1	1	1	1
RgD2	Renova Variant loam, 12 to 20 percent slopes, eroded	49	IVe-2	2r1	1	1	1
RhA	Rib silt loam, 0 to 3 percent slopes	49	IIw-5	3w2	7	6	3
RnB	Ritchey silt loam, 2 to 6 percent slopes	50	IIIe-3	3d1	4	3	2
RnC2	Ritchey silt loam, 6 to 12 percent slopes, eroded	50	IVe-3	3d1	4	3	2

Map symbol	Mapping unit	Described on page	Capability unit	Woodland group	Wildlife group	Recreation group	Tree and shrub group
			Symbol	Symbol	Number	Number	Number
RnD2	Ritchey silt loam, 12 to 20 percent slopes, eroded	50	VIe-3	3d2	4	3	2
RoE	Ritchey soils and Rock outcrop, 20 to 35 percent slopes	51	VIIe-3	3d2	10	3	2
RpB	Rockton silt loam, 2 to 6 percent slopes	52	IIe-2	---	5	3	1
RpC2	Rockton silt loam, 6 to 12 percent slopes, eroded	52	IIIe-2	---	5	3	1
RpD2	Rockton silt loam, 12 to 20 percent slopes, eroded	52	IVe-2	---	5	3	1
SaB	Santiago silt loam, 2 to 6 percent slopes	53	IIe-1	1o1	1	1	1
SaC2	Santiago silt loam, 6 to 12 percent slopes, eroded	53	IIIe-1	1o1	1	1	1
ScC2	Santiago-Antigo complex, 6 to 12 percent slopes, eroded	53	IIIe-1	1o1	1	1	1
ScD2	Santiago-Antigo complex, 12 to 25 percent slopes, eroded	53	IVe-1	1r1	1	1	1
Se	Saprists and Aquents	54	VIIIw-15	6w1	7	6	---
ShA	Sattre loam, 0 to 2 percent slopes	55	IIs-1	2o1	1	1	1
ShB	Sattre loam, 2 to 6 percent slopes	55	IIe-2	2o1	1	1	1
ShC2	Sattre loam, 6 to 12 percent slopes, eroded	55	IIIe-2	2o1	1	1	1
SlA	Sattre silt loam, 0 to 2 percent slopes	56	IIs-1	2o1	1	1	1
SlB	Sattre silt loam, 2 to 6 percent slopes	56	IIe-2	2o1	1	1	1
Sm	Seelyeville muck	56	IVw-9	3w3	8	6	4
SrA	Skyberg silt loam, 0 to 3 percent slopes	57	IIw-2	2o2	6	5	3
Ud	Udifluvents	57	VIIs-9	3s1	6	5	2
VaB	Vlasaty silt loam, 2 to 6 percent slopes	58	IIe-1	2o1	2	4	1
VaC2	Vlasaty silt loam, 6 to 12 percent slopes, eroded	59	IIIe-1	2o1	2	4	1
WhB	Whalan silt loam, 2 to 6 percent slopes	59	IIe-2	2o1	1	3	1
WhC2	Whalan silt loam, 6 to 12 percent slopes, eroded	60	IIIe-2	2o1	1	3	1
WhD2	Whalan silt loam, 12 to 25 percent slopes, eroded	60	IVe-2	2r1	1	3	1

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