Issued June 1968

Major fieldwork for this soil survey was done in the period 1956 to 1960. Soil names and descriptions were approved in 1965. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1966. This survey was made cooperatively by the Soil Conservation Service and the Iowa Agricultural Experiment Station; it is part of the technical

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EXPLANATION

Series Year and Series Number

Series year and number were dropped from all soil surveys sent to the printer after December 31, 1965. Many surveys, however, were then at such advanced stage of printing that it was not feasible to remove series year and number. Consequently, the last issues bearing series year and number will be as follows:

SOIL SURVEY OF WINNESHIEK COUNTY, IOWA

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FIELDWORK BY KENNETH K. KITTLESON, KENNETH C. HINKLEY, HERBERT D. HOLDORF, EARL J. KERKER, AND ROBERT C. RUSSELL, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE IOWA AGRICULTURAL EXPERIMENT STATION

WINNESHIEK COUNTY is in the northeastern part of Iowa (fig. 1). It is the second county west of the Mississippi River and is bordered on the north by the State of Minnesota. The county has a total area of 688 square miles.

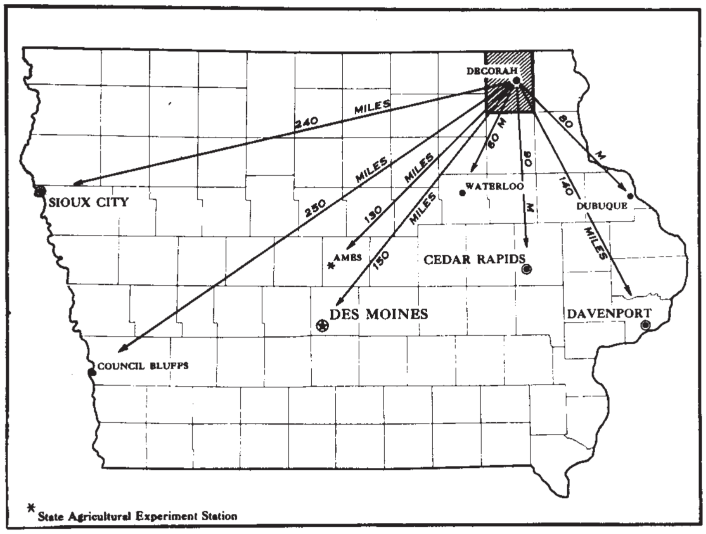


Figure 1.—**Location of Winneshiek County in Iowa.**

Decorah, the county seat, is near the center of the county and is along the Upper Iowa River. It had a population of 6,435 in 1960. The rural population and the population of several of the smaller towns in this county is slowly decreasing. The population of several of the larger towns is increasing.

This county is primarily agricultural. Most of the farm income is derived from the sale of dairy products and hogs, but the feeding of beef cattle is also important. Corn, oats, soybeans, and hay are the principal crops. The crops are fed mainly to livestock.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Winneshiek County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. To use this survey efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Fayette and Dubuque, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that go with their behavior in the natural, untouched landscape. Soils of one series can differ somewhat in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man.

Many soil series contain soils that differ in texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Bassett loam and Bassett silt loam are two soil types in the Bassett series. The difference in texture of their surface layers is apparent from their names.

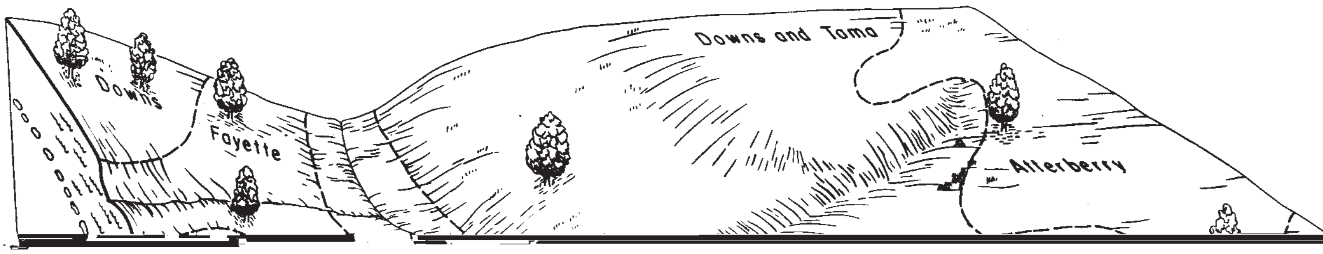
Some types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Downs silt loam, 5 to 9 percent slopes, is one of several phases of Downs silt loam, a soil type that ranges from nearly level to hilly.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodland, buildings, field borders, trees, and other details that greatly help in drawing boundaries accurately. The soil map in the back of this survey was prepared from the aerial photo-

the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present 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 Winneshiek County. A soil association is a landscape that has a distinctive pro-


Downs
Fayette
Downs and Tama
Allerberry

gently sloping soils on narrow ridgetops and gently sloping and sloping soils on the sides of the ridges are typical features of the landscape. Sinkholes are common; an area 20 acres in size generally contains four or five. The sinkholes are 60 to 80 feet across, and some are covered with trees. Many are too deep to be crossed with farm machinery. The drainage pattern is moderately well defined because many waterways begin in this area. This association occupies about 1,280 acres.

Well-drained Fayette soils, formed in a layer of loess 180 to 240 inches thick, occupy most of this association. In areas of these soils that have not been cultivated, the surface layer is thin and moderately dark colored, and it is underlain by a distinct, light-colored subsurface layer. In cultivated areas part of the subsurface layer has been mixed with the plow layer and the present surface layer is light colored both when moist and when dry. The subsoil is brownish and is free of mottles. No stones or pebbles are on the surface or in the soil profile.

In the sinkholes and along the drainageways, the surface layer is slightly darker colored than on the ridgetops and on the sides of ridges. Those areas are usually not wet, because they are underlain by fractured limestone. Most of the drainageways are narrow.

4. Downs-Fayette Association

Well-drained, sloping to moderately steep, moderately dark colored and light-colored, silty soils

Sloping soils on narrow ridgetops and sloping to moderately steep soils on the sides of ridges are typical of this association. The side slopes are dissected by drainageways. The association contains the main stems of upland drainageways. The water from those drainageways has cut gullies and other drainageways that can be crossed with farm machinery. Limestone bedrock is exposed in the gullies and drainageways in some places. A few sinkholes are in this association, but not so many as are in association 3. Scattered trees grow in the drainageways and along fences in some places, and there are a few small timbered areas of irregular shape. This association is in all parts of the county, except in the southwestern. It occupies the most extensive areas underlain by deep loess.

Well-drained Downs and Fayette soils, formed on uplands in a layer of loess 100 to 200 inches thick, occupy the major part of this association. The Downs soils have a thin, moderately dark colored surface layer, a light-colored subsurface layer, and a brownish subsoil that is free of mottling. The Fayette soils are similar are occupied and are in good repair. The farms vary in [illegible]

[illegible]

available native pasture. Nearly all of the farm buildings are occupied and are in good repair. The size of [illegible]

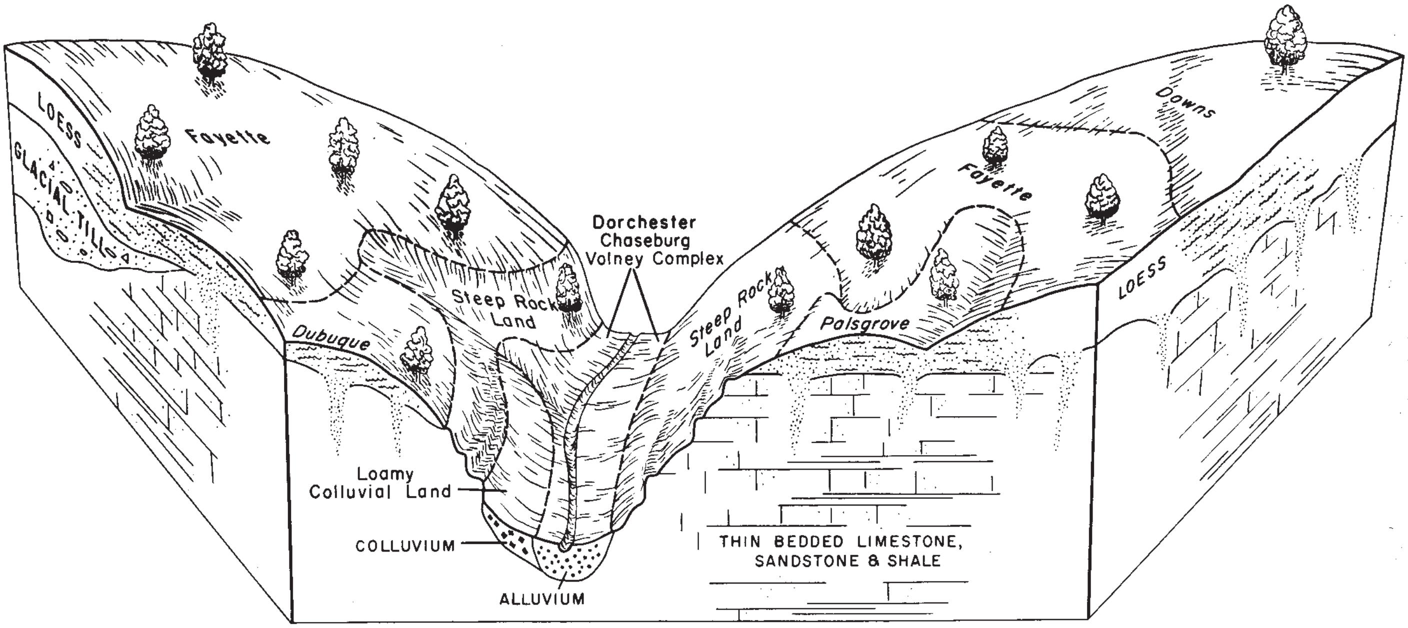


Figure 4.—**Cross section of association 6 and of some areas of association 4 showing the topography, vegetation, soils, and underlying material.**

ways. These drainageways are less entrenched than those in the other associations, except association 7. A distinct band of stones or pebbles can be seen in new road cuts at a depth of 14 to 24 inches (fig. 5). Piles

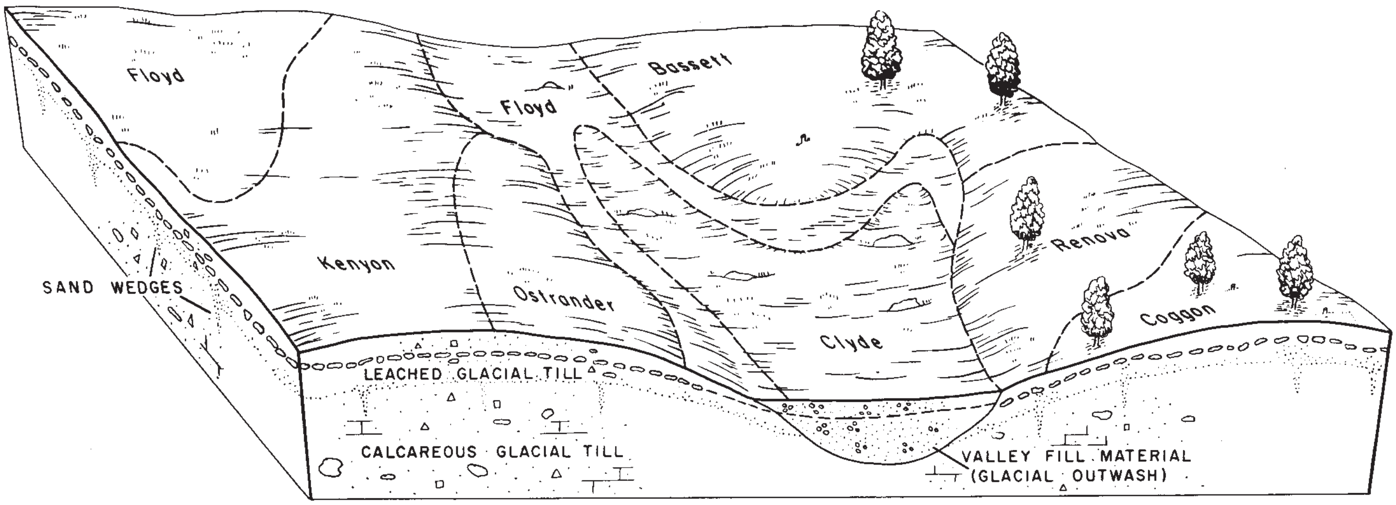


Figure 5.—**Cross section of association 8 showing the topography, vegetation, soils, and underlying material. A distinct band of stones or pebbles is in the underlying material.**

of stones are common along fence rows and in the drainageways. The county roads run along section lines in

in areas where the drainage is poor. If the wet draws and waterways are not drained, they limit the size of fields. In some areas glacial stones and boulders must be removed before a field can be cultivated. Many areas of permanent pasture in the drainageways are too wet and boggy for proper utilization by livestock.

A minor part of the association is made up of poorly drained or somewhat poorly drained Jacwin and poorly drained Calamine soils. The Jacwin and Calamine soils have a dark or moderately dark colored surface layer and a mottled gray or gray and brown subsoil. They are underlain by shale.

The available moisture capacity is low or very low in the areas underlain by limestone; the soils in most of those areas are droughty. The sloping soils are susceptible to erosion where the cover of plants is sparse. The soils in the few areas that are underlain by shale are commonly wet, and tile drainage is needed in those areas. In some places the size and shape of the fields are limited by bedrock near the surface. In other places they are limited by drainageways that cannot be crossed with farm machinery.

Many of the sloping areas where the soils are shallow over limestone or shale are in permanent pasture. Nearly all of the areas of nearly level or gently sloping soils are cultivated, but those soils are only moderately well suited to row crops. The areas of sloping soils need to be stripcropped or farmed on the contour. The steeper soils ought to be kept in permanent pasture or trees, and they can be used for wildlife habitats. Several timbered areas, about 80 acres in size, can be managed as woodland. A few areas that are not cultivated should be seeded to pasture.

Farming is diversified in this association, and hogs and dairy cattle are raised on many farms. In some parts of the association, not enough grain is grown to support the livestock. As a rule, this association is not used for building sites, but the homes and other structures are in the adjoining associations.

Descriptions of the Soils

This section is provided for those who want information about the soils in the county. It describes the single soils, or mapping units; that is, the areas on the detailed soil map that are bounded by lines and are identified by a symbol. For more general information about the soils, the reader can refer to the section "General Soil Map" in which the broad patterns of soils in the county are described. The acreage and proportionate extent of each soil mapped are given in table 1. Their location is shown on the soil map at the back of this soil survey.

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

Mapping unit	Acres	Percent	Mapping unit	Acres	Percent
Alluvial land	3,263	0.7	Colo-Otter-Ossian complex	2,704	.6
Arenzville silt loam	559	.1	Dickinson sandy loam, 0 to 2 percent slopes	595	.1
Atkinson loam, 2 to 5 percent slopes	573	.1	Dickinson sandy loam, 2 to 5 percent slopes	1,986	.5
Atterberry silt loam, 1 to 4 percent slopes	546	.1	Dickinson sandy loam, 5 to 9 percent slopes	737	.2
Backbone loamy sand, 2 to 5 percent slopes	428	.1	Dickinson sandy loam, 9 to 14 percent slopes	127	(1)
Backbone loamy sand, 5 to 9 percent slopes	439	.1	Donnan loam, 2 to 5 percent slopes	141	(1)
Backbone loamy sand, 9 to 14 percent slopes	180	(1)	Dorchester silt loam	8,907	2.0
Bassett loam, 0 to 2 percent slopes	539	.1	Dorchester-Chaseburg-Volney complex, 2 to 5 percent slopes	8,774	2.0
Bassett loam, 2 to 5 percent slopes	8,781	2.0			

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

Mapping unit	Acres	Percent	Mapping unit	Acres	Percent
Fayette silt loam, 5 to 9 percent slopes, moderately eroded	46, 775	10. 6	Nasset silt loam, 9 to 14 percent slopes, moderately eroded	234	. 1
Fayette silt loam, 5 to 9 percent slopes, severely			Nasset silt loam, 14 to 18 percent slopes, moder-		

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

Mapping unit	Acres	Percent
Sattre loam, moderately deep, 9 to 14 percent slopes, moderately eroded	218	(1)
Sattre loam, deep, 0 to 2 percent slopes	774	. 2
Sattre loam, deep, 2 to 5 percent slopes	374	. 1
Sattre loam, deep, 5 to 9 percent slopes, moderately eroded	155	(1)
Spillville loam	971	. 2
Steep rock land	23, 184	5. 3
Steep sandy land, 14 to 30 percent slopes	860	. 2
Terril loam, 0 to 2 percent slopes	1, 707	. 4
Terril loam, 2 to 5 percent slopes	784	. 2
Turlin gritty silt loam, 0 to 2 percent slopes	60	(1)
Turlin gritty silt loam, 2 to 5 percent slopes	537	. 1
Volney channery silt loam, 0 to 1 percent slopes	329	. 1
Volney channery silt loam, 2 to 5 percent slopes	380	. 1
Volney silt loam, overwashed, 0 to 1 percent slopes	355	. 1
Volney silt loam, overwashed, 2 to 5 percent slopes	118	(1)
Waucoma loam, 0 to 2 percent slopes	146	(1)
Waucoma loam, 2 to 5 percent slopes	975	. 2
Waucoma loam, 5 to 9 percent slopes	288	. 1
Waucoma loam, 9 to 14 percent slopes	204	(1)
Waukegan loam, deep, 0 to 2 percent slopes	1, 286	. 3
Waukegan loam, deep, 2 to 5 percent slopes	802	. 2
Waukegan loam, moderately deep, 0 to 2 percent slopes	1, 136	. 3
Waukegan loam, moderately deep, 2 to 5 percent slopes	261	. 1
Whalan loam, 2 to 5 percent slopes	1, 244	. 3
Whalan loam, 5 to 9 percent slopes, moderately eroded	790	. 2
Whalan loam, 9 to 14 percent slopes, moderately eroded	435	. 1
Whalan loam, 14 to 24 percent slopes, moderately eroded	404	. 1
Whalan loam, 14 to 18 percent slopes, severely eroded	178	(1)
Winneshiek loam, 0 to 2 percent slopes	340	. 1
Winneshiek loam, 2 to 5 percent slopes	8, 649	2. 0
Winneshiek loam, 5 to 9 percent slopes	2, 320	. 5
Winneshiek loam, 5 to 9 percent slopes, moderately eroded	322	. 1
Winneshiek loam, 9 to 14 percent slopes	528	. 1
Winneshiek loam, 14 to 18 percent slopes	351	. 1
Total	440, 320	100. 0

[1] Less than 0.05 percent.

In the descriptions that follow, the soils in a series are first discussed as a group by describing important features that apply to all the soils in the series. The location

bows are common in the areas, and some of them are filled with water for long periods.

Where flooding is not controlled, this land type is adjacent to Kennebec, Lawson, Otter, and Chaseburg soils.

Representative profile:

These soils are suited to row crops. The more sloping areas are susceptible to erosion, however, and they should be used for row crops less frequently than the nearly level areas. The soils are medium acid. Legumes grown

These soils are suited to row crops. They are slightly acid to medium acid, however, and the requirements for lime vary. These soils are low in available nitrogen and phosphorus and only medium in available potassium.

Atterberry silt loam, 1 to 4 percent slopes (AyA).—This is the only Atterberry soil mapped in this county. It has a very dark gray surface layer that is 4 to 8 inches thick and a fairly distinct, light-colored subsurface layer.

This soil is on moderately wide ridgetops and at the heads of drainageways. In many places it is surrounded by areas of Downs and Fayette soils.

Included in mapped areas of this soil are areas of a soil that has a black surface layer of silt loam, 8 to 14 inches thick, and no subsurface layer. Also included are a few areas of a soil that has slopes between 5 and 9 percent.

Except in a few of the more sloping areas, runoff is generally slight. A moderately high water table and some

Permeability is rapid in the loamy sand to sandy loam in the upper part of the profile and slow in the thin layer of clay loam or clay. The available moisture capacity is low. These soils are susceptible to erosion by water and wind.

The less sloping areas of these soils are suited to row crops, and the steeper areas are suited to pasture or trees. Lime is needed, and the supply of available nitrogen, phosphorus, and potassium is very low. Adding manure does not greatly improve the tilth or available moisture capacity of these soils.

Backbone loamy sand, 2 to 5 percent slopes (BaB).—In cultivated areas the plow layer of this soil is very dark gray or very dark grayish brown and is 10 inches thick in some places. In areas that have not been cultivated, the surface layer is very dark gray to very dark brown and is 6 to 8 inches thick. In those areas the surface layer is be exposed in the channel if terraces were constructed. Also the fertility of the subsoil is too low to justify terracing.

Yields of corn grown on this soil are generally below average, and yields of meadow are often below average for this county, even if management is good. Response to fertilizer is poor, but legumes respond to applications of lime. (Capability unit IVs–2)

Backbone loamy sand, 9 to 14 percent slopes (BaD).—In cultivated areas the surface layer of this soil is 3 to 6

These soils have high available moisture capacity and moderate to moderately slow permeability. The sloping areas are susceptible to water erosion.

The Bassett soils are suited to row crops, but they are strongly acid and are low in available nitrogen, phosphorus, and potassium. Lime is needed.

Bassett loam, 0 to 2 percent slopes (BeA).—In areas that have not been plowed, this soil has a very dark gray surface layer that is 6 to 8 inches thick, and a distinct, light-colored subsurface layer. In areas that have been or stripcropped, corn or other row crops can be grown 3 years in 5. A greater part of the rotation should consist of meadow, however, if tilth becomes poor. If management is good, yields of corn are generally above average, but legumes need lime. Response to fertilizer is good. (Capability unit IIIe-1)

Bassett loam, 5 to 9 percent slopes, moderately eroded (BeC2).—The surface layer of this soil is very dark gray to very dark grayish brown. The subsurface layer

erally above average if management is good. The eroded areas are very low in content of organic matter and are in poor tilth. Therefore, applications of manure are beneficial. Lime is needed for legumes. Response to fertilizer is good. (Capability unit IIIe-1)

Bertrand Series

In the Bertrand series are well-drained soils that formed

This soil is on the undulating parts of some stream

In years when rainfall is average for this county, this they are near Renova and Racine soils. In this county the individual areas are small.

Representative profile:

0 to 7 inches, very dark brown, very friable sandy loam.
7 to 17 inches, brown to dark-brown, very friable sandy loam.
17 to 42 inches, yellowish-brown, loose gravelly sand.

The color of the surface layer ranges from very dark gray to very dark brown, and the thickness of that layer ranges from 6 to 10 inches. In some places the surface layer and the subsoil contain gravel.

These soils have low available moisture capacity and are droughty. Permeability is moderate in the soil material above the sand and gravel, but it is very rapid in the sand and gravel. These soils warm up quickly in spring and can be worked soon after rains.

These soils are easily eroded by runoff when the surface is bare or when the cover of plants is sparse. The less sloping Burkhardt soils can be used for row crops, although they are poorly suited to that purpose. The steeper areas are suited to pasture, trees, and wildlife habitats. These soils are very low in available nitrogen, phosphorus, and potassium.

Burkhardt soils, 0 to 5 percent slopes (BuB).—These soils have a surface layer of very dark brown to very dark grayish-brown sandy loam that is low in content of organic matter. They are underlain by sand and gravel at a depth of 15 to 24 inches.

These soils occur on stream benches and upland ridges with Dickinson, Lamont, and moderately deep Waukegan and Sattre soils. In places they also occur on uplands with Racine and Renova soils. The individual areas are small. Included in some mapped areas of the Burkhardt soils are areas of a soil that has a lighter colored surface layer than typical.

Much of the acreage is in permanent pasture. Where row crops are grown, these soils are generally cultivated with the adjoining soils. Runoff erodes these soils when the cover of plants is sparse. Therefore, tillage ought to be on the contour if row crops are grown. Where planting and tillage are on the contour, corn or other row crops can be grown 2 years in 5. Adding manure does not improve the moisture-holding capacity enough to justify the cost, and response to commercial fertilizer is poor. (Capability unit IVs–1)

Burkhardt soils, 5 to 14 percent slopes, moderately eroded (BuC2).—The surface layer of these soils is very

stripcropped. If corn is grown, however, yields are below average for the county. These soils are suitable for permanent vegetation, and a stand of meadow is often left until it needs to be renovated. Lime is needed to establish pastures that contain legumes. Adding manure does not improve the moisture-holding capacity enough to justify the cost, and response to commercial fertilizer is poor. (Capability unit IVs–2)

Calamine Series

In the Calamine series are soils that are poorly drained. These soils formed in 15 to 30 inches of silty material over firm clay shale. They have slopes of 0 to 5 percent.

The Calamine soils are on structural benches and foot slopes in the western part of the county. They are adjacent to Jacwin and Marlean soils and to areas of Steep rock land.

Representative profile:

0 to 16 inches, black, friable silty clay loam to silt loam.
16 to 28 inches, gray, dark-gray, olive, and olive-gray, firm silty clay; common yellowish-brown mottles.
28 to 48 inches, brownish-yellow and greenish-gray, very firm silty clay loam; common yellowish-brown and strong-brown mottles.

The surface layer ranges from silty clay loam to silt loam in texture. The color ranges from black to very dark gray to a depth of about 20 inches.

These soils have medium available moisture capacity. Their surface layer puddles easily if it is worked when wet. Permeability is moderate above the shale bedrock, but it is slow or very slow in the bedrock and in the material weathered from bedrock. These soils have a temporary perched water table. Seepage from areas upslope keeps them wet.

Some areas of these soils can be tile drained, but placement of the tile and backfilling are important because of the clayey texture and firm consistence of the subsoil and substratum. Where these soils are artificially drained, they are suitable for row crops. The root growth of some crops is somewhat limited, however, by the firm clay in the subsoil.

Sloping areas of these soils are slightly susceptible to erosion. These soils are medium in available nitrogen and low in available phosphorus and potassium. In most places lime is not needed.

Calamine silty clay loam, 0 to 2 percent slopes

proper backfilling and spacing of the drains are important because of the clay shale near the surface. The tile drains must not be placed too deep in the clay shale, and the backfill needs to be made of porous material.

Areas of this soil that are drained and properly managed can be used for corn or other row crops 3 years in 4. Yields of corn are generally average if management is

color of the soil material beneath the surface layer extends to a depth of 30 inches. Limestone bedrock is at a depth between 30 and 40 inches in many places.

This soil is on slightly concave, low foot slopes. It is downslope from more sloping Calmar, Rockton, and Marlean soils. Included in mapped areas of this soil are areas in which the surface layer is silty clay loam.

In cultivated areas the color of the surface layer ranges from dark gray to very dark grayish brown and part of the light-colored subsurface layer is mixed with

fields are terraced. Where terraces are constructed, the depth of the cuts and fills ought to be kept to a minimum so that the sandy and gravelly underlying material will not occasionally. Some tile drainage and protection from overflow are needed.

If these soils are properly managed, they can be used intensively for row crops. They are low in content of organic matter, however, and puddle if they are worked when wet. The content of lime is excessive, but these soils are very low in available nitrogen and phosphorus and medium in available potassium.

Caneek silt loam (0 to 1 percent slopes) (Ce).—This is the only Caneek soil mapped in this county, and its profile is the one described for the series. Its surface layer contains lime and is low in content of organic matter.

This soil occurs in upland drainageways with soils of the Dorchester-Chaseburg-Volney complex. It also occurs with Dorchester soils on the bottom lands.

Included in some mapped areas of this soil are areas of a light-colored soil that contains lime and is only 18 inches thick over the underlying material. Also included are areas of a soil that is poorly drained.

Corn or other row crops can be grown intensively if this Caneek soil is tile drained and protected from flooding. Yields of corn are generally above average if management is good, but crops are benefited if manure is added. Response to fertilizer is good. (Capability unit IIw–2)

Canoe Series

In the Canoe series are somewhat poorly drained soils formed in silty alluvium. The slopes range from 0 to 3 percent.

The Canoe soils are on the convex sloping parts of stream benches along the Upper Iowa and Turkey Rivers and their tributaries. Adjacent to them are areas of Rowley and Festina soils.

Representative profile:

0 to 8 inches, very dark grayish-brown, friable silt loam.
8 to 18 inches, very dark grayish-brown to dark grayish-brown, friable silt loam.
18 to 60 inches, dark grayish-brown to olive-gray, friable silt loam; many yellowish-brown and light olive-brown mottles.
60 to 82 inches, mottled gray and yellowish-brown, friable silt loam to loam.

The surface layer ranges from 4 to 8 inches in thickness. When it is moist, its color ranges from very dark gray to black, but in cultivated areas it is somewhat light colored when dry.

No stones or pebbles are on the surface or in the profile of these soils. The available moisture capacity is high or very high, and permeability is moderate. These soils have somewhat restricted internal drainage, however, because of the moderately high, but variable, water table.

The Canoe soils are suited to row crops, but they are medium acid to strongly acid. Lime is needed, and these soils are also low in available nitrogen, phosphorus, and potassium.

Canoe silt loam (0 to 3 percent slopes) (Cf).—This is

colored, silty, calcareous wash has been deposited on the surface. The surface layer is moderately low to low in content of organic matter.

This Canoe soil is on stream benches, adjacent to areas of Festina and Rowley soils. Many of the individual areas are small.

Included in mapped areas of this soil are a few areas of a soil that has a very dark gray surface layer 10 to 12 inches thick. Also included is a small acreage of Curran soils, which are mapped in other counties of the State, but occur in too small a total acreage in Winneshiek County to be mapped separately. The areas of Curran soils are indicated on the soil map by the symbol for wet spots.

This Canoe soil is often wet in spring or during periods of extensive rainfall. In some years wetness delays field operations. Tile outlets are easily established, and if this soil is tile drained, farming operations can be more timely. Diversion terraces placed on the adjacent upland slopes will protect this soil from overflow and silting. Adding manure makes tillage easier. Corn or other row crops can be grown intensively where erosion is controlled. If management is good, yields of corn are generally above average. Response to fertilizer is good. (Capability unit I–3)

Chaseburg Series

Well-drained soils formed in silty alluvium are in the Chaseburg series. These soils are light colored, both when moist and when dry. Their slopes range from 0 to 5 percent.

The Chaseburg soils are in the eastern part of the county at the base of upland slopes and in upland drainageways. Adjacent to them are areas of Arenzville, Bertrand, Dorchester, and Lawson soils.

Representative profile:

0 to 7 inches, dark grayish-brown, friable silt loam.
7 to 34 inches, dark grayish-brown, friable silt loam; some coatings of silt on the peds.
34 to 48 inches, brown to dark-brown and yellowish-brown, friable silt loam.

The combined thickness of the surface layer and subsurface layer ranges from 20 to 36 inches.

The surface layer is low in content of organic matter and does not contain lime. No stones or pebbles are on the surface or in the soil profile. These soils have high available moisture capacity and are moderately permeable. In some years, as a result of runoff from the soils upslope, new sediments that may cover young crops are occasionally deposited on their surface.

These soils are suited to row crops and can be protected from overflow by constructing diversion terraces upslope. They are very low in available nitrogen, low in available phosphorus, and medium in available potassium.

Chaseburg silt loam, 0 to 2 percent slopes (ChA).—This soil generally has a profile like the one described as typical

Representative profile:

0 to 22 inches, black and very dark gray, friable silt loam or loam.
22 to 33 inches, mottled gray, strong-brown, and yellowish-red, friable silt loam and loam.
33 to 56 inches, gray and olive-gray, friable to firm cobbly sandy loam and clay loam; some yellowish-brown and strong-brown mottles.

The surface layer ranges from 18 to 24 inches in thickness. Its texture is generally silt loam or loam, but it ranges to silty clay loam or clay loam in places.

These soils have high available moisture capacity. They are moderately permeable but are wet because seep-

10 to 40 inches, brown to dark-brown, yellowish-brown, and dark yellowish-brown, friable sandy clay loam that contains some pebbles and has some sandy coatings below a depth of 15 inches.
40 to 44 inches, olive-gray and yellowish-brown, friable to firm loam that contains some pebbles and has some coatings of sandy material.

In areas that have not been cultivated or that are near small drainageways in side valleys, the surface layer is very dark gray to very dark grayish brown and is 2 to 4 inches thick. It is dark gray or dark grayish brown in areas that have been cultivated.

These soils have high available moisture capacity and moderate to moderately slow permeability. The surface terraces are constructed, stones and pebbles are exposed in the channel of the terrace. Adding manure to the channel improves the intake of water and makes the soil easier to work.

If this soil is stripcropped, corn or other row crops can be grown 2 years in 4. Where the soil is in poor tilth, a larger part of the rotation should consist of meadow. Generally, average yields of corn are obtained if management is good. Response to fertilizer is moderate to good. (Capability unit IIIe-1)

Colo Series

The soils of the Colo series are poorly drained and are flooded occasionally. They formed in silty alluvium. Their surface layer is dark colored, both when moist and when dry, and it does not contain stones or pebbles. The dark color extends to a depth of 3 feet or more. The slopes range from 0 to 2 percent.

The Colo soils are adjacent to Otter and Ossian soils on first bottoms, and they are also at the base of upland slopes that grade to bottom lands or low benches. The individual areas vary in size.

Because the areas of Colo soils are intermingled with areas of Otter or Ossian soils, the Colo soils are mapped

Where these soils have been drained by tile and protected from overflow, corn or other row crops can be grown intensively. Yields of corn are generally above average if management is good. Response to fertilizer is good. (Capability unit IIw-2)

Colo-Otter-Ossian complex (0 to 4 percent slopes) (Ct).—The soils of this complex have a surface layer of black or very dark gray silt loam or silty clay loam. The surface layer is high in content of organic matter, but it puddles easily if the soils are worked when wet. In a few places, a layer of light-colored sandy material, 6 to 12 inches thick, has been deposited on the surface.

These soils are on narrow bottom lands and in upland drainageways, downslope from Floyd and Clyde soils. On the bottom lands, they are also near areas of Turlin and Terril soils. Many of the areas are long and narrow.

Unless they have been tile drained, these soils are wet. The waterways need to be shaped and seeded in places so that tile outlets can be established. These soils dry out slowly in spring and puddle easily if they are worked when wet. Some areas need protection from overflow.

In many places these soils are cropped with the adjacent soils. Where the soils are tile drained, corn or other row crops can be grown intensively. Yields of corn are generally above average if management is good. Meadow

Dickinson sandy loam, 0 to 2 percent slopes (DcA).—This soil has a very dark brown surface layer. In most places dark to moderately dark colors extend to a depth of 20 inches. The underlying material is loamy sand in most areas.

This soil is on stream benches and in the uplands. In [illegible]

[illegible] adjacent to Hagener soils in some places, but most generally it is adjacent to medium-textured soils. In places this soil lies upslope from the Backbone soils and from the till subsoil variant of the Lamont series.

Included in mapped areas of this soil on a few of the stream benches are areas in which gravel and sand are below a depth of 36 inches. However, this Dickinson soil [illegible]

8 to 23 inches, dark-brown to brown, friable to firm clay loam that contains some pebbles.
23 to 52 inches, gray, very firm clay; some red and reddish-brown mottles.

In many of the cultivated areas, part of the subsurface layer is mixed with the material in the plow layer. In those areas the surface layer is very dark gray or very dark grayish brown when moist and is somewhat light colored when dry.

The Donnan soils have high moisture capacity. Not all of the moisture is available for plants, however, because of the clayey texture of the subsoil and underlying material. Permeability is moderately slow above the layer

The color of the surface layer ranges from dark grayish brown to brown, and the thickness of that layer ranges from 20 to 40 inches. Although stones or pebbles are generally absent in these soils, fragments of limestone are on the surface in some areas of the Dorchester-Chaseburg-Volney complex.

The available moisture capacity is high, and these soils are moderately permeable. Some surface sealing occurs during hard rains, however, and crusting occurs in places when the soils are dry.

In many places the Chaseburg soils need protection from overflow and from runoff from the soils upslope.

Dow Series

Well-drained, light-colored soils of the uplands make up the Dow series. These soils formed in loess. They have a distinctly mottled, gray subsoil, but the mottling is not related to the present drainage. The slopes range from 14 to 24 percent.

The Dow soils are on convex side slopes, mainly in small areas in and near section 25 of Washington Town-

The color of the surface layer varies, depending on the amount of erosion and the depth of plowing. In areas that are not eroded, the surface layer ranges from 4 to 8 inches in thickness and from very dark gray to very dark grayish brown in color. In those areas it is underlain by a light-colored subsurface layer. In many places part of this subsurface layer is mixed with the plow layer.

The available moisture capacity is high, and these plow layer is very dark gray or very dark grayish brown and is somewhat light colored when dry.

This soil is on narrow ridgetops and on convex side slopes. In places it grades to areas of Nasset soils downslope. In most places, however, it lies both above and below areas of other Downs soils.

Included in mapped areas of this soil are areas of soils that have a darker, thicker surface layer than typical. In a few places, these included soils lack a distinct, light-colored subsurface layer.

When the surface is bare, this Downs soil is susceptible to erosion. Therefore, tilling on the contour, stripcropping, or terracing is necessary where row crops are grown. If this soil is terraced or stripcropped, corn or other row crops can be grown 3 years in 5. Yields of corn are generally above average if management is good. Lime is needed to help establish a stand of legumes. Response to fertilizer is very good. (Capability unit IIIe–1)

Downs silt loam, 9 to 14 percent slopes (DoD).—In areas of this soil that are in permanent pasture or wooded, the surface layer is very dark brown or very dark gray and is 4 to 8 inches thick. In cultivated areas the surface layer is very dark grayish brown.

This soil is on convex side slopes below less sloping Downs soils. It lies upslope from soils of the Otter-Lawson-Ossian and Dorchester-Chaseburg-Volney complexes, which are in drainageways.

Included in mapped areas of this soil are a few areas of soils that have a darker, thicker surface layer than typical. These included soils lack a light-colored surface layer.

[redacted]

feasible, but a diversion terrace placed at the base of a slope occupied by this soil will protect the soils downslope. The drainageways should be shaped and seeded so that gullies will not develop. Small areas of this soil can be used as wildlife habitats.

Generally, yields of corn are average for the county if this soil is well managed, but lime is needed to establish a stand of legumes. Response to fertilizer is good to moderate. (Capability unit IVe–1)

Downs silt loam, 18 to 24 percent slopes, moderately eroded (DoF2).—The surface layer of this soil is very dark gray or very dark grayish brown in most places, but it varies in color and thickness. The areas that are in permanent pasture or trees and that are not eroded have a darker surface layer than typical. Where the cover of plants is sparse and where some erosion has taken place, the subsurface layer or the subsoil is exposed in many places. In those areas this soil is light colored when dry.

This Downs soil is on convex side slopes that are cut by gullies and by drainageways. Second-growth trees or shrubs grow in some of the drainageways. In some places less sloping Downs soils are upslope and soils of the Dorchester-Chaseburg-Volney complex are downslope. The individual areas of this Downs soil are small.

This soil is easily eroded when its surface layer is bare. It is suited to permanent pasture, trees, or wildlife habitats. In the pastured areas, however, grazing must be controlled so that the cover of plants will not be destroyed. Operating farm machinery is hazardous because of the steep slopes, drainageways, and gullies. Legumes

[redacted]

These soils are susceptible to erosion when the surface is bare. Therefore, it is necessary to till on the contour, terrace, or stripcrop if corn or other row crops are grown. If this soil is terraced or stripcropped, row crops can be grown 3 years in 5, and yields of corn are generally above average if management is good. Lime is needed to establish a stand of legumes. Response to fertilizer is very good. (Capability unit IIIe-1)

Downs and Tama silt loams, 5 to 9 percent slopes, moderately eroded (DtC2).—Most of this undifferentiated unit is cultivated, and in the cultivated areas the plow layer ranges from very dark brown to very dark grayish brown when moist. In some spots the plow layer is light colored when dry. The Downs soil is dominant in this unit. The Tama soil has a profile like the one described as typical for the Tama series.

The soils of this unit are on narrow, convex ridges and on the side slopes of ridges. Because of the small size of the areas of Tama soil and the pattern in which that soil occurs, the Tama soil was not mapped separately. However, the individual areas of Downs and Tama soils that make up this unit are large.

Further erosion takes place when these soils are bare or when the cover of plants is sparse. It can be satisfactorily controlled, however, by practicing contouring, terracing, or stripcropping when corn or other row crops are grown. Row crops can be grown 3 years in 5 where these soils are terraced or stripcropped.

If management is good, yields of corn are generally above average. Legumes respond well to applications of lime. Response to fertilizer is very good. (Capability unit IIIe-1)

Downs and Tama silt loams, 9 to 14 percent slopes, moderately eroded (DtD2).—In areas of these soils that are cultivated, the plow layer is very dark grayish brown. In some places near drainageways that cut into sidehills and on the lower parts of slopes, the surface layer is thicker and darker colored than typical. The surface layer in areas in permanent pasture or in wooded areas is very dark brown or very dark gray.

The Downs soil is predominant in this undifferentiated unit, and it has a light-colored subsurface layer. The Tama soil lacks a light-colored subsurface layer. Its profile is similar to the profile described for the Tama series.

These soils are on convex side slopes that are dissected by drainageways. Adjacent to them are other Downs and Tama soils. Many of the individual areas are small.

Most of the acreage is cultivated, but some of it is in permanent pasture or trees. In the cultivated areas, these soils are susceptible to further erosion when they are bare or when the plants growing on them are small. Tilling on the contour, terracing, or stripcropping is necessary if corn or other row crops are grown. Row crops can be grown 2 years in 6 if this soil is stripcropped. Yields of

ered material and hard limestone bedrock that is fractured in some places. The slopes range from 5 to 30 percent.

These Dubuque soils are on convex upland ridges and side slopes in the eastern part of the county. In many places they are downslope from Fayette, Palsgrove, and Nasset soils and upslope from Nordness soils and outcroppings of Steep rock land. Some areas of these soils are small, but the total acreage is large.

Representative profile:

0 to 6 inches, dark grayish-brown, friable silt loam.
6 to 25 inches, dark-brown to brown and yellowish-brown, friable silt loam and silty clay loam.
25 to 27 inches, dark reddish-brown and reddish-brown, firm clay or silty clay underlain by hard limestone bedrock at a depth of 27 inches.

Where these soils are not eroded or have not been cultivated, the color of their surface layer ranges from very dark gray to very dark grayish brown. The surface layer is dark grayish brown in cultivated areas. In areas that are not eroded, these soils contain a distinct, light-colored subsurface layer, but that layer is mixed into the surface layer in eroded areas.

The roots of some crops grown on these soils develop to only a limited extent because of the limestone bedrock near the surface. These soils are moderately permeable and have very low or low available moisture capacity. Lack of moisture is likely to damage crops if rains are not timely during the growing season.

The Dubuque soils are subject to erosion when they have only a sparse cover of plants. Any loss of soil material through erosion decreases the depth to limestone and definitely affects the use of these soils. The less sloping areas are suited to row crops, but the steeper areas are suitable only for pasture, trees, or wildlife habitats.

These soils are acid. Therefore, legumes grown on them respond to applications of lime. The soils are very low in available nitrogen, low in available phosphorus, and low to medium in available potassium.

Dubuque silt loam, 5 to 9 percent slopes, moderately eroded (DuC2).—The surface layer of this soil is dark grayish brown when moist and is much lighter colored when dry. It is very low in content of organic matter. Most of the acreage is cultivated, and both the surface layer and the former subsurface layer in the cultivated areas are now a part of the plow layer. Limestone bedrock is at a depth between 15 and 30 inches.

Included in mapped areas of this soil are severely eroded areas where the brown or yellowish-brown subsoil is exposed. Those areas are shown on the soil map by the symbol for severe erosion. Also included are many wooded areas where the soil is not eroded.

In cultivated areas this Dubuque soil is susceptible to

Dubuque silt loam, 9 to 14 percent slopes, moderately eroded (DuD2).—Many areas of this soil are cultivated or were formerly cultivated, but in much of the acreage, this soil is wooded and is not eroded. The surface layer in the cultivated areas is generally dark grayish brown when brown or yellowish brown. It is light colored and is very low in content of organic matter. The texture of the surface layer ranges to silty clay loam in places. The surface layer is in poor tilth. It often seals during rains, and a crust forms when the soil dries. Depth to limestone is gen-

In areas that have not been cultivated, the surface layer of these soils is very dark gray or very dark grayish brown and is only 1 to 4 inches thick. A distinct, light-colored subsurface layer underlies the surface layer in those areas. The color of the surface layer ranges from dark gray to dark grayish brown where these soils are cultivated but are not severely eroded.

Even though the surface layer is low in content of organic matter and is in poor tilth, these soils are easily tilled. A seedbed can be prepared without difficulty, except in the severely eroded areas. Permeability is moderate, and the available moisture capacity is high.

The sloping Fayette soils are subject to erosion when they are only sparsely covered by plants. The less sloping Fayette soils are suited to row crops, but the steeper areas should be used for permanent pasture, as woodland, or for wildlife habitats.

These soils are acid unless they have been limed. They are very low in available nitrogen, medium to high in available phosphorus, and medium to low in available potassium.

Fayette silt loam, 0 to 2 percent slopes (FaA).—Most areas of this soil are cultivated. The plow layer in the cultivated areas is dark gray or dark grayish brown when moist, but this layer is much lighter colored when dry. Part of the light-colored subsurface layer has been mixed with the plow layer.

This soil is on convex ridges that form watershed divides. Downs soils are adjacent to it in some places, and more sloping Fayette soils are adjacent to it downslope. The individual areas are small. Therefore, this soil is generally managed with the more sloping Fayette soils.

Included in mapped areas of this soil are areas of soils in small, slight depressions. The included soils have a slightly darker surface layer than typical and a subsoil that is slightly mottled.

Because this Fayette soil is nearly level and generally takes in water well, little or no runoff takes place. A slight crust may form, however, when the surface layer dries. Applying manure reduces the surface crusting and makes the structure more nearly granular.

Where management is good, this soil is suited to intensive use for corn or other row crops. Meadow can be included in the rotation if tilth becomes poor. Where nitrogen and some phosphate and potash have been applied, yields of corn are generally above average. Lime is also required, however, for good crop response. (Capability unit I–1)

Fayette silt loam, 2 to 5 percent slopes (FaB).—In cultivated areas this soil has a dark-gray or dark grayish-brown surface layer when moist, but that layer is much lighter colored when dry. The surface layer in the few areas that are in permanent pasture or trees, however, is very dark gray or very dark grayish brown and is 1 to 4 inches thick. A thin mulch of twigs and leaves covers the surface in some wooded areas.

This soil is on ridges adjacent to nearly level watershed divides. It lies upslope from steeper Fayette soils and is adjacent to areas of Orwood soils in places.

This Fayette soil is easily eroded when the surface layer is bare or has only a sparse cover of plants. Therefore, it ought to be tilled on the contour or terraced. Corn or other row crops can be grown intensively in areas that are terraced, and the terraces also protect the soils downslope.

If management is good, yields of corn are generally above average. Response to fertilizer is very good, but legumes need lime. (Capability unit IIe–1)

Fayette silt loam, 5 to 9 percent slopes, moderately eroded (FaC2).—This soil is cultivated in some places. The plow layer in the cultivated areas is dark gray or dark grayish brown when moist and is much lighter colored when dry. The plow layer consists not only of the surface layer but also of part of the subsurface layer. It is low in content of organic matter. The subsoil of brown or dark-brown silty clay loam is exposed in places. In the areas near drainageways in side valleys that dissect areas of this soil, the surface layer is darker and thicker than typical. Included in mapped areas of this soil is about 20,000 acres in which the soil is in pasture or trees and is not eroded. Also included are a few areas of gray variants of the Fayette series.

Further erosion is a hazard when the surface is bare or is only sparsely covered by plants. The drainageways should be shaped and reseeded to reduce the hazard of gullying. If row crops are grown, tillage should be on the contour or terracing or stripcropping is necessary. Corn or other row crops can be grown 3 years in 5 where the areas are terraced or stripcropped.

Yields of corn grown on this soil are generally above average if good management is used. Response to lime and fertilizer is very good. (Capability unit IIIe–1)

Fayette silt loam, 5 to 9 percent slopes, severely eroded (FaC3).—This soil has a surface layer of silt loam to silty clay loam. The surface layer is generally brown to dark brown when moist and is much lighter colored when dry. It is slightly darker and thicker, however, in areas of this soil near drainageways that cut into sidehills. The surface layer is very low in content of organic matter.

This soil is on convex side slopes, below less sloping Fayette soils, and it is surrounded by areas of less eroded Fayette soils in most places. The individual areas are too small to be managed separately. Included in mapped areas of this soil are a few areas of gray variants of the Fayette series.

Hard clods form if this severely eroded Fayette soil is worked when wet, but a seedbed is usually not difficult to prepare. The surface layer seals during rains, and a crust forms when the soil dries. Where the cover of plants is sparse, this soil will continue to erode. If corn or other row crops are grown, this soil can be tilled on the contour, or it can be terraced or stripcropped. Where the areas are terraced or stripcropped, row crops can be grown 2 years in 4. Adding manure and crop residue increases the intake of water. If poor tilth continues to be a problem, however, a large part of the cropping system ought to consist of meadow.

Yields of corn grown on this soil are above average if good management is used. Response to manure and comof this soil is generally dark grayish brown when moist and is much lighter colored when dry. It includes part of the subsurface layer and, in places, part of the subsoil. In some places near the base of slopes, however, or near drainageways that cut into sidehills, the surface layer is slightly darker.

This soil is on convex side slopes, below less sloping Fayette soils. Adjacent to it downslope in some places are

This soil is on convex side slopes, below less sloping Fayette soils. In some places it occupies an entire side slope and grades to soils of the Dorchester-Chaseburg-Volney complex downslope. In many places where this soil is on the upper part of the slope, it is above the Palsgrove and Dubuque soils or above areas of Steep rock land. The individual areas of this Fayette soil are generally large enough that they can be managed separately. In-is severely eroded and has a surface layer of brown or

Festina Series

adjacent bottom lands. Included in the mapped areas of this soil are areas of soils that have a darker, thicker surface layer than typical.

This Festina soil is subject to water erosion when the surface is bare. If corn or other row crops are grown, tillage ought to be on the contour or the areas should be terraced. Where this soil is terraced, row crops can be grown intensively. However, terraces are difficult to lay out in some places because of the shape of the slopes. Yields of corn grown on this soil are generally above average if management is good, but lime is needed. Response to fertilizer is very good. (Capability unit IIe-1)

Floyd Series

In the Floyd series are somewhat poorly drained soils

Floyd loam, 0 to 5 percent slopes (FIB).—This soil has a black to very dark gray surface layer. The surface layer is generally 12 to 18 inches thick, but the dark color extends to a depth of 24 inches in places. Stones or boulders are common on the surface in areas that have not been cultivated.

This soil is in concave areas below Kenyon and Bassett soils. In many places it is adjacent to Clyde soils in drainageways.

Included in mapped areas of this soil are a few patches in which the surface layer is silty, and those areas lack stones or pebbles. Also included are areas in which firm glacial till is at a depth of 30 to 40 inches.

Because of the seepage water that drains from the soils upslope, and because of the high but variable water table, this Floyd soil is wet. It dries somewhat slowly and

26 to 68 inches, mottled light-gray, strong-brown, dark-brown, and yellowish-brown, friable or friable to firm clay loam that contains some pebbles.

The surface layer ranges from black to very dark gray in color and from 4 to 8 inches in thickness. In places part of the light-colored subsurface layer is mixed with the plow layer. These soils are somewhat lighter colored when dry than when moist.

The available moisture capacity is high or very high. Permeability is moderate or moderately slow.

Runoff erodes these soils when the surface is bare or is only sparsely covered by plants. Because these soils are adjacent to upland drainageways, they receive some seepage water from the soils upslope. The water table is moderately high, but its height is variable.

Many areas of these soils are managed with the adjacent soils. The soils are suited to row crops, but they are acid and crops grown on them need lime. They are low in available nitrogen and phosphorus and medium in available potassium.

Franklin silt loam, gray subsoil variant, 2 to 5 percent slopes (FnB).—The profile of this soil is like the one just described. Most of the areas have been cultivated and have a surface layer that is very dark gray. Below the plow layer is a distinct, light-colored subsurface layer.

This soil is in and adjacent to drainageways in the

The Frankville soils are on convex ridges and on side slopes. They are mainly in the western part of the county, near the valleys of rivers and their tributaries. These soils are below Downs and Nasset soils and above Nordness soils and Steep rock land. The individual areas vary in

4 where this soil is terraced or stripcropped. Most areas of this soil are not suitable for terraces, however, because of the limestone near the surface.

If management is good, yields of corn are generally average, but lime is needed for legumes. Response to

Hagener Series

In the Hagener series are excessively drained, dark-colored soils of the uplands. These soils formed in loamy sand and sand. Their slopes range from 0 to 14 percent.

The Hagener soils are on benches, ridges, and side slopes in the western part of the county. In most places they occur as small islands, adjacent to such medium-textured soils as the Ostrander and Kenyon. Most of the individual areas are small.

Representative profile:

0 to 18 inches, very dark brown and very dark grayish-brown, loose loamy sand.
18 to 25 inches, very dark grayish-brown and brown to dark-brown, loose sand.
25 to 60 inches, yellowish-brown and yellow, loose sand.

The surface layer ranges from 6 to 18 inches in thick-

This soil is mainly on convex ridges and on side slopes, but in a few places it is on slopes that border stream benches. In many places it occurs as a small island of sandy material, adjacent to medium-textured soils. Most of the individual areas are small, and many of them are managed with the adjoining soils. Included in the mapped areas of this soil are a few spots in which the texture of the surface layer is sandy loam.

Wind and runoff erode this soil where the cover of plants is sparse. Tillage should be on the contour when a row crop is grown, and crop residue ought to be left on the surface to give protection from wind erosion. This soil is not suitable for terraces; the sand in the subsoil is infertile, and the sandy material in the back slopes has poor stability.

If this soil is farmed on the contour, corn or other row crops can be grown 2 years in 4. The amount of moisture subsurface layer. The slopes range from 0 to 4 percent.

Hayfield loam, moderately deep, 0 to 4 percent slopes

of organic matter, has granular structure, and is in good tilth.

This soil is at the mouths of upland drainageways that fan out onto bottom lands and stream benches. Adjacent to it are Lawson, Kennebec, and Otter soils.

In some places runoff from the soils upslope has deposited about 6 inches of light-colored, silty material on the surface of this soil. Diversion terraces placed upslope can be used to control runoff and to prevent further silting. Protection from overflow is also needed.

Corn or other row crops can be grown intensively on this soil, and yields of corn are generally above average if good

above the underlying shale and slow or very slow in the shale.

During wet seasons, seepage causes a temporary perched water table that makes these soils wet. These soils dry out slowly, and the surface layer puddles if it is worked when wet. Tile drainage is needed, but the tile drains must be placed correctly and the backfilling done properly for them to work well. The soils should be checked in the field to determine the correct spacing and depth needed for the tile. The sloping areas are subject to water erosion when their surface is only sparsely covered by plants.

the seepage in the sandy material above the clay shale. The surface layer puddles easily if it is worked when wet.

Corn or other row crops can be grown 3 years in 5 if this soil is tile drained and tilled on the contour. Correct placement of the tile drains is important, however, because of the clay shale in the subsoil and substratum. The tile drains must not be placed too deep in the shale. The back-

This Jacwin soil is susceptible to water erosion when it is only sparsely covered by plants. Seepage from the soils upslope make it wet.

This soil is suited both to hay and pasture. It is mainly in permanent pasture, however, because the individual areas are small and because the adjoining soils are better suited to that use. If the areas are large enough, they series. Its surface layer is black and is 12 to 16 inches thick. In places the soil material is moderately dark colored to a depth of 24 inches. Loamy sand and sand are at a depth of 24 to 36 inches.

This soil is on stream benches and in upland drainageways. It is adjacent to Kato loam, deep, 0 to 4 percent slopes, and to Waukegan soils. The individual areas are

of variations in the depth and thickness of the layer of sand and of the underlying shale.

Corn and other row crops can be grown intensively on this soil. Tile drains are needed, however, to help to improve yields and to allow farming to be more timely. Yields of corn are generally above average if good management is used. Response to fertilizer is good. (Capatable is below a depth of 4 feet, but its height is variable. The Kennebec soils are flooded during periods when a large amount of rainfall is received.

These soils are suited to intensive use for row crops.

the intake of water. This soil dries out more slowly than the adjacent Ostrander soils, but wetness is normally a seasonal problem.

Yields of corn are generally above average if good mantured soils, such as the Coggon and Renova. The individual areas are generally less than 12 acres in size. Therefore, this soil is often managed with the adjoining soils.

This soil is subject to erosion by wind or water when it is only sparsely covered by plants. Therefore, crop residue ought to be left on the surface. Where row crops are grown, tillage ought to be on the contour or this soil should

Included in the mapped areas of this soil are a few small eroded areas in which the surface layer consists of dark-brown to brown loam. Also included are a few patches in which the texture is loamy sand, sand, or silt loam at a depth of 20 to 40 inches.

The intake of water is good, but this soil is susceptible to water erosion when the surface is bare. Crop residue ought moist and light colored when dry, but it is darker colored and thicker in a few small areas. The surface layer ranges from 4 to 8 inches in thickness. It is low in content of organic matter.

This soil is on narrow ridges and on convex side slopes,

of light-colored material has been deposited on the surface. Also, in a few areas of these soils, the surface layer is dark grayish brown and the subsoil is grayer than typical.

The soils of this unit are on bottom lands and low benches. Where they are near a drainageway or near the ville, Dickinson, and Backbone soils in some places. Profiles of these soils can be found under their respective series.

Permeability is moderate, and the available moisture capacity is high. Where this land type receives runoff from soils upslope, soil material is usually deposited on

Loamy Terrace Escarpments

Loamy terrace escarpments, 16 to 30 percent slopes (LoF) consists of well-drained loamy material that is extremely variable in color. The texture is generally loam to a depth of 20 inches or more, but thin layers of coarser

These soils have very low available moisture capacity and are moderately permeable. Subsoil moisture is often lost through leaching. The root zone is generally thin, but it varies in thickness. Roots can extend into the soil material, however, between the fragments of limestone.

The Marlean soils are subject to erosion, but the fragments of shaly limestone on the surface protect them to some extent. Because these soils are shallow over limestone and are subject to erosion, they are more suitable for pastures, trees, and wildlife habitats than for row crops. The less sloping areas can be used for row crops, however, if these soils are properly managed.

These soils are low in nitrogen and are very low in phosphorus and potassium. Lime is not needed.

Marlean loam, 2 to 5 percent slopes (MaB).—This soil has a black to very dark brown surface layer that is 8 to 12 inches thick. It has fragments of limestone on the surface. Fragmented limestone is at a depth ranging from 5 to 15 inches, but it is between 10 and 15 inches in most places.

This soil is on ridges above areas of more sloping Marlean soils. On the wider ridges, it is nearly level in places. Included in mapped areas of this soil are a few spots in which the surface layer is very dark grayish brown and is only 3 to 6 inches thick.

The intake of water is generally good, but some runoff takes place because of the gentle slopes. The amount of

izer, especially to applications of phosphate. (Capability unit IVs-3)

Marlean loam, 5 to 9 percent slopes, moderately eroded (MaC2).—The surface layer of this soil varies in color and thickness, but it is very dark grayish brown and is 3 to 6 inches thick in most places. In a few severely eroded areas, however, the surface layer is dark brown. Fragments of limestone are on the surface, and limestone bedrock is generally at a depth of only 5 to 10 inches.

This Marlean soil is on side slopes adjacent to other Marlean soils. In places it is upslope from Steep rock land. Many of the areas are small and are managed with the adjoining soils.

When the surface is bare, this soil is subject to further water erosion. The large number of coarse fragments on the surface, however, tend to curtail erosion to some extent. Rain quickly saturates the thin layer of soil material, and then runoff takes place. This soil does not store enough water for crops to grow well.

Much of the acreage is cultivated, but this soil should be used for hay and pasture instead of for corn or other row crops. A row crop can be grown as often as 1 year in 6, however, if stripcropping is practiced. The pastures are usually not renovated until the stand becomes poor. Many areas of this soil are idle. The small areas can be used for wildlife habitats.

If corn is grown on this soil, yields are generally very

In many places this soil is only sparsely covered by plants, and as a result, it continues to erode. The coarse fragments of limestone, however, curtail erosion to some extent.

This soil is often left idle while the adjoining soils are used for crops. It is suitable for permanent pasture, trees, or wildlife habitats. The carrying capacity of the pas-

the surface layer is light colored when dry. The slopes range from 5 to 18 percent.

The Nasset soils are on side slopes, generally downslope from Downs soils and upslope from Frankville soils. The individual areas are small.

Representative profile:

dark grayish-brown surface layer that is generally low in content of organic matter. The subsurface layer is lighter colored than the surface layer and is a part of the surface layer in places. Neither the surface layer nor the subsoil contains stones or pebbles. The underlying limestone is at a depth ranging from 30 to 50 inches, but it is at a depth of less than 40 inches in many places.

This soil is on convex side slopes, below Downs and other Nasset soils. In many places it is upslope from Frankville soils or Steep rock land. The individual areas are small, and most of the acreage is managed with the adjacent soils.

Included in mapped areas of this soil are a few tracts in which the surface layer is dark colored and is 8 to 16

rock or a thin layer of silty clay loam or silty clay and bedrock. Stones or pebbles are not common on the surface, but pieces of limestone are typical. The slopes range from 5 to 24 percent.

The Nordness soils are on narrow ridges and side slopes. In many places they are below Dubuque and Palsgrove soils and above Steep rock land and other Nordness soils.

Representative profile:

0 to 2 inches, very dark gray and dark grayish-brown, friable silt loam.
2 to 5 inches, dark grayish-brown friable silt loam .
5 to 9 inches, dark-brown to brown, friable silt loam.
9 to 12 inches, dark-brown, friable silty clay loam; underlain by limestone bedrock and some soil material

soil ranges from very dark gray to brown in color, but it is much lighter colored when dry. In wooded areas the surface layer is very dark gray and is 2 to 3 inches thick. Beneath the surface layer in wooded areas is a distinct, light-colored subsurface layer. The surface layer is dark grayish brown to brown in eroded areas that are pastured. A few fragments of limestone are on the surface in places. Limestone is at a depth that is generally between 5 and 15 inches, but it is at a depth of less than 10 inches in a large part of the acreage. Limestone crops out on the surface in a few small areas that are less than one-fourth of an acre in size.

This Nordness soil is on side slopes and escarpments below Frankville and less sloping Nordness soils. In many places it is upslope from areas of Steep rock land.

Runoff is rapid on this soil, and it causes erosion when the surface is bare. The growth of plants is limited because of the low available moisture capacity. Therefore, grazing ought to be controlled in the pastured areas, especially in midsummer.

This soil can be used for permanent pasture, trees, or wildlife habitats, but it is better used for trees or wildlife habitats than for pasture. The wooded areas need proper management.

erally needed if use of the soils for crops is to be profitable. These soils are easily tilled.

The Oran soils are suited to row crops. The sloping areas are subject to erosion, however, when the surface is bare or is only sparsely covered by plants.

These soils are acid; crops grown on them respond to applications of lime. The soils are low in available nitrogen, phosphorus, and potassium.

Oran loam, 0 to 2 percent slopes (OrA).—This soil has a black or very dark gray surface layer that is 6 to 8 inches thick. The surface layer is low to medium in content of organic matter and is somewhat light colored when dry. Stones and pebbles are absent from the surface but are in the subsoil.

This soil is in moderately wide areas near drainageways. In some places it is adjacent to sloping Oran, Racine, or Bassett soils. Some of the individual areas are large enough to be managed separately.

A moderately high water table makes this soil wet, and no runoff takes place. If tile drainage is provided, farming can be more timely. Tile drainage is generally needed if crops are to be grown profitably.

This soil is suited to intensive use for corn and other row crops, and yields of corn are generally above average if

The Orwood soils are on convex ridges and on side slopes in areas that border the Upper Iowa River and its tributaries. In many places they are adjacent to Fayette, Downs, and Lamont soils. Many of the areas are large enough to be managed separately.

Representative profile:

0 to 8 inches, very dark grayish-brown, friable silt loam to loam.

8 to 50 inches, dark-brown and dark yellowish-brown, friable

now a part of the plow layer in many places. Near drainageways that cut into sidehills, the surface layer is slightly darker and thicker than in other places. Many areas of this soil that are in pasture or wooded are not eroded.

This soil is on convex side slopes, in most places above or below other Orwood soils. Downslope from it in some places are Downs and Fayette soils.

Included in mapped areas of this soil are a few severely

Orwood silt loam, 14 to 18 percent slopes, moderately eroded (OsE2).—This soil has a surface layer that is very dark brown to very dark grayish brown when moist, but the surface layer is somewhat light colored when dry. In many places near drainageways in side valleys and at the base of slopes, the surface layer is darker and thicker than in other areas. The surface layer ranges from silt loam to loam in texture and is low in content of organic matter.

This soil is on convex side slopes below other Orwood [illegible]

boundary is abrupt between the surface layer and the subsoil.

This soil is on convex side slopes below less sloping Orwood soils. In some places it is upslope from Dubuque and Nordness soils or from Steep rock land. Many of the individual areas are small. Included in the mapped areas of this soil are patches in which the subsoil is exposed at the surface. These severely eroded spots are indicated on the soil map by the symbol for severe erosion.

[illegible]

Many of the individual areas are small and are managed with the adjoining soils.

This soil is very wet. Tile drains should be placed where they will intercept seepage water and lower the water table. In some places, however, outlets for these drains are difficult to establish.

Where this soil has been tile drained, it is suited to intensive use for corn or other row crops. Yields of corn are above average if management is good, and small grains also yield well. Response to fertilizer is good. (Capability unit IIw–2)

Ostrander Series

Well-drained soils that have a distinct, dark-colored surface layer and that are in the uplands are in the Ostrander series. These soils formed in loamy glacial sediment over friable, glacial till. A thin band of stones and pebbles separates the sediment from the underlying till. Stones and pebbles are common in the subsoil. The slopes range from 0 to 9 percent.

These soils are on convex ridges and side slopes in the western part of the county. In some places they are adjacent to Kenyon and Racine soils, and upslope from Floyd, Clyde, and Atkinson soils. Many of the areas are small and are farmed with the adjoining soils.

Representative profile:

Corn or other row crops can be grown intensively on this soil. Because of the small size of the areas, however, row crops should be grown less frequently than on the adjoining soils. Lime is needed for crops to make good growth, but yields of corn are above average if management is good. Response to fertilizer is very good. (Capability unit I–1)

Ostrander loam, 2 to 5 percent slopes (OuB).—The surface layer of this soil is very dark brown and is 8 to 15 inches thick. The texture is generally loam, but in a few places it is silt loam. The surface layer is high in content of organic matter, is in good tilth, and in most places is free of stones. A few stones and pebbles are in the subsoil.

This soil is on convex ridges and on a few side slopes upslope from Kenyon, Floyd, Clyde, and Atkinson soils. In places it is adjacent to areas of Racine and Bassett soils.

Some water runs off this soil. Therefore, erosion is a hazard when the surface is bare. Tillage should be on the contour or this soil ought to be terraced if a row crop is grown. Where terraces are constructed, small stones and pebbles are exposed in the channel of the terrace in many places. Applying manure and commercial fertilizer in the channel not only increases the supply of plant nutrients but also increases the intake of water.

Where this soil is terraced, it is suited to intensive use for corn or other row crops. Yields of corn are generally bottom lands and in upland drainageways, they also occur with Lawson and Ossian soils and are mapped with those soils.

Representative profile:

0 to 37 inches, black, friable silt loam.
37 to 58 inches, dark-gray and olive-gray to light olive-gray, friable silt loam mottled with yellowish brown.

The Otter soils have high available moisture capacity and moderate permeability. The water table is high, but the height is variable.

These soils are suited to extensive use for row crops,

colored sediments has been deposited on the surface in some places.

These soils have a seasonal high water table. Tile drainage is needed if crops are to grow satisfactorily. Where drainage is provided, corn or other row crops can be grown intensively and yields of corn are above average if management is good. Lime is not needed in most places, but response to fertilizer is good. (Capability unit IIw-2)

Otter and Ossian silt loams, overwashed (0 to 3 percent slopes) (Ox).—Soils that are poorly drained and that

Representative profile:

0 to 6 inches, dark grayish-brown, friable silt loam.
6 to 40 inches, brown to dark-brown, yellowish-brown, and dark yellowish-brown, friable silty clay loam and silt loam.
40 to 42 inches, dark-brown to brown, firm gritty silty clay; contains some yellowish-brown and grayish-brown mottles; underlain by fractured hard limestone.

In areas where these soils have not been cultivated and are not eroded, the surface layer ranges from very dark gray to very dark grayish brown in color and from 2 to 4

Palsgrove silt loam, 9 to 14 percent slopes, moderately eroded (PaD2).—Most areas of this soil are cultivated, and the surface layer in most of the cultivated areas is dark gray or dark grayish brown when moist and is much lighter colored when dry. In most places near drainageways that cut into sidehills, however, the surface layer is generally darker and thicker than in other areas. The surface layer is low in content of organic matter, and the subsurface layer in most areas is now a part of the

This soil is suited to pasture, but it can be used for corn or other row crops 1 year in 6 if it is terraced or stripcropped. Because of the location and small size of the areas, however, this soil is usually farmed with less eroded Palsgrove soils.

Yields of corn are below average on this soil, even if management is good. When pastures are seeded, manure, lime, and commercial fertilizer ought to be applied to help establish the stand. (Capability unit IVe-2)

Palsgrove silt loam, 14 to 18 percent slopes, mod-

manure, and commercial fertilizer help to establish the stand. (Capability unit VIe-1)

Palsgrove silt loam, 18 to 24 percent slopes, moderately eroded (PaF2).—The surface layer of this soil is generally dark gray or dark grayish brown when moist and is 3 to 6 inches thick. It is slightly darker and thicker, however, near drainageways that cut into sidehills. This layer is much lighter colored when dry. The subsurface layer is absent in many places, and in some areas it is a part of the surface layer. Limestone bedrock or material

Peaty muck (0 to 12 percent slopes) (Pk).—This soil has a black surface layer consisting of organic material that is 10 to 48 inches thick. The surface layer has a soft, spongy feel. In the areas that have not been drained, the hoofs of animals cut the surface and this soil will not support the weight of farm equipment.

This soil is in slight depressions or in slightly elevated areas on bottom lands and in broad drainageways. In most places it occurs within larger areas of Floyd, Clyde, Ossian, or Otter soils or it is adjacent to those soils.

Peaty muck is very wet because it receives seepage water from the surrounding soils and has a high water table. The excess water should be controlled by installing tile or surface drainage. Each area ought to be checked carefully, however, before tile drains are installed. Outlets are difficult to obtain in some places.

Where this soil is drained, corn and other row crops can be grown intensively, but many crops do not mature properly. The corn that is grown is often used for silage. Only average yields are obtained from corn that is grown for grain, and the grain often needs to be dried before it is stored. Applications of phosphate and potassium are needed. (Capability unit IIIw–3)

Peaty muck, overwashed (0 to 12 percent slopes) (Pw).—This soil consists of dark-colored peaty muck over which 6 to 20 inches of light-colored silty material has generally been deposited. The thickness of the silty material varies considerably within short distances. Some areas have received as much as 40 inches.

This soil is on bottom lands and in broad drainageways in the uplands, mainly in the eastern part of the county. Adjacent to it in many places are Dorchester, Ossian, and Otter soils and complexes of those soils. The individual areas are small and are managed with the adjoining soils.

This soil is wet, but the areas that have only a thin deposit of silty material on the surface need drainage more than the areas where the deposit is thick. Tile drains are difficult to install and to maintain. The organic material is unstable, and the tile drains ought to be placed in the underlying soil material. Corn or other row crops can be grown intensively if this soil is drained. Average yields of corn are generally obtained if management is good.

Lime is not needed on this soil. Good response is received, however, if fertilizer is applied. (Capability unit IIw–3)

Racine Series

In the Racine series are well-drained soils of the uplands. These soils have a moderately dark colored surface layer and a light-colored subsurface layer. They formed in a thin layer of loamy material over friable glacial till. Some pebbles are in the subsoil, and a few are on the surface. The slopes range from 0 to 14 percent.

These soils are on ridges and side slopes in the western part of the county, adjacent to Bassett, Coggon, Renova, and Oran soils in many places. They are upslope from areas of Waucoma, Winneshiek, or Floyd soils in some places.

Representative profile:

0 to 8 inches, very dark gray, friable loam.
8 to 12 inches, dark grayish-brown, friable loam.
12 to 34 inches, dark-brown to brown and yellowish-brown, friable loam that contains some stones and pebbles; few coatings of silt.
34 to 44 inches, yellowish-brown and some grayish-brown, friable sandy clay loam that contains some stones and pebbles.

The surface layer ranges from black to very dark gray in color and from 4 to 8 inches in thickness. The subsurface layer ranges from 2 to 6 inches in thickness.

These soils have high available moisture capacity and are moderately permeable. The sloping areas erode, however, when the surface layer is bare or is only sparsely covered by plants. Crop residue can be left on the surface and manure can be added to increase the intake of water.

These soils are suited to row crops, but the steep Racine soils are better suited to hay or pasture. The soils are acid. Therefore, lime is needed for the good growth of crops. These soils are low in available nitrogen, phosphorus, and potassium.

Racine loam, 0 to 2 percent slopes (RaA).—This soil has a surface layer that ranges from 4 to 8 inches in thickness. The surface layer is black to very dark gray when moist, but it is somewhat lighter colored when dry. The content of organic matter is moderately low. In most places the surface layer is free of stones, but stones and pebbles are in the subsoil.

This soil is on moderately wide convex ridges within larger areas of more sloping Racine soils. The individual areas are small. Therefore, this soil is managed with the adjoining soils.

Little or no runoff takes place, but water does not pond on the surface. Crop residue can be left on the surface to maintain a good intake of water.

This soil is suited to intensive use for corn and other row crops. If tilth becomes poor, a meadow crop can be included in the rotation. Yields of corn are generally above average if management is good. Applying lime, manure, and commercial fertilizer helps the growth of crops. Response to fertilizer is very good. (Capability unit I–1)

Racine loam, 2 to 5 percent slopes (RaB).—This soil has a surface layer that is very dark gray when moist but that is somewhat lighter colored when dry. The surface layer is 4 to 8 inches thick. Beneath it is a distinct, light-colored subsurface layer. No stones are on the surface, but some stones and pebbles are in the subsoil. In some wooded areas, this soil has a thin cover of twigs and leaves on the surface.

This soil is on convex ridges, above Oran and other Racine soils. It is upslope from Floyd soils and is adjacent to Ostrander or Renova soils in places.

Generally, the intake of water is good. However, crop residue can be kept on the surface and manure can be applied to maintain a good intake of water. Runoff erodes this soil when the surface is bare. Therefore, tillage should be on the contour or this soil ought to be terraced if row crops are grown. Where this soil is terraced, corn or other row crops can be grown intensively. If tilth is poor, meadow can be included in the rotation. Yields of corn are generally above average if management is good, but lime is needed for above-average yields of crops. Response to fertilizer is good. (Capability unit IIe–1)

Racine loam, 5 to 9 percent slopes (RaC).—Some areas of this soil are wooded or in permanent pasture. In those areas the surface layer is very dark gray when moist, is 4

erosion. In places some stones or pebbles are on the surface plants. Therefore, crop residue ought to be left on the surface in cultivated areas. If the less sloping Renova

for severe erosion. Some stones or pebbles are in the subsoil and on the surface.

pebbles are on the surface and in the subsoil in many places.

This soil is on convex knobs that occur on slopes, generally between drainageways that cut into sidehills. As a rule, it occurs within larger areas of less eroded Renova and Coggon soils.

The surface layer is in poor tilth. It seals during rains.

to be kept in permanent pasture, because it is highly susceptible to further erosion when the surface is bare. Also, it can be used as woodland or as habitats for wildlife. Small areas that are surrounded by soils more suitable for crops are especially suitable for use as habitats for wildlife.

Grazing ought to be controlled to prevent losing a seed-spots in which the loamy material is as much as 30 to 40 inches thick over firm glacial till.

Permeability is moderately slow in the subsoil. The water table is moderately high during part of the year, but its height varies. Some tile drainage makes farming more timely.

Runoff erodes this soil. Therefore, when row crops are grown, tillage should be on the contour or this soil ought to be terraced or stripcropped. Corn or other row crops can be grown intensively where this soil is terraced or stripcropped. The cuts and fills necessary for constructing terraces expose the firm subsoil. Therefore, manure

a depth between 20 and 30 inches, but it is at a depth between 30 and 40 inches in a few areas.

This soil is on convex ridges and structural benches, adjacent to Atkinson and Winneshiek soils. Above or below it are Marlean, Jacwin, and other Rockton soils. Some of the areas are large enough to be managed separately.

This soil takes in water well. Because of the limestone near the surface, however, only a limited amount of water can be stored for the use of crops.

This soil is suited to intensive use for corn and other row crops. Yields of corn are variable, but they are generally above average if good management is used. Response to

Rockton loam, 9 to 14 percent slopes (RkD).—This soil is largely in permanent pasture, and the surface layer in

Rowley silt loam, 0 to 4 percent slopes (RoA).—This soil has a black surface layer that is 8 to 15 inches thick,

This soil is on the escarpments of benches and on side

on the surface and manure can be added to increase the

The color of the surface layer ranges from black to very dark brown. In some places the surface layer is 40 or more inches thick.

These soils are moderately permeable. They are high or very high in available moisture capacity and take in water well, but they are occasionally flooded. If flooding occurs, it usually takes place early in spring before crops are planted.

These soils are suited to row crops. They are slightly acid in many places, however, and lime is needed in some places for the optimum growth of crops. These soils are medium in available nitrogen and potassium and low in available phosphorus.

Spillville loam (0 to 1 percent slopes) (Sp).—This is the only Spillville soil mapped in the county. It has no stones or pebbles on the surface and has a thick, black surface layer that is high in content of organic matter. In some places this soil contains thin layers of sandy material at a depth of 30 inches or below. A large stream that cannot be crossed with farm machinery dissects the areas in a few places.

This soil is on bottom lands, adjacent to Turlin and Otter soils. In a few places, it is adjacent to areas of Terril soils.

No runoff takes place on this soil. The intake of water is good; therefore, water does not pond on the surface. This soil is generally not wet, but it is flooded occasionally in some years.

Corn or other row crops can be grown intensively if this soil is protected from occasional flooding. If management is good, yields of corn are above average. Response to fertilizer is good. (Capability unit I–2)

Steep Rock Land

Steep rock land (3 to 40 percent slopes) (Sr) consists of the Hagener, Chelsea, Lamont, and Dickinson soils are described under their respective series.

Steep sandy land has very low available moisture capacity and is rapidly permeable. Where the surface is bare, this land is subject to erosion caused by runoff or wind. It is droughty and supports only a limited

The surface layer ranges from very dark brown to black in color. Its thickness ranges from 20 to 40 inches.

The Terril soils have high available moisture capacity and are moderately permeable. They are not wet, but infrequently they receive runoff from the soils upslope.

ment is good. Response to fertilizer is very good. (Capability unit IIe–2)

Turlin Series

In the Turlin series are somewhat poorly drained soils formed in loamy alluvium. These soils have no stones or pebbles on the surface, and they have a thick surface layer that is dark colored. The slopes range from 0 to 5 percent.

These soils are near the place where the bottom lands are adjacent to upland slopes. They also are on low benches that consist of the first bottoms of side streams. In adjoining areas are Colo, Otter, Kato, Terril, and Spillville soils.

Representative profile:

0 to 34 inches, very dark brown and black, friable gritty silt loam and loam.

34 to 41 inches, very dark grayish-brown, friable loam; common, dark yellowish-brown and dark-brown to brown mottles.

41 to 52 inches, very dark grayish-brown and dark grayish-brown, friable loam; common, strong-brown and dark yellowish-brown mottles.

The surface layer ranges from black or very dark gray to very dark brown in color, from silt loam to loam in texture, and from 20 to 36 inches in thickness. In many places the moderately dark color extends to a depth of about 40 inches.

The available moisture capacity is high or very high, and permeability is moderate. These soils generally take in water well. They are slightly wet, however, because of a moderately high but variable water table and occasional flooding. Wetness usually does not limit the growth of crops, but tile drainage allows farming to be more timely. In years when rainfall is above average, wetness reduces yields in fields that have not been tile drained.

These soils are suited to row crops. They are neutral or slightly acid, and lime is generally not needed for crops to make good growth. These soils are medium in available nitrogen and potassium and low in available phosphorus.

Turlin gritty silt loam, 0 to 2 percent slopes (TgA).—This soil has a black to very dark brown surface layer of silt loam to loam. The surface layer is 24 to 36 inches thick. It is high in content of organic matter and is generally in good tilth.

This soil is on bottom lands, adjacent to Colo, Otter, Terril, Spillville, and more sloping Turlin soils. Included in mapped areas of this soil are areas on low benches that have a moderately dark colored deposit of soil material on their surface.

No runoff takes place on this Turlin soil. The intake of water is generally good. Therefore, water does not pond on the surface. The water table is moderately high, but its height is variable. Flooding occurs at times during periods when there is a large amount of rainfall and when this soil receives runoff. During the growing season, however, the water table is low enough that the growth of crops is not affected. Some tile drainage allows farming to be more timely. In years when rainfall is above normal, wetness reduces yields in areas that are not tile drained.

Corn or other row crops can be grown intensively on this soil, and yields of corn are above average if management is good. Good response is received from applications of fertilizer. (Capability unit I–2)

Turlin gritty silt loam, 2 to 5 percent slopes (TgB).—This soil has a black to very dark gray surface layer that is 20 to 36 inches thick. The surface layer ranges from silt loam to loam in texture. It is high in content of organic matter and is in good tilth.

This soil is on bottom lands at the foot of upland slopes. Adjacent to it are Terril, Spillville, Colo, Otter, and Dorchester soils.

Occasional flooding and a water table that is moderately high make this soil slightly wet. In most years, however, wetness does not affect yields of crops. Some tile drainage allows farming to be more timely. It reduces wetness caused by seasonal seepage.

Runoff occurs on this soil to some extent. Where the surface is bare or is only sparsely covered by plants, some erosion takes place. Therefore, tillage should be on the contour if row crops are grown. Row crops can be grown 3 years in 4 if tillage is on the contour. Where tilth is poor, 1 year of meadow can be substituted in the rotation for a catch crop and oats.

Yields of corn are above average on this soil if management is good. Lime is generally not needed for crops to grow well. Response to fertilizer is good. (Capability unit IIe–2)

Volney Series

The Volney series consists of soils that are well drained and that have a dark-colored, silty surface layer high in content of lime. These soils formed in medium-textured material. They have many fragments of limestone on their surface, and they contain many fragments of limestone. The proportion of fragments increases with increasing depth. The material is predominantly limestone at a depth of 24 to 36 inches. The slopes range from 0 to 5 percent.

These soils are on alluvial fans and on bottom lands, mainly in the eastern part of the county. They are downslope from Fayette and Nordness soils and Steep rock land. They are above or adjacent to Dorchester soils and to soils of the Dorchester-Chaseburg-Volney complex.

Representative profile:

0 to 30 inches, very dark gray, friable silt loam; contains many fragments of limestone.

30 to 50 inches, fragments of limestone and some silt loam.

In the typical Volney soils, the color of the surface layer ranges from very dark gray to very dark brown. In the overwashed phases, however, the color of the surface layer ranges from dark grayish brown to brown.

The Volney soils have medium available moisture capacity and are moderately permeable. In places they lose some subsoil moisture through deep percolation. The numerous fragments of limestone on the surface make preparation of a seedbed difficult in places, and they may damage farm machinery.

The sloping Volney soils are subject to erosion and also receive sediments and fragments of limestone from the soils upslope. Gullies form in the areas where water concentrates. Diversion terraces can be placed in areas

The surface layer ranges from 5 to 9 inches in thickness.

These soils have medium available moisture capacity, and the loamy material is moderately permeable. In places bedrock limits the root growth of some plants.

Runoff erodes the sloping Waucoma soils if the surface is bare or is only sparsely covered by plants. Crop residue can be left on the surface to increase the intake of water and to reduce runoff.

These soils are medium acid in most places, and lime is needed for the optimum growth of crops. The soils are low in available nitrogen, phosphorus, and potassium.

cultivated crops. The surface layer in the areas that are not cultivated is very dark gray to very dark brown loam or silt loam, and it is 5 to 8 inches thick. In the cultivated areas, the surface layer is 3 to 6 inches thick and is very dark grayish brown. Most of the subsurface layer has been mixed into the surface layer in many of the cultivated areas. Limestone is at a depth ranging from 30 to 50 inches. It is between 30 and 40 inches in much of the acreage. The subsoil contains some stones or pebbles.

This soil is on convex side slopes, both below and above other Waucoma soils. It is upslope from Winneshiek soils, and it is adjacent to Atkinson, Whalan, or Jacwin to 45 inches of loam to silt loam over leached sand and gravel. They do not have stones or pebbles on the surface or in the subsoil. The slopes range from 0 to 5 percent.

These soils are mainly on stream benches, and they are also on convex ridges or on the side slopes of uplands in a few places. On the benches they are adjacent to Kato, Sattre, Bixby, and Camden soils. Near them on the adjacent uplands are Ostrander and Atkinson soils.

Two depth phases of Waukegan soils are mapped in this county. In the deep phase, sand and gravel are at a depth of 36 to 45 inches. In the moderately deep phase, they are at a depth of 24 to 36 inches.

Representative profile of a moderately deep Waukegan soil:

0 to 14 inches, black and very dark grayish-brown, friable loam.

14 to 25 inches, dark-brown and dark yellowish-brown, friable loam.

management is good, but some lime is needed for optimum yields. Response to fertilizer is good. (Capability unit I-4)

Waukegan loam, deep, 2 to 5 percent slopes (WdB).—In most places this soil has a surface layer of very dark brown loam to silt loam that is 8 to 12 inches thick. In a few areas, however, 6 to 18 inches of light-colored sandy material has been deposited on the surface. The underlying sand and gravel are at a depth of 36 to 45 inches. They are at a depth of less than 42 inches in much of the acreage. The surface is free of stones and pebbles.

This soil is mainly on stream benches, but it is on upland ridges in places. It is adjacent to less sloping Waukegan soils, and in some places it is also adjacent to Kato and Sattre soils. In many places this soil is near areas of Ostrander and Atkinson soils, which are on the adjoining upland slopes.

Some runoff takes place and causes erosion on this soil when the surface is bare. Therefore, row crops ought to

This soil warms up quickly in spring and can be worked soon after rains. It is droughty, however, and is easily eroded by runoff when it is only sparsely covered by plants. Tillage can be on the contour when a row crop is grown, but this soil is generally too shallow for terraces.

If crop residue is left on the surface and if this soil is farmed on the contour, corn or other row crops can be grown 3 years in 4. Where moisture is adequate in the soil and good management is used, yields are generally above average. Lime and fertilizer are needed, however, to help in establishing a stand. Response to fertilizer is

Depth to limestone or to material weathered from limestone ranges from 15 to 30 inches.

This soil is on convex ridges in the uplands and on structural benches below Renova and Coggon soils. In most places it is upslope from other Whalan soils.

Where the ridges are moderately wide, tracts of nearly level Whalan soils are included in mapped areas of this soil. Also included are patches of Roseville soils in which the depth to limestone is 30 to 50 inches. Roseville soils are not mapped separately in this county.

Some water runs off this Whalan soil, and it causes lizer are needed if a stand of legumes is to be established. Moderate response is received from fertilizer. (Capability unit IIIe–5)

Whalan loam, 9 to 14 percent slopes, moderately eroded (WhD2).—Trees or permanent pasture occupy about two-thirds of the acreage of this soil. In the wooded or pastured areas, this soil is not eroded. The surface layer in those areas is very dark gray loam to silt loam and is 2 to 4 inches thick. It is underlain by a light-colored subsurface layer. In wooded areas a thin layer of leaf litter is

Lime, manure, and commercial fertilizer are needed to help establish a stand of pasture. (Capability unit VIe–2)

Whalan loam, 14 to 18 percent slopes, severely eroded (WhE3).—The present surface layer of this soil consists of brown loam to silt loam that was formerly part of the subsoil. The surface layer has a somewhat lighter color when dry than when moist. It is very low in content of organic matter and is in poor tilth. A few stones and pebbles are on the surface and in the subsoil. In most places depth to

For some plants, the limestone near the surface limits the growth of roots. Unless rains are timely during summer, crops lack adequate moisture for good growth.

These soils vary in reaction, but legumes that are grown on them generally need lime. The soils are low in available nitrogen, phosphorus, and potassium.

Winneshiek loam, 0 to 2 percent slopes (WkA).—The surface layer of this soil is very dark gray when moist, but it is somewhat lighter colored when dry. The surface layer is 6 to 9 inches thick and is underlain by a distinct, light-colored subsurface layer. Stones and pebbles are in the subsoil, but the surface is free of them in some places. Depth to limestone ranges from 20 to 30 inches.

This soil is on convex ridges and on high, nearly level structural benches. It is upslope from steeper Winneshiek soils, and it is adjacent to Rockton, Marlean, and Whalan soils in places. The individual areas are small. Therefore, much of the acreage is managed with the adjoining soils.

Little or no runoff takes places on this soil. Because of the limestone near the surface, not enough moisture is a depth of 20 inches. The depth is as much as 36 inches in some places.

This soil is on convex side slopes in the uplands, and it is also on structural benches. It is downslope from Waucoma, Bassett, and other Winneshiek soils and is commonly adjacent to Rockton, Marlean, and Whalan soils.

The intake of water is good in most places, but this soil is easily eroded when the surface is bare. If row crops are grown, this soil ought to be tilled on the contour or stripcropped. It is too shallow over limestone to be suitable for terraces.

Lack of moisture limits the growth of crops on this soil in years when rainfall is only average. Corn or other row crops can be grown 1 year in 4, however, if this soil is stripcropped. Yields of corn are variable but are usually about average for the county. Meadows are generally renovated after about 3 years.

Areas where the timber is good should not be cleared but ought to be managed as woodland. The pastures respond to applications of lime, manure, and commercial fertilizer. (Capability unit IIIe-5) cluded in mapped areas of this soil are patches in which the surface layer is dark grayish brown and is only 3 to 6 inches thick.

If this Winneshiek soil is cultivated, it is subject to erosion unless it is protected. This soil is too shallow over limestone to be suitable for terraces.

Corn or other row crops can be grown 1 year in 6 or when a pasture is renovated. Pastures are seldom left more than 4 years before they are renovated. If corn is

by the county extension director. It may, however, help the farmer or others plan suitable management for the soils.

Use and Management of the Soils for Crops and Pasture

Farming in Winneshiek County consists mainly of producing corn, small grains, hay, and pasture. These

Figure 8.—**An aerial view of a field where stripcropping has been used to protect the soils from erosion.**

production declines. Renovation consists of applying lime and fertilizer according to the results of soil tests, controlling erosion, preparing a good seedbed, using a combination of adapted legumes and grasses for seeding, controlling weeds, and controlling grazing.

The soils in capability classes I, II, III, and IV are generally not used for permanent pastures but are used for field crops. When those soils are used for permanent pastures, and when the pastures are renovated and well managed, good yields are generally obtained.

If renovation is practical, the soils in capability classes

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

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

Class V. Soils subject to little or no erosion but that have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover. (None in Winneshiek County)

Class VI. Soils that have severe limitations that make them generally unsuitable for cultivation and that limit their use largely to pasture or range, woodland, or wildlife food and cover.

Class VII. Soils that have very severe limitations that make them unsuitable for cultivation and that restrict their use largely to grazing, woodland, or wildlife.

Class VIII. Soils and landforms that have limitations that preclude their use for commercial plant production and that restrict their use to recreation, wildlife, water supply, or esthetic purposes. (None in Winneshiek County)

Capability Subclasses are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with the growth of plants or with cultivation (in some soils the wetness can of each capability unit, but this does not mean that all the soils of a given series appear in the unit. To find

contain abundant lime, but the other soils are slightly acid to medium acid.

however, and part of the acreage is used for oats, hay, and pasture.

Row crops can be grown intensively on these soils. Because some areas are small, however, they are managed with the adjoining soils. A satisfactory rotation is one in which row crops are grown for 3 years and are

CAPABILITY UNIT I-5

In this capability unit are level or nearly level, somewhat poorly drained or moderately well drained soils of the Lawson, Rowley, and Volney series. These soils are on flood plains, and they have an overwash of friable, light-colored, medium-textured sediments on their surbeen limed, they are acid. Except for the Ostrander and Tama soils, which are low to medium in available nitrogen, these soils are low or very low in available nitrogen. The Downs and Fayette soils are low to medium in available potassium and medium to high in available phosphorus. All of the other soils, except the Tama, are low in these elements. The Tama soil is low to medium in available phosphorus and medium in available potassium.

These soils are suitable for row crops, but they are subject to some sheet erosion because of their gentle slopes. Droughtiness and wetness are not hazards. The soils are subject to water erosion when the surface is bare or when the cover of plants is sparse.

If these soils are terraced, row crops can be grown intensively. Where they are not terraced but are tilled on the contour, a rotation that will help to control erosion consists of row crops grown for 3 consecutive years and followed by a crop of oats and a crop of meadow. If practices are not used to control erosion, growing row crops only 2 years in 4 protects the soils.

If good management is used, these are among the most productive soils in the county. They are suited to corn,

These soils are suited to cultivated crops, but they are subject to occasional overflow and to some sheet erosion. Because the soils are at the base of slopes, they receive about as much soil material through runoff from the slopes above as they lose through erosion. Artificial drainage is needed in some areas of the Lawson and Turlin soils, which are slightly wet. Many areas of these soils are managed with the soils of capability units I–2 and I–5.

If these soils are well managed, they are productive. They are used for corn, soybeans, hay, and pasture, and trees grow well on them. Most of the acreage is used for cultivated crops, but a smaller proportion of the Volney acreage is cultivated than of other soils in the unit. Corn is the main crop, but soybeans can be substituted for corn in the rotation.

These soils can be used intensively for row crops if they are tilled on the contour and diversion terraces are placed upslope. A suitable cropping system is one in which row crops are grown successively for 3 years and are followed by a crop of oats and a crop grown as green manure. Tile drainage is needed in some areas of the Lawson and Turlin soils so that field operations can be more timely.

oats, hay, and pasture. They are productive under good management.

If these soils are terraced, and if tile drains are installed in some places, row crops can be grown intensively. Row crops can be grown 3 years in 5 if these soils are tilled on the contour. Where practices are not used to control erosion, row crops should be grown only 2 years in 5.

Lime is needed on all of these soils for optimum yields; legumes are difficult to establish unless these soils receive lime and fertilizer. Corn that is not preceded by a legume needs nitrogen, and corn, soybeans, oats, and legumes need phosphate and potash. Less potash is required on the Franklin soil, however, than on the other soils.

CAPABILITY UNIT IIe–4

In this capability unit are gently sloping, dark-colored or light-colored soils that are well drained. These soils are on uplands and stream benches and are deep over bedrock or coarse-textured material. They are in the Atkinson, Calmar, Camden, Sattre, Waucoma, and Waukegan series. Except for the Calmar soil, which has a moderately fine textured surface layer, all of the soils have a friable, medium-textured surface layer and a friable, medium-textured to moderately fine textured subsoil. The Camden, Sattre, and Waukegan soils are underlain by coarse-textured material at a depth of about 36 to 45 inches. The other soils of the unit, except the Calmar, are underlain either by limestone or by material weath-

mar soil in years when rainfall is above average. A few areas of these soils are managed with the soils of capability units I–4 and IIIe–2.

These soils are used for corn, soybeans, oats, hay, and pasture, and they are also suited to trees. Nearly all of the acreage is in cultivated crops. Where the subsoil moisture is low and the preceding crop was a legume, grain sorghum can be substituted for corn in the cropping system.

Row crops can be grown intensively if these soils are terraced. When the terraces are constructed, cuts and fills should be held to a minimum so that bedrock or coarse-textured material will not be exposed in the channel of the terrace. If the Camden, Sattre, and Waukegan soils are tilled on the contour, a suitable rotation is 3 successive years of row crops followed by a crop of oats and a green-manure crop. On the other soils, tillage should be on the contour and a meadow crop ought to be grown 1 year in 5. Where practices that control erosion are not used, row crops can be grown on the Camden, Sattre, and Waukegan soils 2 years in 4. One additional year of meadow is desirable on the other soils.

Response is good to applications of lime and fertilizer on these soils. Corn that is not preceded by a legume needs nitrogen, and all the crops respond to applications of phosphate.

CAPABILITY UNIT IIe–5

In this capability unit are gently sloping, dark-colored

If these soils are tilled on the contour and tile drained where feasible, row crops can be grown for 3 consecutive years. They should be followed by a crop of oats and a crop of meadow. Where erosion control practices are not used but where wetness is controlled, the soils can be used for row crops 2 years in 5. If the soils are in poor tilth, meadow should make up a larger part of the rotation. These soils are generally not suitable for terraces, because of their clayey subsoil.

These soils are low in available phosphorus and potassium. The Donnan soil is low to medium and the Jacwin soil is medium in available phosphorus. The Donnan soil is medium acid to strongly acid, and the Jacwin soil is slightly acid or neutral.

For optimum yields, corn that is not preceded by a legume needs nitrogen. Corn, soybeans, oats, and meadow crops grown on these soils respond to applications of phosphate and potash. Lime is generally not needed on the Jacwin soil, but crops grown on the Donnan soil respond to applications of lime.

CAPABILITY UNIT IIe-6

In this capability unit are gently sloping, dark-colored or light-colored, well-drained soils of the Bixby, Rockton, Sattre, Waukegan, Whalan, and Winneshiek series. It also includes the till subsoil variant of the Lamont series. These soils are on uplands and stream benches. The Lamont variant is moderately coarse textured and is underlain by glacial material. The other soils are medium textured and are moderately deep over bedrock or coarse-textured material.

All of these soils, except the Lamont variant, have a

crops do not have enough moisture to make good growth. These soils are easily tilled and can be worked soon after rains. They are often managed with the soils of capability unit IIs-1.

These soils are productive if they are well managed. They are suited to corn, soybeans, oats, hay, and pasture, and they are also suitable for trees. Most of the acreage is cultivated.

If the Bixby, Lamont variant, Sattre, and Waukegan soils of this unit are tilled on the contour, row crops can be grown successively for 3 years but should be followed by a crop of oats and a green-manure crop. Row crops ought to be grown on the other soils only 2 years in 4 where those soils are tilled on the contour. If no practices are used to control erosion, the Bixby, Lamont variant, Sattre, and Waukegan soils should be used for row crops only 2 years in 4, and the other soils, only 1 year in 4. Many of the areas are not suitable for terraces, because of the bedrock or coarse-textured material near the surface. The Lamont variant can be terraced, however, because it is underlain by glacial till.

Lime and fertilizer are needed on these soils for optimum yields. Corn that is not preceded by a legume responds well to nitrogen, and corn, soybeans, oats, and legumes respond well to applications of phosphate and potash. Less potash is needed on the Sattre than on the other soils.

CAPABILITY UNIT IIs-1

In this capability unit are level or nearly level, dark-colored or light-colored soils that are well drained or somewhat poorly drained. These soils soil is very low and the Kato is medium in available nitrogen. The Volney soil is very low in available phosphorus, and the other soils are low in that element. All of the soils are very low to medium in available potassium.

The soils of this unit are suited to cultivated crops, but many of the areas. These soils puddle easily if worked when wet, and some runoff takes place in the sloping areas. Plowing in fall is often desirable to prevent planting from being delayed in spring.

These soils are highly productive if they are well managed. The areas that have been drained are used for row these soils. The development of drainageways is needed in some places. Where these soils are near the base of upland slopes, diversion terraces should be placed upslope to protect them from runoff from the higher lying soils. Some fields are plowed in spring, especially where planting is delayed because the soils are wet.

If these soils are used intensively for row crops, fertilizer is needed for continued optimum yields. Lime is generally not needed. Corn that is not preceded by a legume responds well to applications of nitrogen. Corn, soybeans, oats, and legumes need phosphate. Potash is

bility unit. These soils are in the Jacwin and Kato series. They have a surface layer that is friable and medium textured. The Jacwin soil has a subsoil that is fine textured and very firm. The Kato soil has a subsoil that is friable, but is has a fine-textured, very firm substratum.

Permeability is moderate in the loamy material and slow or very slow in the underlying shaly material. Both soils have high water-holding capacity, but not all of the moisture is available to plants. Seepage and a temporary perched water table make these soils wet, and aeration is somewhat restricted. Surface runoff is slow, and water is generally good, but some runoff takes place be-

These soils are acid. In general they are low in medium to high in available phosphorus and medium to low in available potassium. The Orwood soil is low in available phosphorus and medium in available potassium.

The use of these soils is seriously limited by erosion, but the soils are moderately well suited to cultivated crops if erosion is controlled. Wetness or drought are not hazards. Leaving crop residue on the surface increases the intake of water and reduces runoff. In many places these soils are managed with the soils of capability unit IIIe–1.

The soils of this unit are moderately productive if they are well managed. All of the moderately eroded soils are used for cultivated crops, and the slightly eroded areas are used for cultivated crops to some extent. A few areas are in permanent pasture or trees. These soils are suited to corn, oats, hay, and pasture, and they are also suitable for trees. Soybeans are usually not grown.

All of these soils, except the Racine and Renova, can be used for row crops 2 years in 6 if they are terraced or stripcropped. If the same soils are tilled on the contour, they can be used for row crops 1 year in 5. Row crops can be grown 1 year in 4 if the Racine and Renova soils are terraced or stripcropped, and they can be grown 1 year in 6 if those soils are tilled on the contour. The soils of this unit should be used for long-term meadow, unless practices are used to control erosion. In places the drainageways that cut into sidehills need to be shaped and reseeded.

Lime and fertilizer are necessary for optimum yields on these soils. Manure should be applied, especially in the channels of the terraces. Nitrogen is needed for corn that is not preceded by a legume. Corn, oats, and legumes respond to applications of phosphate and potash. Less phosphate is needed on the Downs and Fayette soils, however, than on the other soils.

CAPABILITY UNIT IIIe–4

[illegible]

soil tilth is fair to poor in places. The Calmar soil is sometimes difficult to till in years when the amount of rainfall is above average. The soils of this unit warm up quickly in spring and can be worked soon after rains. All of these soils are highly susceptible to severe erosion.

The Calmar soil of this unit is neutral in reaction, but the other soils are acid. Most of the soils are low or very low in available nitrogen and low in available phosphorus. The Calmar soil, however, is low to medium in available nitrogen. The Waucoma soil is low in available potassium, but the supply of that element is medium to low in the other soils.

The use of these soils is seriously limited by erosion, but the soils are moderately well suited to cultivated crops if erosion is controlled. Wetness is not a hazard, but these soils are somewhat droughty in years when rainfall is below average. The underlying limestone bedrock limits the growth of roots of some plants. In places these soils are managed with the soils of capability unit IIIe–2.

The soils of this unit are moderately productive if they are properly managed. Although much of the acreage is in permanent pasture or trees, all of the moderately eroded soils and some areas of the soils that are not eroded are used for cultivated crops. The soils are suited to corn, oats, hay, and pasture, and they are also suited to trees. Corn is the major row crop grown. Soybeans are generally not grown.

If these soils are terraced or stripcropped, a suitable rotation is 1 year of corn, 1 year of oats, and 3 years of meadow. If tillage is on the contour, a row crop can be grown for 1 year when a long-term meadow is renovated. Because of the bedrock or sand and gravel near the surface, terraces should be constructed so that the cuts and fills are held to a minimum. Manure is needed in the channels of the terraces.

Lime and fertilizer are needed for optimum yields on [illegible] however, runoff takes places. The surface layer of the moderately eroded soils tends to seal during hard rains,

The soils of this capability unit are moderately well suited to cultivation, but they are susceptible to erosion.

[illegible] the soils are [illegible] some plants. These soils are seepy because they have a

[illegible]

Most areas of this land type are in permanent pasture or in second-growth stands of trees. In a few small

capability unit. The unit consists of soils of the Downs, Fayette, Nasset, Orwood, Palsgrove, and Renova series

The soils of this unit are moderately permeable. The Fayette and Renova soils have high water-holding capa-

and the Rockton, Whalan, and Winneshiek soils are low in available potassium.

on the surface to reduce erosion by wind and water. The soils are moderate to low in productivity. Yields are variable and depend on the amount of rainfall and on the level of fertilization.

Although these soils are more suitable for long-term meadow than for row crops, a rotation consisting of 1 year of row crops followed by a crop of oats and then by 3 years of meadow is suitable if the soils are terraced or stripcropped. The soils are generally not suitable for terraces, however, because of the loamy sand and sand near the surface. Good stands of legumes or of grasses

grass respond to applications of nitrogen, phosphate, and potash.

CAPABILITY UNIT IVs-1

In this capability unit are nearly level or gently sloping, dark-colored or light-colored, excessively drained soils of uplands and stream benches. These soils are shallow over bedrock or coarse-textured material. They are in the Backbone, Burkhardt, Chelsea, and Hagener series.

These soils have a loose or very friable, moderately coarse textured or coarse textured surface layer and subsoil. The Backbone soil is underlain by limestone bed-lime, phosphate, and potash. Because these soils are droughty, however, large applications of fertilizer generally are not worth while.

CAPABILITY UNIT IVs-2

Moderately sloping to strongly sloping, dark-colored or light-colored, excessively drained soils of uplands and stream benches make up this capability unit. These soils are shallow over bedrock or coarse-textured material. They are in the Backbone, Burkhardt, Chelsea, and Hagener series. The soils have a loose or very friable surface layer and subsoil of moderately coarse textured or coarse textured material. Limestone bedrock underlies the Backbone soil at a depth between 20 and 40 inches, and gravelly sand underlies the Burkhardt soils at a depth between 15 and 24 inches. The soil material in the other soils grades to sand with increasing depth.

The water-holding capacity of these soils is low or very low. Permeability is very rapid.

The intake of water is good, but these soils hold only a small amount of moisture for the use of plants. Much of the moisture is lost through deep percolation, and part of it is lost through runoff. These soils are subject to both sheet erosion and wind erosion when their surface is bare or is only sparsely covered by plants. They are easily tilled, warm up quickly in spring, and can be worked soon after rains.

These soils are medium acid to strongly acid. They are very low in available nitrogen, phosphorus, and potassium.

Droughtiness and susceptibility to erosion are very severe limitations to use of these soils. During years when rainfall is only average, the soils generally do not contain enough moisture for crops to grow well. Both sheet erosion and wind erosion are hazards; newly seeded crops on these and on adjoining soils are often damaged by blowing sand. The soils need to have crop residue left on the surface to reduce erosion. They are too porous for it to be practical to try to build up the content of organic matter. The limestone bedrock underlying the Backbone soil limits the development of roots of some plants.

The soils of this unit can be used for corn, oats, hay, or pasture, and they are suitable for some kinds of trees. Part of the acreage is used for cultivated crops, and other areas are in pasture or trees. Corn is the major row crop grown. These soils are low in productivity.

If these soils are stripcropped, a suitable rotation is one in which row crops are grown only 2 years in 5. If practices are not used to control erosion, the soils are used for hay or pasture. A row crop can be grown for 1 year when a pasture is renovated. Terraces are generally not built on these sandy soils.

Lime and fertilizer are needed on the soils of this unit. Adding a large amount of fertilizer is generally not worth while, however, because these soils are droughty. Lime, nitrogen, phosphate, and potash are needed for corn, oats, and grass. Manure is likely to be needed to help establish a stand of legumes. Trying to build up the content of organic matter is impractical; the soils are too porous, and the organic residue decomposes readily.

CAPABILITY UNIT IVs-3

In this capability unit are gently sloping or moderately sloping, dark colored or moderately dark colored, excessively drained soils of the Marlean series. These soils are on uplands and are shallow or very shallow over fragmented material or hard bedrock. They have a friable, medium-textured surface layer and subsoil and are underlain by soft limestone bedrock. In the areas where these soils are underlain by fragmented material, the fragments of limestone have some soil material between them.

The water-holding capacity is very low. Permeability is moderate, but the underlying fragmented or fractured bedrock is rapidly permeable in most places.

These soils are well aerated. The intake of water is generally good, but much of the moisture is lost through runoff and deep percolation. In most places the soils are easily tilled, but cultivation turns up fragments of limestone. These soils warm up quickly in spring and can be worked soon after rains.

Lime is abundant in many of the areas. These soils are generally very low in available nitrogen, phosphorus, and potassium, but the uneroded Marlean soils are medium in available nitrogen.

The fragmented material or bedrock near the surface and the susceptibility to erosion are very severe limitations to the use of these soils. The soils are very droughty, and they do not store enough moisture for plants to grow well. Bedrock near the surface limits the root growth of nearly all crops.

In some places these soils are used for cultivated crops, and they are cultivated with the adjoining soils in many places. Corn, oats, legumes, and grasses are grown, and trees also grow in some areas. These soils are not very productive, but the gently sloping areas are more productive than the others.

If the gently sloping areas of Marlean soils are stripcropped, they can be used for row crops 2 years in 5. If these same areas are tilled on the contour, a row crop can be grown 1 year in 5. Where the more sloping areas are stripcropped, a row crop can be grown 1 year in 6. A row crop is usually grown when a meadow or pasture needs renovation. Corn is the main row crop. The limestone near the surface makes these soils unsuitable for terraces.

Lime is generally not needed to establish a stand of legumes on these soils. Corn, oats, and grass need nitrogen, phosphate, and potash, and legumes respond to applications of phosphate and potash. However, large applications of fertilizer are generally not worth while.

CAPABILITY UNIT VIe-1

In this capability unit are moderately steep, light-colored, well-drained, severely eroded soils of the uplands. These soils are in the Dow, Fayette, Orwood, Palsgrove, and Renova series. Their surface layer is friable and medium textured, and their subsoil is friable and is medium textured or moderately fine textured. The Palsgrove soil is underlain by limestone bedrock at a depth between 30 and 50 inches.

The water-holding capacity of the Palsgrove soil is medium, but the water-holding capacity of the other soils is high. Permeability is moderate.

Although air and water move readily through these soils, tilth is poor. Also, the surface of these soils sometimes seals during hard rains. Because of the surface sealing and the large amount of runoff, the soils are extremely erodible. They warm up quickly in spring, and farm equipment can be moved over them fairly soon after rains. The content of organic matter is very low.

All of these soils, but the Dow, are acid. The soils are very low in available nitrogen. The Fayette soil is

All of the soils of this unit are acid. The soils are low or very low in available nitrogen and low to medium in available phosphorus.

These soils are highly susceptible to further erosion and are very droughty. They are not suited to cultivated crops, but a crop of oats can be grown when a pasture is renovated. The bedrock near the surface limits the root growth of some crops. In years when the amount of rainfall is only average, these soils lack sufficient moisture for crops to make satisfactory growth.

The severely eroded Dubuque soil was formerly cultivated, but the present trend is toward using these soils for pasture. Many of the areas that are not eroded are version terraces placed in some areas of these soils will protect the soils downslope.

The soils of this unit can be used for permanent pasture, as woodland, or as habitats for wildlife. Small areas that occur with soils more suitable for cultivation are excellent for wildlife habitats. The areas in trees need good management.

Lime and some fertilizer are needed on the permanent

deep drainageways have cut into sidehills in places. The surface layer of these soils is friable and medium textured, and their subsoil is friable and medium textured or moderately fine textured. The Dubuque soils are underlain by limestone bedrock at a depth of only 15 to 30 inches.

The Fayette soil has high water-holding capacity. The water-holding capacity of the Dubuque and Whalan

CAPABILITY UNIT VIIs-2

Only a miscellaneous land type, Steep sandy land, 14 to 30 percent slopes, is in this capability unit. This land type is on uplands and benches. It is coarse textured, is very rapidly permeable, and has very low water-holding capacity.

This land type is extremely droughty and low in fertility, and it is easily eroded. In many places it limits the size and use of areas of adjacent soils. In some of the areas, farm machinery cannot be safely operated.

This land type is of little value as permanent pasture, but a few areas are in trees. Grazing needs to be controlled in the pastured areas. There are a few sand pits, but the commercial value of the sand is likely to be low because the particles are too fine. Small areas of this land type are generally idle.

Predicted Yields

Table 2 gives the estimated yields of the principal crops grown in the county under a high level of manage-

and that the yields reflect the major effects of good management practices. A high level of management includes the following practices:

1. Draining wet soils adequately with tile or surface drainage.
2. Using suitable varieties of crops.
3. Effectively controlling weeds, diseases, and insects.
4. Controlling erosion.
5. Planting the amount of seed that will produce a plant population no greater than the available moisture will support.
6. Applying the kinds and amounts of fertilizer indicated by the results of soil tests so that the soil reaches the levels of fertilization and reaction approaching those suggested by the soil testing laboratory of the Iowa State University.
7. Planting, cultivating, and harvesting at the proper time.
8. Planting alfalfa and bromegrass or orchardgrass

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soy-beans	Oats	Hay	Pas-ture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
BeB	Bassett loam, 2 to 5 percent slopes.	Slightly erodible	RROM	None	86	30	65	3.4	170
			RRROM	Contouring	86	30	65	3.4	170
			Intensive row cropping.	Terracing	86	30	65	3.4	170
BeC	Bassett loam, 5 to 9 percent slopes.	Moderately erodible	ROMM	None	78	27	58	3.1	155
			RROMM	Contouring	78	27	58	3.1	155
			RRROM	Terracing or stripcropping.	78	27	58	3.1	155

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management: Corn	Soybeans	Oats	Hay	Pasture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
CcB	Calmar clay loam, 2 to 5 percent slopes.	Slightly erodible	RROMM	None	80	28	60	3.2	160
			RRROM	Contouring	80	28	60	3.2	160
			Intensive row cropping.	Terracing	80	28	60	3.2	160
CcC	Calmar clay loam, 5 to 14 percent slopes.	Moderately erodible	Long-term meadow.	None				2.7	135
			ROMMM	Terracing or stripcropping.	68	24	51	2.7	135

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soy-beans	Oats	Hay	Pas-ture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
Cs	Colo and Otter silt loams	Very wet; has a high	Intensive row	Tile drainage;	80	28	60	3. 2	160

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soybeans	Oats	Hay	Pasture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
DoE2	Downs silt loam, 14 to 18 percent slopes, moderately eroded.	Highly erodible	Long-term meadow.	None	----	----	----	2. 7	135
			ROMMM	Stripcropping	68	----	51	2. 7	135
DoF2	Downs silt loam, 18 to 24 percent slopes, moderately eroded.	Extremely erodible	Permanent pasture.[5]	Controlled grazing	----	----	----	2. 0	100
DtB	Downs and Tama silt loams, 2 to 5 percent slopes.	Slightly erodible	RROM	None	95	33	72	3. 8	190
			RRROM	Contouring	95	33	72	3. 8	190
			Intensive row cropping.	Terracing	95	33	72	3. 8	190
DtC	Downs and Tama silt loams, 5 to 9 percent slopes.	Moderately erodible	ROMM	None	90	31	67	3. 6	180
			RROMM	Contouring	90	31	67	3. 6	180
			RRROM	Terracing or stripcropping.	90	31	67	3. 6	180
DtC2	Downs and Tama silt loams, 5 to 9 percent slopes, moderately eroded.	Moderately erodible	ROMM	None	88	31	66	3. 5	175
			RROMM	Contouring	88	31	66	3. 5	175
			RRROM	Terracing or stripcropping.	88	31	66	3. 5	175
DtD2	Downs and Tama silt loams, 9 to 14 percent	Highly erodible	Long-term meadow.	None	----	----	----	3. 3	165

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soy-beans	Oats	Hay	Pas-ture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
FaC2	Fayette silt loam, 5 to 9 percent slopes, moderately eroded.	Moderately erodible	ROMM	None	82	29	61	3. 2	160
			RROMM	Contouring	82	29	61	3. 2	160
			RRROM	Terracing or stripcropping.	82	29	61	3. 2	160
FaC3	Fayette silt loam, 5 to 9 percent slopes, severely eroded.	Moderately erodible; in poor tilth; low in fertility.	ROMMM	None	78	27	58	3. 1	155
			RROMM	Contouring	78	27	58	3. 1	155
			RROM [6]	Terracing or stripcropping.	78	27	58	3. 1	155
FaD2	Fayette silt loam, 9 to 14 percent slopes, moderately eroded.	Highly erodible	Long-term meadow.	None	-----	-----	----	3. 0	150
			ROMMM	Contouring	74	-----	56	3. 0	150
			RROMMM	Terracing or stripcropping.	74	-----	56	3. 0	150
FaD3	Fayette silt loam, 9 to 14 percent slopes, severely eroded.	Highly erodible; in poor tilth; low in fertility.	Long-term meadow.	None	-----	-----	----	2. 8	140
			ROMM	Terracing or stripcropping.	70	-----	52	2. 8	140
FaE2	Fayette silt loam, 14 to 18 percent slopes, moderately eroded.	Highly erodible	Long-term meadow.	None	-----	-----	----	2. 6	130
			ROMMMM	Stripcropping	66	-----	49	2. 6	130
FaE3	Fayette silt loam, 14 to 18 percent slopes, severely eroded.	Extremely erodible; in poor tilth; low in fertility.	Permanent pasture.[5]	Controlled grazing.	-----	-----	----	2. 3	115
FaF2	Fayette silt loam, 18 to 24 percent slopes	Extremely erodible	Permanent pasture.[5]	Controlled grazing.	-----	-----	----	1. 6	80

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management: Corn	Soybeans	Oats	Hay	Pasture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
FrC	Frankville silt loam, 5 to 9 percent slopes.	Moderately erodible; limited root zone; slightly droughty.	Long-term meadow.	None	----	----	----	2.7	135
			ROMMM	Contouring	67	24	50	2.7	135
			ROMM [6]	Terracing or stripcropping.	67	24	50	2.7	135
FrD2	Frankville silt loam, 9 to 14 percent slopes, moderately eroded.	Highly erodible; limited root zone; slightly droughty.	Hay or pasture	None	----	----	----	2.2	110
			ROMMMM	Stripcropping	55	----	41	2.2	110
FrE2	Frankville silt loam, 14 to 18 percent slopes, moderately eroded.	Highly erodible; limited root zone; slightly droughty.	Permanent pasture.[5]	Controlled grazing	----	----	30	1.9	95
HaA	Hagener loamy sand, 0	Very droughty; low in	RROMM	Mulch tillage	55	19	41	2.2	110

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soybeans	Oats	Hay	Pasture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
KaA	Kato loam, moderately deep, 0 to 4 percent slopes.	Limited root zone; slightly droughty; has a variable water table.	Intensive row cropping.	None	82	29	61	3.3	165
KdA	Kato loam, deep, 0 to 4 percent slopes	Moderately wet; has a variable water table	Intensive row cropping	Some tile drainage	90	31	67	3.6	180

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management: Corn	Soybeans	Oats	Hay	Pasture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
LoF	Loamy terrace escarpments, 16 to 30 percent slopes.	Extremely erodible; low in fertility.	Permanent pasture.[5]	Controlled grazing.	-----	-----	-----	1.2	60
MaB	Marlean loam, 2 to 5 percent slopes.	Shallow but variable root zone; very droughty; slightly erodible; low in fertility.	Hay and pasture	None	-----	-----	-----	2.0	100
			ROMMM	Contouring	50	18	37	2.0	100
			RROMM	Stripcropping	50	18	37	2.0	100
MaC	Marlean loam, 5 to 9 percent slopes.	Shallow but variable root zone; very droughty; moderately erodible; low in fertility.	Hay and pasture	None	-----	-----	-----	1.7	89
			ROMMMM	Stripcropping	42	15	32	1.7	89
MaC2	Marlean loam, 5 to 9 percent slopes, moderately eroded.	Shallow but variable root zone; very droughty; moderately erodible; low in fertility.	Hay and pasture	None	-----	-----	-----	1.5	75
			ROMMMM	Stripcropping	38	13	28	1.5	75
MaD2	Marlean loam, 9 to 14 percent slopes, moderately eroded.	Shallow but variable root zone; very droughty; very erodible; low in fertility.	Permanent pasture.[5]	Controlled grazing.	-----	-----	-----	1.6	80
MaD3	Marlean loam, 9 to 14 percent slopes, severely eroded.	Shallow but variable root zone; very droughty; very erodible; low in fertility; in poor tilth.	Permanent pasture.[5]	Limited grazing	-----	-----	-----	1.0	50
MaE2	Marlean loam, 14 to 24 percent slopes, moderately eroded.	Highly erodible; shallow but variable root zone; very droughty; low in fertility.	Permanent pasture.[5]	Limited grazing	-----	-----	-----	1.2	60
MaE3	Marlean loam, 14 to 24 percent slopes, severely eroded.	Extremely erodible; shallow but variable root zone; very droughty; low in fertility.	Permanent pasture.[5]	Limited grazing	-----	-----	-----	.8	40
NaC2	Nasset silt loam, 5 to 9 percent slopes, moderately eroded.	Moderately erodible; somewhat limited root zone.	ROMMMM	None	72	25	54	2.9	145
			RROMMM	Contouring	72	25	54	2.9	145
			RROM [6]	Terracing or stripcropping.	72	25	54	2.9	145
NaD2	Nasset silt loam, 9 to 14 percent slopes, mod-	Highly erodible; somewhat limited root	Long-term meadow.	None	-----	-----	-----	2.6	130

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soy-beans	Oats	Hay	Pas-ture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
NoE	Nordness silt loam, 14 to 24 percent slopes.	Shallow root zone; very droughty; extremely erodible; low in fertility.	Permanent pasture.[5]	Limited grazing	----	----	----	.5	25
OrA	Oran loam, 0 to 2 percent slopes.	Moderately wet; has a variable water table.	Intensive row cropping.	Some tile drainage	88	31	66	3.5	175
OrB	Oran loam, 2 to 5 percent slopes.	Slightly erodible; slightly wet; has a variable water table.	RROMM	Some tile drainage	83	29	62	3.3	165
			RRROM	Contouring and some tile drainage.	83	29	62	3.3	165
			Intensive row cropping.	Terracing and some tile drainage.	83	29	62	3.3	165
OsB	Orwood silt loam, 2 to 5 percent slopes.	Slightly erodible	RROM	None	90	31	67	3.6	180
			RRROM	Contouring	90	31	67	3.6	180
			Intensive row cropping.	Terracing	90	31	67	3.6	180
OsC2	Orwood silt loam, 5 to 9 percent slopes, moderately eroded.	Moderately erodible	ROMM	None	80	28	60	3.2	160
			RROMM	Contouring	80	28	60	3.2	160
			RRROM	Terracing or stripcropping.	80	28	60	3.2	160
[illegible]	Orwood silt loam, 9 to [illegible]	Highly erodible	Long-term [illegible]	None	----	----	----	2.9	145

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soy-beans	Oats	Hay	Pas-ture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
Ow	Otter-Ossian complex	Very wet; occasionally flooded; has a high water table; slow runoff.	Intensive row cropping.	Tile drainage; protection from flooding.	86	30	65	3.4	170
Ox	Otter and Ossian silt loams, overwashed.	Very wet; occasionally to frequently flooded; has a high water table.	Intensive row cropping.	Protection from overflow; tile drainage.	84	30	65	3.4	170
PaC2	Palsgrove silt loam, 5 to 9 percent slopes, moderately eroded.	Moderately erodible; somewhat limited root zone.	Long-term meadow.	None	----	----	----	2.7	135
			ROMM	Contouring	68	24	51	2.7	135
			RROMM	Terracing or stripcropping.	68	24	51	2.7	135
PaD2	Palsgrove silt loam, 9 to 14 percent slopes, moderately eroded.	Highly erodible; somewhat limited root zone.	Long-term meadow.	None	----	----	----	2.4	120
			ROMMM	Terracing or stripcropping.	60	----	45	2.4	120
PaD3	Palsgrove silt loam, 9 to 14 percent slopes, severely eroded.	Highly erodible; somewhat limited root zone; in poor tilth; low in fertility.	Long-term meadow.	None	----	----	----	2.0	100
			ROMMMM	Terracing or stripcropping.	50	----	37	2.0	100
PaE2	Palsgrove silt loam, 14 to 18 percent slopes, moderately eroded.	Highly erodible; somewhat limited root zone.	Long-term meadow.	None	----	----	----	2.1	115
			ROMMMM	Stripcropping	52	----	39	2.1	115
PaE3	Palsgrove silt loam, 14 to 18 percent slopes, severely eroded.	Extremely erodible; somewhat limited root zone; in poor tilth; low in fertility.	Permanent pasture. [5]	Controlled grazing.	----	----	----	1.8	90
PaF2	Palsgrove silt loam, 18 to 24 percent slopes, moderately eroded.	Extremely erodible; somewhat limited root zone.	Permanent pasture. [5]	Controlled grazing.	----	----	----	1.0	50
Pk	Peaty muck	Very wet, has a high water table; subject to ponding, and there is a frost hazard; low in fertility.	Intensive row cropping.	Tile drainage and surface drainage.	60	21	45	2.4	120
Pw	Peaty muck, overwashed.	Very wet; has a variable water table; subject to overflow.	Intensive row cropping.	Tile drainage or surface drainage and protection from overflow.	65	23	48	2.6	130
RaA	Racine loam, 0 to 2 percent slopes.	None	Intensive row cropping.	None	92	32	69	3.7	185
RaB	Racine loam, 2 to 5 percent slopes.	Slightly erodible	RROM	None	88	31	66	3.5	175
			RRROM	Contouring	88	31	66	3.5	175
			Intensive row cropping.	Terracing	88	31	66	3.5	175
RaC	Racine loam, 5 to 9 percent slopes.	Moderately erodible	ROMM	None	80	28	60	3.2	160
			RROMM	Contouring	80	28	60	3.2	160
			RRROM	Terracing or stripcropping.	80	28	60	3.2	160
RaC2	Racine loam, 5 to 9 percent slopes, moderately eroded.	Moderately erodible	ROMM	None	76	27	57	3.0	150
			RROMM	Contouring	76	27	57	3.0	150
			RRROM	Terracing or stripcropping.	76	27	57	3.0	150

See footnotes at end of table.

TABLE 2.—*Management and yield data for soils*—Continued

					Expected yields per acre under high-level management

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soy-beans	Oats	Hay	Pas-ture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
Rw	Rowley and Lawson silt loams, overwashed.	Slightly wet; occasionally flooded.	Intensive row cropping.	Protection from overflow and some tile drainage.	90	31	67	3.6	180
SdA	Sattre loam, moderately deep, 0 to 2 percent slopes.	Slightly droughty; limited root zone.	Intensive row cropping.	None	78	27	58	3.1	155
SdB	Sattre loam, moderately deep, 2 to 5 percent slopes.	Slightly erodible; limited root zone; slightly droughty.	RROM	None	72	25	54	2.9	145
			RRROx	Contouring	72	25	54	2.9	145
SdC2	Sattre loam, moderately deep, 5 to 9 percent slopes, moderately eroded.	Moderately erodible; limited root zone; slightly droughty.	ROMMM	None	62	22	47	2.5	125
			RROMMM	Contouring	62	22	47	2.5	125
			RROM [6]	Terracing or stripcropping.	62	22	47	2.5	125
SdD2	Sattre loam, moderately deep, 9 to 14 percent slopes, moderately eroded.	Highly erodible; limited root zone; slightly droughty.	Hay or pasture	None				2.1	105
			ROMMM	Terracing or stripcropping.	52		39	2.1	105
SbA	Sattre loam, deep, 0 to 2 percent slopes.	Somewhat limited root zone.	Intensive row cropping.	None	85	30	64	3.4	170
SbB	Sattre loam, deep, 2 to 5 percent slopes.	Slightly erodible; somewhat limited root zone.	RROM	None	80	28	60	3.2	160
			RRROx	Contouring	80	28	60	3.2	160
			Intensive row cropping.	Terracing	80	28	60	3.2	160
SbC2	Sattre loam, deep, 5 to 9 percent slopes, moderately eroded	Moderately erodible; somewhat limited root zone	ROMMM	None	72	25	54	2.9	145
			RROMMM	Contouring	72	25	54	2.9	145
			RROM [6]	Terracing or strip- [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management: Corn	Soybeans	Oats	Hay	Pasture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
WhC2	Whalan loam, 5 to 9 percent slopes, moderately eroded.	Moderately erodible; limited root zone; slightly droughty.	Long-term meadow.	None	-----	-----	----	2.3	115
			ROMMM	Contouring	58	20	43	2.3	115
			ROMM [6]	Terracing or stripcropping.	58	20	43	2.3	115
WhD2	Whalan loam, 9 to 14 percent slopes, moderately eroded.	Highly erodible; limited root zone; slightly droughty.	Hay or pasture	None	-----	-----	----	2.2	110
			ROMMMM	Stripcropping	54	-----	40	2.2	110
WhE2	Whalan loam, 14 to 24 percent slopes, moderately eroded.	Highly erodible; limited root zone; slightly droughty.	Permanent pasture.[5]	Controlled grazing.	-----	-----	----	1.0	50
WhE3	Whalan loam, 14 to 18 percent slopes, severely eroded.	Extremely erodible; limited root zone; slightly droughty; in poor tilth; low in fertility.	Permanent pasture.[5]	Limited grazing	-----	-----	----	1.2	60

cine, Atterberry, and Oran. These soils are deep and generally contain an ample supply of soil moisture. Soils that are somewhat droughty, however, namely, the Backbone, Lamont, and Chelsea, also occur in this area.

On the rolling uplands, the stands contain some maple, elm, basswood, hackberry, green ash, and cherry in addition to the oak and hickory. Also, landscape plantings and plantings for windbreaks have been established since the time the area was first settled. Trees in those plantings include Scotch, white, red, and Austrian pines, Douglas-fir, and Norway spruce.

Oak-hickory type on steep uplands.—This type of woodland is in the eastern part of the county and along areas that border the major streams and tributaries throughout the county. The soils on steep uplands vary in moisture-supplying capacity and in depth over bedrock and shale. Some of them formed in deep loess. The principal soils on steep uplands are the Dubuque, Fayette, Palsgrove, Whalan, Frankville, Orwood, Nasset, Waucoma, and Winneshiek. Also common along stream bottoms are the Chaseburg soils.

Soft maple-elm on nearly level stream benches and bottoms.—A number of different soils support this woodland type, and the soils vary in moisture-supplying capacity. Examples of these soils are the Bixby, Camden, Sattre, and Hayfield, which occur on benches and are underlain by sand and gravel. Other soils that are deeper over coarse-textured material are the Bertrand, Chaseburg, and Canoe.

The predominant species on the nearly level stream benches and bottoms are maple and elm, but willow, swamp white oak, bur oak, shellbark hickory, cottonwood, green ash, and black walnut are common. Willow, cottonwood, and swamp white oak are more common on the bottom lands than in other areas.

Factors affecting woodland management

Soils differ in their capabilities for use as woodland. The factors that influence such use are somewhat different and less restrictive than those that limit use of the soils for cultivated crops. This soil survey can help the owner of a wooded tract determine where he can get the best returns for his investment in woodland management. If the soils are good for trees, the owner can afford to spend time and money in managing his woodland carefully. Little management other than that needed to protect the soils—however, is justified on poor sites. Some factors

broad ridgetops than on slopes facing south or west. Steep, long slopes that have various exposures are typical for soils and land types, such as the Fayette, Nordness, and Steep rock land.

Erosion.—Eroded soils are generally not suitable for hardwoods, though pines may be planted on those sites. Examples of soils in which erosion has reduced the effective depth are the Winneshiek, Waucoma, Whalan, Rockton, Sattre, and Nordness. Natural reseeding of trees is greatly reduced by erosion.

Other factors.—Other factors that affect the growth of trees are soil reaction and soil fertility. Also, soils that are frequently flooded are generally not desirable for woody cover suitable for wildlife, although wildlife use those areas part of the time. In this county the growth of trees and the adaptation of different species do not appear to have been influenced by soil reaction and lack of fertility. Flooding and poor soil drainage, however, have affected the growth of trees in areas of Alluvial land and of Dorchester and Arenzville soils.

A higher mortality of trees and wildlife species can be expected on droughty or tight soils than on soils more suitable for trees and wildlife. Also, most pines do poorly on soils that are high in lime, although Eastern redcedar is more tolerant of lime than are some other species. In general, hardwoods grow better than conifers on soils that are high in lime.

Woodland suitability groups

Management of woodland can be planned more effectively if soils are grouped according to those characteristics that affect the growth of trees and the management of the stands. For this reason, the soils of Winneshiek County have been placed in five woodland suitability groups (see table 3). Each group consists of soils that have about the same suitability for wood crops, require about the same management, and have about the same potential productivity.

In each group trees most suitable for forest, windbreaks, and Christmas trees are listed. Also listed are trees and shrubs most suitable as cover for wildlife. These include some species that provide food as well as cover. The county agent or the Experiment Station can provide additional information about the suitability of certain trees for a specific use.

In table 3 the estimated potential annual acre yields of hardwoods and the site index also are given for the soils

TABLE 3.—*Soil ratings for the planting of trees and for woodland production*

[Absence of a site index or yield figure indicates that the soils have developed under prairie, and trees generally do not grow on them]

Soil series and mapping unit	Woodland suitability group [1]	Estimated site index	Annual production of hardwoods in board feet per acre [2]
Alluvial land (Ab)	2	60	190
Arenzville (Ar)	4	65	220
Atkinson (AtB)	3		
Atterberry (AyA)	3	60	190
Backbone (BaB, BaC, BaD)	1	50	125
Bassett (BeA, BeB, BeC, BeC2, BIB, BIC)	3	53	140
Bertrand (BnA, BnB)	3	65	220
Bixby (BoA, BoB, BoC2)	3	50	125
Burkhardt (BuB, BuC2)	1		
Calamine (CaA, CaB)	5		
Calmar (CcB, CcC)	3		
Camden (CdA, CdB, CdC)	3	62	195
Caneek (Ce)	4		
Canoe (Cf)	3	60	190
Chaseburg (ChA, ChB)	3	63	200
Chelsea (ClB, ClD)	1	56	155
Clyde (CmB)	4		
Coggon (CoB, CoC2)	3	53	140
Colo and Otter (Cs)	4		
Colo-Otter-Ossian complex (Ct)	4		
Dickinson (DcA, DcB, DcC, DcD)	1		
Donnan (DdB)	5		
Dorchester (De)	4	63	200
Dorchester-Chaseburg-Volney complex (DgB)	4	60	190
Dow (DhE3)	3	60	190
Downs (DoA, DoB, DoC, DoD, DoE2, DoF2)	3	68	250
Downs and Tama (DtB, DtC, DtC2, DtD2)	3	68	250
Dubuque (DuC2, DuD2, DuD3, DuE2, DuE3, DuF2)	3	60	190
Fayette (FaA, FaB, FaC2, FaC3, FaD2, FaD3, FaE2, FaE3, FaF2, FaF3, FaG)	3	68	250
Festina (FeA, FeB)	3	68	250
Floyd (FlB)	3		
Floyd-Clyde complex (FmB)	4		
Franklin, gray subsoil variant (FnB)	3	58	165
Frankville (FrC, FrD2, FrE2)	3	60	190
Hagener (HaA, HaB, HaD)	1		
Hayfield (HdA, HmA)	3	58	165
Huntsville (HuA, HuB)	3		
Jacwin (JaA, JaB, JaC, JaD)	5		
Kato (KaA, KdA, KsB, KsC)	3		
Otter and Ossian, overwashed (Ox)	4		
Palsgrove (PaC2, PaD2, PaD3, PaE2, PaE3, PaF2)	3	63	200
Peaty muck (Pk)			
Peaty muck, overwashed (Pw)			
Racine (RaA, RaB, RaC, RaC2, RaD2)	3	60	190
Renova (ReB, ReC, ReC2, ReD2, ReD3, ReE2, ReE3)	3	60	190
Riceville (RfB)	3		
Rockton (RkA, RkB, RkC, RkD)	3		
Rowley (RoA)	4		
Rowley and Lawson, overwashed (Rw)	4		
Sattre (SbA, SbB, SbC2, SdA, SdB, SdC2, SdD2)	3	60	190
Spillville (Sp)	4		
Steep rock land (Sr)	1	45	80
Steep sandy land (SsF)	1	50	125
Terril (TeA, TeB)	3		
Turlin (TgA, TgB)	4		
Volney (VcA, VcB, VoA, VoB)	4	60	190
Waucoma (WcA, WcB, WcC, WcD)	3	63	200
Waukegan (WdA, WdB, WgA, WgB)	3		
Whalan (WhB, WhC2, WhD2, WhE2, WhE3)	3	58	165
Winneshiek (WkA, WkB, WkC, WkC2, WkD, WkE)	3	60	190

[1] Refers to planting on all aspects.
[2] Figure given is for fully stocked, even-aged stands under a high level of management.

WOODLAND SUITABILITY GROUP 1

The soils in this group generally are droughty because of their slopes and their position, as on narrow ridgetops. They are also droughty because of their extremely sandy texture, excessively drained sandy or gravelly subsoil, or a layer of rock close to the surface. Some areas of these soils are nearly level, but in other places the slopes are as steep as 14 percent. The soils that have slopes of between 0 and 14 percent have all exposures. Those that have slopes greater than 14 percent have northern and eastern exposures.

but where the slopes face north or east. The trees suitable for planting in these less favorable areas are—

Eastern redcedar. Scotch pine.
Jack pine.

The shrubs and trees suitable for wildlife cover are—

Eastern redcedar. Honeysuckle.

WOODLAND SUITABILITY GROUP 2

The soils in this group are similar to those of group 1, except that they are subject to repeated overflow.

The trees suitable for planting are—

Cottonwood.

The shrubs and trees suitable for wildlife cover are—

The shrubs and trees suitable for wildlife cover are—

Honeysuckle.

WOODLAND SUITABILITY GROUP 5

The soils of this group are tight at a depth fairly near the surface. They are moderately permeable to very slowly permeable, and their texture ranges from clay loam to silty clay or clay. The ones that have a slope range of between 0 and 14 percent generally have all exposures. Those that have slopes of more than 14 percent generally have northern or eastern exposures.

The trees suitable for planting are—

Cottonwood. Green ash.

heavy loads and where the excavations are deeper than the depths of the layers reported. Furthermore, engi-

words, for example, soil, clay, silt, and sand may have special meanings in soil science. These and other special

TABLE 4.—*Brief description of the soil*

Symbol on map	Soil name	Description of soil material and site	Depth from surface
			Inches
Ab	Alluvial land.	Sandy, gravelly, or silty alluvial soil material that is excessively drained to poorly drained. On flat, low bottom lands. Subject to flooding.	(1)
Ar	Arenzville silt loam.	Deep, noncalcareous alluvial soil material low in content of sand. Well drained and on low bottom lands. No effective water table. Surface layer low in content of organic matter, but content of organic matter medium to high below a depth of 20 inches or more. Subject to frequent flooding.	0–30 30–46
AtB	Atkinson loam, 2 to 5 percent slopes.	30 to 50 inches of medium-textured glacial soil material of fairly variable particle size. Underlain by bedrock, dominantly lime-	0–13 13–36

material and its estimated properties

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1).
Silt loam	CL or ML	A-4 or A-6	100	100	95-100	0. 8-2. 5	0. 18	6. 6-7. 3	Moderate.
Silt loam	CL or ML	A-6 or A-7	100	100	95-100	0. 8-2. 5	. 20	6. 6-7. 3	Moderate to high.
Loam	ML or CL	A-4 or A-6	95-100	95-100	55-75	0. 8-2. 5	. 17	5. 6-7. 3	Low.
Clay loam	CL	A-4 or A-6	85-100	80-95	50-75	0. 8-2. 5	. 18	5. 1-6. 0	Moderate.
Clay	CH	A-7-6	85-100	80-100	70-100	<0. 05	. 15	6. 6-8. 4	High to none.
Silt loam	CL or ML	A-6 or A-7-6	100	100	95-100	0. 8-2. 5	. 20	5. 6-6. 6	Moderate.
Silty clay loam	CL or ML	A-7-6	100	100	95-100	0. 8-2. 5	. 18	5. 6-6. 0	Moderate.
Silt loam	CL or ML	A-6 or A-7-6	100	100	95-100	0. 8-2. 5	. 19	6. 1-7. 3	Moderate.
Loamy sand to sandy loam.	SM	A-2-4	95-100	95-100	25-35	2. 5-5. 0	. 12	6. 1-6. 5	Low.
Sandy loam	SM	A-2-4	95-100	95-100	25-35	2. 5-5. 0	. 11	6. 5-7. 0	Low.
Clay	CH	A-7-6	85-100	80-100	70-100	<0. 05	. 15	6. 2-8. 2	(1).
Loam	CL	A-6	95-100	95-100	65-75	0. 8-2. 5	. 18	5. 6-6. 6	Moderate.
Loam [2]	CL	A-6 or A-4	90-95	80-95	55-65	0. 8-2. 5	. 16	4. 5-5. 5	Moderate.
Sandy clay loam	SC or CL	A-4 or A-6	90-100	85-100	30-65	0. 2-0. 8	. 16	4. 5-6. 0	Moderate.
Silt loam	CL or ML	A-4 or A-6	98-100	98-100	95-100	0. 8-2. 5	. 20	5. 1-6. 6	Moderate.
Loam [2]	CL	A-6 or A-4	90-95	80-90	55-65	0. 8-2. 5	. 16	4. 5-5. 5	Moderate.
Loam	CL	A-6	90-100	85-100	55-75	0. 2-0. 8	. 16	5. 1-6. 0	Moderate.
Silt loam	CL or ML	A-6 or A-4	100	100	95-100	0. 8-2. 5	. 18	6. 0-6. 8	Moderate.
Silt loam	CL or ML	A-6 or A-7-6	100	100	95-100	0. 8-2. 5	. 18	5. 4-6. 2	Moderate.
Loam to gravelly clay loam.	CL	A-6	90-100	85-100	55-75	2. 5-5. 0	. 16	5. 0-5. 6	Moderate.
Loam	CL	A-4 or A-6	90-100	85-100	55-75	0. 8-2. 5	. 15	6. 0-6. 6	Low.
Sandy clay loam	SC or CL	A-4 or A-6	90-100	85-100	35-65	0. 8-2. 5	. 16	5. 4-6. 1	Low.
Sandy loam	SM	A-2	90-100	85-100	25-35	2. 5-5. 0	. 12	5. 4-6. 1	Low.
Gravelly sand [3]	GM or SM	A-1 or A-2	45-90	5-85	10-35	10+	. 02	5. 4-6. 2	Low to none.
Loam to sandy loam	SM	A-4 or A-2	85-100	80-100	25-45	2. 5-5. 0	. 16	6. 0-6. 6	Low.
Loam to sandy loam	SM	A-4 or A-2	85-100	80-100	20-45	2. 5-5. 0	. 16	5. 6-6. 2	Low.
Gravelly sand [3]	GM or SM	A-1 or A-2	45-90	5-85	5-35	10+	. 02	5. 4-6. 4	None.
Silty clay loam	CL or CH	A-7-6	90-100	85-100	85-100	0. 2-0. 8	. 20	6. 4-7. 4	Moderate to high.
Silty clay	CH	A-7-6	90-100	85-100	85-100	<0. 05	. 15	6. 4-7. 4	High.
Silty clay loam	CH	A-7-6	90-100	85-100	85-100	<0. 05	<. 14	6. 8-7. 8	High to moderate.
Clay loam	CL or CH	A-6 or A-7-6	90-100	80-100	55-85	0. 2-0. 8	. 18	6. 0-6. 6	Moderate to high.
Clay loam	CL or CH	A-6 or A-7-6	90-100	80-100	55-85	0. 2-0. 8	. 18	6. 0-6. 6	Moderate to high.
Clay	CH	A-7-6	90-100	85-100	85-100	<0. 05	. 15	6. 4-7. 2	High.
Limestone	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4).

TABLE 4.—*Brief description of the soil*

Symbol on map	Soil name	Description of soil material and site	Depth from surface
			Inches
CdA CdB CdC	Camden silt loam, 0 to 2 percent slopes. Camden silt loam, 2 to 5 percent slopes. Camden silt loam, 5 to 9 percent slopes.	At least 36 inches of medium-textured soil material that is low or medium in content of sand. Underlain by gravelly sand. Well drained and in flat areas or on convex slopes on terraces. No effective water table. Surface layer low in content of organic matter.	0–12 12–25 25–39 39–60
Ce	Caneek silt loam.	Deep alluvial soil material low in content of sand. Somewhat poorly drained and on low bottom lands. A seasonal high water [illegible]	0–15 [illegible]

material and its estimated properties—Continued

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
Silt loam	CL or ML	A–4 or A–6	100	100	95–100	0. 8–2. 5	. 18	6. 2–6. 8	Low to moderate.
Silt loam	CL	A–6	90–100	85–100	55–85	0. 8–2. 5	. 15	6. 2–6. 8	Moderate.
Silty clay loam to sandy clay loam.	SC or CL	A–6	90–100	85–100	35–65	0. 8–2. 5	. 16	6. 2–6. 8	Low.
Loamy sand	SP or SM	A–1 or A–2	85–100	85–100	5–15	5. 0–10. 0	. 03	5. 8–6. 6	None.
Silt loam	CL or ML	A–4 or A–6	100	100	95–100	0. 8–2. 5	. 18	7. 4–8. 4	Low to moderate.
Silt loam	CL or ML	A–4 or A–6	100	100	95–100	0. 8–2. 5	. 21	6. 6–7. 2	Low to moderate.
Silt loam	OL or ML	A–6 or A–7–6	100	100	95–100	0. 8–2. 5	. 22	6. 6–7. 0	Low to moderate.
Silt loam	CL or ML	A–6 or A–7–6	100	100	95–100	0. 8–2. 5	[5] . 20	6. 1–6. 5	Moderate.
Silt loam	CL or ML	A–7–6	100	100	95–100	0. 8–2. 5	. 18	5. 1–6. 0	Moderate.
Silt loam	CL or ML	A–4 or A–6	100	100	95–100	0. 8–2+5	. 18	6. 4–7. 2	Low to moderate.
Silt loam	CL or ML	A–6	100	100	95–100	0. 8–2+5	. 18	6. 4–7. 2	Low to moderate.
Loamy fine sand	SM	A–2–4	90–100	85–100	10–30	5. 0–10+0	. 05	5. 8–6. 4	None.
Sand	SM or SP	A–2 or A–1	90–100	85–100	5–15	10	. 03	5. 8–6. 4	None.
Silt loam	OL or ML	A–7–6 or A–8	100	100	95–100	0. 8–2. 5	. 21	6. 4–7. 4	High.
Loam	CL	A–6	85–100	80–100	55–75	0. 8–2. 5	. 16	6. 4–7. 4	Moderate.
Loam and silt loam	CL	A–6	85–100	80–100	55–75	0. 8–2. 5	. 16	6. 4–7. 4	Moderate.
Clay loam and cobbly sandy loam.	CL	A–6 or A–6	85–100	80–100	55–85	0. 8–2. 5	. 17	7. 0–7. 8	Moderate.
Loam	CL or ML	A–6 or A–4	95–100	95–100	65–75	0. 8–2. 5	. 18	5. 6–6. 8	Moderate.
Sandy clay loam.[2]	SC or CL	A–4 or A–6	75–95	65–95	35–65	0. 8–2. 5	. 15	4. 8–5. 8	Moderate.
Sandy clay loam	SC or CL	A–4 or A–6	90–100	85–100	35–65	0. 2–0. 8	. 15	4. 8–5. 8	Moderate.
Loam	CL	A–6	90–100	85–100	55–75	0. 2–0. 8	. 15	5. 0–5. 6	Moderate.
Silt loam to silty clay loam.	OL or ML	A–6 or A–7–6	100	100	95–100	0. 8–2. 5	. 21	6. 5–7. 4	High.
Silty clay loam	OL or ML	A–7–6	100	100	95–100	0. 2–0. 8	. 18	6. 6–7. 4	High.
Silty clay loam	MH or CL	A–7–6	95–100	90–100	85–100	0. 8–2. 5	. 18	6. 6–7. 4	High to moderate.
Gravelly sandy loam	SM or GM	A–1 or A–2	50–90	20–95	15–30	5. 0–10. 0	. 08	6. 6–7. 4	None.
Silt loam	ML or OL	A–6 or A–7–6	100	100	95–100	0. 8–2. 5	. 20	6. 4–7. 4	Moderate to high.
Silt loam	ML or CL	A–7–6	100	100	95–100	0. 8–2. 5	. 18	6. 4–7. 4	High.
Silt loam	ML or CL	A–6 or A–7–6	100	100	95–100	0. 8–2. 5	. 18	6. 4–7. 4	Moderate to high.
Sandy loam	SM	A–2–4	95–100	95–100	25–35	2. 5–5. 0	. 13	5. 2–6. 0	Low.
Sandy loam	SM	A–2–4	95–100	95–100	25–35	2. 5–5. 0	. 12	5. 0–5. 6	Low to none.
Loamy sand and sand.	SP or SM	A–2	85–100	85–100	3–15	5. 0–10. 0	. 03	5. 0–5. 6	None.

TABLE 4.—*Brief description of the soil*

Symbol on map	Soil name	Description of soil material and site	Depth from surface
			Inches
DdB	Donnan loam, 2 to 5 percent slopes.	20 to 40 inches of friable, medium-textural glacial soil material of fairly variable particle size over firm till that resembles gumbo. Moderately well drained and on convex slopes in the uplands. A seasonal high water table is at a depth of 1½ to 3½ feet. Surface layer medium in content of organic matter. Commonly a prominent stone line at a depth of 18 to 24 inches.	0–8 8–23 23–52
De	Dorchester silt loam.	Deep, calcareous soil material low in content of sand. Well drained and on low bottom lands. No effective water table. Surface layer low in content of organic matter, and buried soil	0–20 20–59

material and its estimated properties—Continued

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				

TABLE 4.—*Brief description of the soil*

Symbol on map	Soil name	Description of soil material and site	Depth from surface
			Inches
FaF3	Fayette silt loam, 18 to 24 percent slopes, severely eroded.		
FaG	Fayette silt loam, 24 to 35 percent slopes.		
FeA	Festina silt loam, 0 to 2 percent slopes.	Deep, medium-textured alluvial soil material low in content of sand. Well drained and in flat areas or on convex slopes on terraces. A seasonal high water table is below a depth of 4 feet. Surface layer medium in content of organic matter.	0–12
FeB	Festina silt loam, 2 to 5 percent slopes.		12–38
			38–60

material and its estimated properties—Continued

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
Silt loam	CL or ML	A-4 or A-6	100	100	95-100	0.8-2.5	.20	5.6-6.6	Moderate.
Silt loam	CL	A-6 or A-7-6	100	100	95-100	0.8-2.5	.18	5.4-6.2	Moderate to high.
Silt loam	CL	A-6 or A-7-6	100	100	95-100	0.8-2.5	.18	5.4-6.2	Moderate to high.
Loam to gritty silty clay loam.	OL or CL	A-6 or A-7-6	85-100	80-100	55-75	0.8-2.5	.20	6.4-7.2	Moderate to high.
Loam	CL or SC	A-6 or A-4	75-100	70-95	35-75	0.8-2.5	.17	5.8-7.2	Moderate.
Clay loam	CL	A-6	85-100	80-100	55-75	0.2-0.8	.17	5.8-7.8	Moderate.
Silt loam	CL or ML	A-6 or A-4	100	95-100	95-100	0.8-2.5	.20	5.4-6.2	Moderate.
Silt loam and silty clay loam.	CL	A-6 or A-7-6	100	95-100	95-100	0.8-2.5	.18	4.8-5.6	Moderate to high.
Loam	CL	A-6	90-100	85-100	55-75	0.2-0.8	.16	5.2-6.2	Moderate.
Silt loam	CL or ML	A-4 or A-6	100	100	95-100	0.8-2.5	.20	6.0-6.8	Moderate.
Silt loam and silty clay loam.	CL	A-6 or A-7-6	100	100	95-100	0.8-2.5	.18	5.8-6.4	Moderate to high.
Clay and fragments of limestone.	CH	A-7-6	85-100	80-100	70-100	<0.05-5.0	.15	6.4-8.2	High.
Loamy sand	SM	A-2	100	95-100	10-30	5.0-10.0	.04	5.6-6.8	None.
Loamy sand	SP or SM	A-2	100	95-100	5-20	5.0-10.0	.03	5.4-6.4	None.
Sand	SP or SM	A-1 or A-2	100	95-100	0-20	10+	.03	5.4-6.4	None.
Loam	CL	A-6	90-100	90-100	55-75	0.8-2.5	.16	6.0-6.8	Moderate.
Loam, light clay loam, and sandy	CL or SC	A-2 or A-6	90-100	85-100	30-65	0.8-2.5	.15	5.0-5.6	Low to moderate.

TABLE 4.—*Brief description of the soil*

Symbol on map	Soil name	Description of soil material and site	Depth from surface
			Inches
KaA	Kato loam, moderately deep, 0 to 4 percent slopes.	36 to 42 inches of glacial outwash soil material over outwash of gravelly sand of uniform particle size. Somewhat poorly drained and in flat areas, on concave slopes of terraces, or in drainageways iu the uplands; a seasonal high water table is at a depth of 1½ to 3 feet. Surface layer high in content of organic matter.	0–17 17–37 37–43
KdA	Kato loam, deep, 0 to 4 percent slopes.	36 to 42 inches of glacial outwash soil material of uniform particle size. Underlain by sandy material over clayey shale that is within 4 feet of the surface. Somewhat poorly drained and in flat areas or on concave or convex slopes in the uplands. The areas in many places resemble benches. A seasonal high water table is at a depth of 1½ to 3½ feet. Surface layer high in content of organic matter.	0–14 14–30 30–44 44
KsB	Kato loam, deep, clay shale substratum, 1 to	24 to 36 inches of glacial outwash soil material of uniform particle	0–15

material and its estimated properties—Continued

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
Loam	OL or CL	A-6 or A-7-6	85-100	80-100	55-75	0. 8-2. 5	. 17	5. 8-7. 0	Moderate to high.
Loam	CL	A-6	85-100	80-100	55-75	0. 8-2. 5	. 16	5. 6-6. 6	Moderate.
Gravelly loamy sand	SM or GM	A-1 or A-2-4	50-90	20-95	15-30	10+	. 03	5. 6-6. 6	None.
Loam	CL or OL	A-6 or A-7-6	85-100	80-100	55-75	0. 8-2. 5	. 17	6. 4-7. 2	Moderate to high.
Loam to clay loam	CL	A-6	85-100	70-100	55-75	0. 8-2. 5	. 16	6. 4-7. 2	Moderate.
Sandy loam to sand	SM or GM	A-2-4	50-90	20-95	15-30	5. 0-10. 0	. 03	6. 4-7. 2	Low to none.
Shale material or	CH	A-7-6	85-100	80-100	70-100	<0. 05	[illegible]	[illegible]	[illegible]

TABLE 4.—*Brief description of the soil*

Symbol on map	Soil name	Description of soil material and site	Depth from surface
			Inches
MaD3 MaE2 MaE3	Marlean loam, 9 to 14 percent slopes, severely eroded. Marlean loam, 14 to 24 percent slopes, moderately eroded. Marlean loam, 14 to 24 percent slopes, severely eroded.		
NaC2 NaD2 NaE2	Nasset silt loam, 5 to 9 percent slopes, moderately eroded. Nasset silt loam, 9 to 14 percent slopes, moderately eroded. Nasset silt loam, 14 to 18 percent slopes, moderately eroded.	30 to 50 inches of loessal soil material of low sand content over limestone bedrock. Well drained and on convex slopes in the uplands. No effective water table. Surface layer medium in content of organic matter.	0–15 15–37 37–42 42
NoD NoE	Nordness silt loam, 5 to 14 percent slopes. Nordness silt loam, 14 to 24 percent slopes.	Less than 15 inches of loamy soil material over limestone bedrock. Well drained to excessively drained and on convex slopes in the uplands. No effective water table. Surface layer low in content of organic matter.	0–5 5–12 12–18
OrA OrB	Oran loam, 0 to 2 percent slopes. Oran loam, 2 to 5 percent slopes.	Deep, medium-textured, glacial soil material of variable particle size. Somewhat poorly drained and in flat areas, on concave or convex slopes in the uplands, or in drainageways in the uplands. A seasonal high water table is at a depth of 1 to 3½ feet. Surface layer medium in content of organic matter. In places a prominent stone line at a depth of 18 to 28 inches	0–14 14–42 42–50
OsB OsC2 OsD2 OsE2 OsE3 OsF2	Orwood silt loam, 2 to 5 percent slopes. Orwood silt loam, 5 to 9 percent slopes, moderately eroded. Orwood silt loam, 9 to 14 percent slopes, moderately eroded. Orwood silt loam, 14 to 18 percent slopes, moderately eroded. Orwood silt loam, 14 to 18 percent slopes, severely eroded. Orwood silt loam, 18 to 30 percent slopes, moderately eroded.	Deep, medium-textured, windblown soil material moderately low to medium in content of sand. Well drained and on convex slopes in the uplands. A seasonal high water table is below a depth of 4 feet. Surface layer medium in content of organic matter, except in severely eroded areas, where the content of organic matter is low.	0–8 8–50 50–60
Ot	Ossian silt loam.	Deep, medium-textured alluvial soil material low in content of sand. Poorly drained and in flat areas or on concave slopes of very low terraces or narrow bottom lands. Has a seasonal high water table.	0–15 15–42 42–50
OuA OuB OuC	Ostrander loam, 0 to 2 percent slopes. Ostrander loam, 2 to 5 percent slopes. Ostrander loam, 5 to 9 percent slopes.	Deep, medium-textured, glacial soil material of variable particle size. Well drained and on convex slopes in the uplands. A seasonal high water table is at a depth of 3½ to more than 5 feet. Surface layer medium in content of organic matter. A prominent stone line common at a depth of 18 to 24 inches.	0–18 18–24 24–55
OvB	Otter-Lawson-Ossian complex, 1 to 4 percent slopes.	For a description of the Otter soil material, see Colo and Otter silt loams; for a description of the Lawson soil material, see Lawson	

material and its estimated properties—Continued

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
Silt loam	CL or ML	A-4 or A-6	100	100	95–100	0. 8–2. 5	. 20	5. 6–6. 8	Moderate.
Silt loam and silty clay loam.	CL	A-7 or A-6	100	100	95–100	0. 8–2. 5	. 18	5. 4–6. 4	Moderate to high.
Clay	CH	A-7-6	85–100	80–100	70–100	<0. 05	. 15	6. 2–7. 2	High.
Limestone	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4).
Silt loam	CL or ML	A-4 or A-6	100	100	95–100	0. 8–2. 5	. 18	6. 2–6. 8	Low to moderate.
Silt loam and silty clay loam.	CL	A-6 or A-7-6	95–100	95–100	90–100	0. 8–2. 5	. 18	6. 2–6. 8	Moderate.
Clay and limestone	CH	A-7-6	85–100	80–100	70–100	0. 05–2. 5	. 15	6. 2–8. 2	High.
Loam	CL or ML	A-6	85–100	80–100	55–75	0. 8–2. 5	. 16	5. 2–6. 8	Moderate.
Heavy loam [2]	CL	A-6	85–100	80–100	55–75	0. 2–0. 8	. 16	5. 4–6. 2	Moderate.
Loam	CL	A-6	85–100	80–100	55–75	0. 2–0. 8	. 15	6. 2–7. 8	Moderate.
Silt loam	CL or ML	A-4 or A-6	100	100	85–100	0. 8–2. 5	. 19	5. 8–7. 0	Moderate.
Loam and silt loam	CL or ML	A-6	100	90–100	60–90	0. 8–2. 5	. 16	5. 4–6. 2	Moderate.
Silt loam	CL or ML	A-4 or A-6	100	100	85–100	0. 8–2. 5	. 16	5. 4–6. 4	Moderate.
Silt loam	ML or OL	A-7-6	100	100	95–100	0. 8–2. 5	. 20	6. 2–7. 2	High.
Silt loam	ML or CL	A-6 or A-7-6	100	100	95–100	0. 8–2. 5	. 18	6. 2–7. 2	Moderate to high.
Silt loam	ML or CL	A-6	100	100	95–100	0. 8–2. 5	. 18	6. 4–7. 6	Moderate

TABLE 4.—*Brief description of the soil*

Symbol on map	Soil name	Description of soil material and site	Depth from surface
			Inches
Pk	Peaty muck.	10 to 48 inches of soil material, very high in content of organic matter, over silty, loamy, or sandy material. Poorly drained and in flat areas, on convex slopes in the uplands, or in drainageways in the uplands. A seasonal high water table is at the surface.	0–37 37–46
Pw	Peaty muck, overwashed.	6 to 20 inches of medium-textured alluvial soil material low in content of sand and underlain by peaty muck and muck. Somewhat poorly drained or poorly drained and in flat areas, on concave or convex slopes of narrow bottom lands, or in drainageways in the uplands. A seasonal high water table is at the surface of the peaty muck or muck. Surface layer low in content of organic matter; the next lower layer very high in content of organic matter.	0–10 10–31 31–42
RaA	Racine loam, 0 to 2 percent slopes.	Deep, medium-textured, glacial soil material of variable particle size. Well drained and on convex slopes in the uplands. A seasonal high water table is at a depth of 3½ to more than 5 feet. Surface layer medium in content of organic matter. A prominent stone line common at a depth of 18 to 24 inches.	0–12 12–34 34–44
RaB	Racine loam, 2 to 5 percent slopes.		
RaC	Racine loam, 5 to 9 percent slopes.		
RaC2	Racine loam, 5 to 9 percent slopes, moderately eroded.		
RaD2	Racine loam, 9 to 14 percent slopes, moderately eroded.		
ReB	Renova loam, 2 to 5 percent slopes.	Deep, medium-textured, glacial soil material of variable particle size. Well drained and on convex slopes in the uplands. A seasonal high water table is below a depth of 4 feet. Low content of organic matter. A prominent stone line common at a depth of 18 to 24 inches.	0–7 7–16 16–50
ReC	Renova loam, 5 to 9 percent slopes.		
ReC2	Renova loam, 5 to 9 percent slopes, moderately eroded.		
ReD2	Renova loam, 9 to 14 percent slopes, moderately eroded.		
ReD3	Renova loam, 9 to 14 percent slopes, severely eroded.		
ReE2	Renova loam, 14 to 18 percent slopes, moderately eroded.		
ReE3	Renova loam, 14 to 18 percent slopes, severely eroded.		
RfB	Riceville loam, 2 to 7 percent slopes.	Deep, medium-textured, glacial soil material of fairly variable particle size. Moderately well drained and on convex slopes in the uplands. The structure, texture, and bulk density result in firm consistence at a depth of 1½ to 3½ feet. Surface layer medium in content of organic matter.	0–12 12–16 16–56
RkA	Rockton loam, 0 to 2 percent slopes.	15 to 30 inches of medium-textured glacial soil material of variable particle size over limestone bedrock. Well drained and on convex slopes in the uplands. No effective water table. Surface layer medium in content of organic matter.	0–18 18–28 28–31 31
RkB	Rockton loam, 2 to 5 percent slopes.		
RkC	Rockton loam, 5 to 9 percent slopes.		
RkD	Rockton loam, 9 to 14 percent slopes.		
RwA	Rowley silt loam, 0 to 4 percent slopes.	Deep, medium-textured alluvial soil material low in content of	0–13

material and its estimated properties—Continued

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
Peaty muck	Pt	(1)	(1)	(1)	(1)	(1)	.25	6.0–7.0	Moderate.
Silty clay loam	CL	A–7–6	85–100	80–100	65–100	0.2–0.8	.18	6.0–7.0	Moderate to high.
Silt loam	CL or ML	A–4 or A–6	100	100	95–100	0.8–2.5	.18	6.6–7.8	Low to moderate.
Peaty muck	Pt	(1)	(1)	(1)	(1)	(1)	.25	6.0–7.0	Moderate.
Loam	CL	A–6	85–100	80–100	55–85	0.8–2.5	.14	6.0–7.0	Moderate.
Loam	CL	A–6 or A–4	95–100	90–100	65–75	0.8–2.5	.16	5.6–6.8	Moderate.
Loam [2]	CL	A–6	75–95	65–95	65–75	0.2–0.8	.15	5.0–5.8	Moderate.
Sandy clay loam	CL or SC	A–6 or A–4	90–95	80–95	40–75	0.2–0.8	.14	5.0–7.6	Moderate.
Loam	CL	A–6 or A–4	95–100	95–100	65–75	0.8–2.5	.16	5.8–6.8	Moderate.
Loam [2]	CL	A–6	75–95	65–95	65–75	0.8–2.5	.15	5.0–6.0	Moderate.
Loam and sandy clay loam.	CL or SC	A–6 or A–4	90–95	80–95	40–75	0.8–2.5	.14	5.0–6.4	Moderate.

TABLE 4.—*Brief description of the soil*

Symbol on map	Soil name	Description of soil material and site	Depth from surface
			Inches
SdA SdB SdC2 SdD2	Sattre loam, moderately deep, 0 to 2 percent slopes. Sattre loam, moderately deep, 2 to 5 percent slopes. Sattre loam, moderately deep, 5 to 9 percent slopes, moderately eroded. Sattre loam, moderately deep, 9 to 14 percent slopes, moderately eroded.	24 to 36 inches of medium-textured soil material that is medium to high in content of sand and is underlain by gravelly sand. Well drained and in flat areas or on convex slopes on terraces or uplands. No effective water table above a depth of 4 to 5 feet. Surface layer medium in content of organic matter.	0–10 10–30 30–46
Sp	Spillville loam.	Deep, alluvial soil material medium to high in content of sand. Moderately well drained and on flat, low bottom lands. A seasonal high water table is below a depth of 4 feet. Uppermost 30 to 50 inches medium in content of organic matter.	0–60
Sr	Steep rock land.	Outcrops of bedrock dominant in these areas. The bedrock is dominantly limestone, but sandstone and shale are interbedded.	(4)
SsF	Steep sandy land, 14 to 30 percent slopes.	Sandy loam to sand is dominant in this land type, and the soil material includes some gravel. Dominantly terrace escarpments, but there are some convex slopes in the uplands.	0–60
TeA TeB	Terril loam, 0 to 2 percent slopes. Terril loam, 2 to 5 percent slopes.	Deep, uniform, alluvial loam. Well drained and on convex slopes of terraces and alluvial fans. A seasonal high water table is below a depth of 4 feet. The surface layer is 20 to 40 inches thick and is high in content of organic matter.	0–32 32–48
TgA TgB	Turlin gritty silt loam, 0 to 2 percent slopes. Turlin gritty silt loam, 2 to 5 percent slopes.	Deep, medium-textured, alluvial soil material that is medium to high in content of sand and is of uniform particle size. Somewhat poorly drained and in low, flat areas or on convex slopes on terraces. A seasonal high water table is at a depth of 2 to 3½ feet. The surface layer is 20 to 40 inches thick and is moderately high in content of organic matter.	0–34 34–52
VcA VcB	Volney channery silt loam, 0 to 1 percent slopes. Volney channery silt loam, 2 to 5 percent slopes.	Deep, medium-textured, alluvial soil material low in content of sand. Fragments of limestone that are generally 2 to 6 inches in diameter but that range from one-eight inch in diameter to slabs 15 inches in diameter are dominant in the soil material. Well drained and on low bottom lands that are frequently flooded. No effective seasonal high water table. Low in content of organic matter.	0–30 30–50
VoA VoB	Volney silt loam, overwashed, 0 to 1 percent slopes. Volney silt loam, overwashed, 2 to 5 percent slopes.	6 to 20 inches of medium-textured, alluvial soil material low in content of sand. Underlain by medium-textured alluvial soil material, also low in content of sand, in which fragments of limestone 2 to 6 inches in diameter are dominant. Well drained and on low bottom lands that are commonly flooded. No effective seasonal high water table. Low in content of organic matter.	0–17 17–37 37–50
WcA WcB WcC WcD	Waucoma loam, 0 to 2 percent slopes. Waucoma loam, 2 to 5 percent slopes. Waucoma loam, 5 to 9 percent slopes. Waucoma loam, 9 to 14 percent slopes.	30 to 50 inches of medium-textured glacial soil material of variable particle size over limestone bedrock. Well drained and on convex slopes in the uplands. No effective water table. Surface layer medium in content of organic matter.	0–14 14–23 23–36

material and its estimated properties—Continued

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
Loam	CL	A-6 or A-4	90–100	80–100	55–75	0. 8–2. 5	. 16	5. 8–6. 8	Low to moderate.
Loam	CL	A-6	90–100	80–100	55–75	0. 8–2. 5	. 15	5. 4–6. 6	Moderate.
Sand (gravelly) [3]	SM or SW	A-2	70–100	75–100	0–15	5–10	. 02	4. 8–5. 8	None.
Loam	CL	A-6 or A-4	95–100	95–100	55–85	0. 8–2. 5	. 17	6. 6–7. 4	Moderate.
([4])	([4])	([4])	([4])	([4])	([4])	([4])	([4])	([4])	([4]).
Sand	SM or SW	A-1, A-2, or A-4.	90–100	80–100	5–50	2–5–10. 0	. 03	5. 4–6. 6	Low to none.
Loam	CL	A-6	85–100	80–100	55–75	0. 8–2. 5	. 18	6. 4–7. 0	Moderate.
Loam	CL	A-6	85–100	80–100	55–75	0. 8–2. 5	. 17	6. 4–7. 0	Moderate.
Gritty silt loam and loam.	OL or ML	A-6	95–100	90–100	55–75	0. 8–2. 5	. 18	6. 2–7. 2	Moderate.
Loam	CL	A-6 or A-4	95–100	90–100	55–75	0. 8–2. 5	. 17	5. 8–7. 0	Moderate.
Channery silt loam	SC	A-4 or A-2	50–60	40–60	25–50	0. 8–2. 5	. 17	7. 0–8. 2	Low.
Limestone fragments and silty material.	GM	A-2-4	10–50	20–50	15–35	5. 0–10. 0+	. 08	6. 6–7. 6	None.
Silt loam	ML or CL	A-4 or A-6	95–100	90–100	85–100	0. 8–2. 5	. 18	6. 8–8. 2	Low to moderate.
Channery silt loam	SC	A-4 or A-2	50–60	40–60	25–50	0. 8–2. 5	. 17	7. 0–8. 2	Low.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 4.—*Brief description of the soil*

Symbol on map	Soil name	Description of soil material and site	Depth from surface
			Inches
WhB	Whalan loam, 2 to 5 percent slopes.	15 to 30 inches of medium-textured glacial soil material of fairly variable particle size. Underlain by bedrock, dominantly limestone. Well drained and on convex slopes in the uplands. No effective water table. Low in content of organic matter.	0–7 7–15 15–28 28–30 30
WhC2	Whalan loam, 5 to 9 percent slopes, moderately eroded.		
WhD2	Whalan loam, 9 to 14 percent slopes, moderately eroded.		
WhE2	Whalan loam, 14 to 24 percent slopes, moderately eroded.		
WhE3	Whalan loam, 14 to 18 percent slopes, severely eroded.		
WkA	Winneshiek loam, 0 to 2 percent slopes.	15 to 30 inches of medium-textured glacial material of fairly variable particle size. Underlain by bedrock, dominantly limestone. Well drained and on convex slopes in the uplands. No effective water table. Surface layer medium in content of organic matter.	0–11 11–21 21–24 24
WkB	Winneshiek loam, 2 to 5 percent slopes.		
WkC	Winneshiek loam, 5 to 9 percent slopes.		
WkC2	Winneshiek loam, 5 to 9 percent slopes, moderately eroded.		
WkD	Winneshiek loam, 9 to 14 percent slopes.		
WkE	Winneshiek loam, 14 to 18 percent slopes.		

[1] No estimates feasible.
[2] Includes pebble band or stone line.
[3] Has a variable content of gravel, ranging from only a small amount to dominant.

TABLE 5.—*Interpretations of*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Alluvial land (Ab)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Arenzville (Ar)	Good	Not suitable.	Not suitable.	Not suitable.	Fair to very poor; low stability and bearing capacity when wet; in many	Poor; subject to frequent flooding; low potential as borrow material; poor	Not suitable; nearly level; subject to frequent flooding; if used for a

material and its estimated properties—Continued

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
Loam to silt loam	CL	A-4 or A-6	85–100	80–100	55–75	0.8–2.5	.16	5.6–6.8	Moderate.
Loam	CL	A-6	85–100	80–100	55–75	0.8–2.5	.15	5.4–6.2	Moderate.
Clay loam	CL	A-6	85–100	80–100	55–75	0.2–0.8	.16	5.2–6.2	Moderate.
Clay	CH	A-7-6	85–100	80–100	70–100	<0.05	.15	6.4–7.8	High.

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Atterberry (AyA)	Good	Not suitable.	Not suitable.	Not suitable.	Poor; high volume change and low bearing capacity when wet; moderate to high compressibility; very narrow range of moisture content for suitable compaction.	Fair to poor; seasonal high water table; moderately high content of organic matter in the surface layer; low potential as borrow material.	Fair; bottom of reservoir should be compacted.
Backbone (BaB BaC, BaD).	Very poor	Fair; poorly graded sand.	Not suitable.	Bedrock suitable for crushing.	Sand is good; bedrock not suitable unless crushed; good bearing capacity and shear strength; very low compressibility.	Fair; generally great need for cuts and fills; bedrock at a depth of 20 to 40 inches; good potential as borrow material.	Poor; rapid seepage; material too porous to hold water.
Bassett loam (BeA, BeB, BeC, BeC2).	Good to fair.	Not suitable.	Not suitable.	Not suitable.	Good below a depth of 15 to 20 inches; fair to good bearing capacity; easily compacted to a high density.	Good; seepage may occur in some cuts; susceptible to frost action where pockets of water-bearing sand occur; good workability.	Good to fair; vertical and horizontal veins of sand are common; bottom of reservoir should be scarified and compacted.
Bassett silt loam (BlB, BlC).	Good	Not suitable.	Not suitable.	Not suitable.	Fair in the silty material, which is about 20 inches thick over glacial till; good in the till; the till has good bearing capacity.	Good; in places seepage may occur in some cuts; susceptible to frost action where the soil material is water bearing.	Good to fair; vertical and horizontal veins of sand are common; bottom of reservoir should be scarified and compacted.
Bertrand (BnA, BnB)	Fair	Not suitable.	Not suitable.	Not suitable.	Poor; moderate to high volume change; poor stability when wet.	Fair to poor; poor potential as borrow material; poor compaction when wet.	Fair to poor; the subsoil is pervious; sealer may be required to prevent excessive seepage.

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Fair; fair stability; moderate to high volume change; difficult to compact to high density.	Tile drains function well but are not required in all areas.	Good; in places tile drains are required before an area is irrigated; high available moisture capacity.	Generally not needed, because of gently sloping topography.	Satisfactory, but in places tile drains are needed on the sides of the waterways to control seepage.	Moderate to severe; seasonal high water table.	Moderate; in places saturation is likely to cause the soil to lose cohesion and settle; uniform consolidation; seasonal high water table.
Fair to poor; pervious, even where compacted; high stability; low volume change when the soils are wetted; susceptible to piping.	Not needed	Fair; low available moisture capacity; high infiltration rate.	Terraces difficult to construct and maintain; limestone at a depth of 20 to 40 inches.	Erodible, and vegetation is difficult to establish or maintain.	Moderate to severe; in places the cracked bedrock allows unfiltered sewage to travel a long distance.	None where footings rest on bedrock.
Good; moderate stability; slow permeability and low volume change where compacted.	Tile drains function well, but they are not needed in most areas.	Fair; moderate or moderately slow permeability below a depth of 2½ feet; high available moisture capacity.	Subsoil is low in fertility below a depth of about 15 to 20 inches; cuts should be held to a minimum; stones occur in places.	Some limitations; vegetation difficult to establish; tile drains needed on the sides of waterways to control seepage.	Moderate; moderate or moderately slow permeability below a depth of 2½ feet.	Slight; good bearing capacity and shear strength; low compressibility.
Good; moderate stability; moderate volume change in silty material; slow permeability where compacted.	Not needed	Good; moderate or moderately slow permeability below a depth of 3 feet; high available moisture capacity.	Well suited	Well suited; tile drains needed on the sides of the waterways to control seepage.	Slight to moderate; moderate or moderately slow permeability below a depth of 3 feet.	Slight; moderate to low compressibility; fair to good bearing capacity and shear strength.
Good to fair; moderate stability; poor compaction when wet.	Not needed	Good water intake and high moisture capacity.	Good, but not needed in most places.	Satisfactory, but not needed in most places.	Slight; moderate permeability.	Moderate; fair shear strength; moderate compressibility; saturation may cause soil to lose cohesion and settle.

TABLE 5.—*Interpretations of engineering*

properties of soils—Continued

Farm ponds—Con. Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for— Septic tank fields	Foundations for low buildings
Good; very stable; fair to good compaction, except where the content of fines is less than 15 percent; low volume change.	Not needed	Good; because of the gravelly sand below a depth of 2 feet, however, more frequent application of water is required than in areas where the underlying material is finer textured; low to medium available moisture capacity.	The ridges of terraces are difficult to construct and maintain.	Not needed in most places; vegetation difficult to establish.	Slight; in places, however, the gravelly sand may allow unfiltered sewage to travel a long distance.	Slight; good bearing capacity and shear strength; low compressibility; low volume change.
Fair; very stable; pervious; fair to good compaction, except where the content of fines is less than 15 percent; low volume change when the soils are wetted.	Not needed	Fair; rapid permeability; low available moisture capacity.	Highly erodible, and vegetation is difficult to establish; shallow over coarse-textured material.	Highly erodible, and vegetation difficult to establish and maintain.	Moderate; poor filtering of the material allows unfiltered sewage to travel a long distance.	Slight; good shear strength; low compressibility; low volume change if the soil material is wetted.
Poor; high in content of clay; wet; high in content of organic matter and less than 3 feet deep over shale; the shale has high shrink-swell potential.	Each site requires investigation; tile may not drain all areas.	Poor; slow or very slow permeability in the substratum; drainage needed before irrigating.	Diversions, properly placed, make the soils less wet by preventing local flooding.	Tile drains needed to control seepage so that vegetation can be established.	Not suitable; has a seasonal high water table; slow or very slow permeability.	Severe; underlain by weathered shale; subject to dangerous expansion if initially dry; moderate compressibility.
Fair; contains a limited supply of suitable material; compaction good in soil material above bedrock; low compressibility.	Generally not needed.	Fair; low to moderate available moisture capacity.	Bedrock hinders construction in places; cuts should be held to a minimum.	Satisfactory for shallow excavations, but not needed in most places.	Moderate; the fractured bedrock allows unfiltered sewage to travel a long distance.	None where the foundation rests on limestone bedrock.
Fair to good; the subsoil has moderate stability and moderate volume change; the substratum has high stability and low volume change.	Not needed	Good; medium available moisture capacity; moderately permeable.	Cuts should be restricted to a minimum to prevent exposing the coarse-textured material in the substratum.	Satisfactory, but not needed in most places.	Slight; the coarse texture of the substratum, however, may permit unfiltered sewage to travel a long distance.	Slight below a depth of 3 feet; good shear strength; low compressibility; low volume change on wetting and drying.

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Caneek (Ce)	Good	Not suitable.	Not suitable.	Not suitable.	Fair to poor; has very low stability and bearing capacity when wet; difficult to compact to high density.	Poor; subject to flooding and has a high water table; the soil material has low density and has low potential as borrow material.	Poor to fair; subject to flooding; some seepage can be expected.
Canoe (Cf)	Good	Not suitable.	Not suitable.	Not suitable.	Poor; has high volume change and low bearing capacity when wet; very narrow range of moisture content for suitable compaction.	Fair to poor; has seasonal high water table; surface layer moderately high in content of organic matter; has low potential as borrow material.	Fair, but a good site is rare; bottom of reservoir should be compacted.
Chaseburg (ChA, ChB, DgB). (In places mapped with Dorchester and Volney soils; interpretations for the Dorchester and Volney soils are given under their respective series.)	Good	Not suitable.	Not suitable.	Not suitable.	Fair to poor; low stability and bearing capacity when wet; poor compaction when wet.	Fair; subject to flash flooding; low potential as borrow material.	Poor to fair; the bottom of reservoir should be compacted; some seepage can be expected.
Chelsea (ClB, ClD)	Not suitable.	Good; source of poorly graded fine to medium sands.	Not suitable.	Not suitable.	Fair to good; except when damp, lacks stability under wheel loads; no volume change when wet.	Fair to good; loose sand may hinder hauling operations; highly erodible; vegetation difficult to establish on cuts; may become quick or flow when saturated.	Not suitable; rapid permeability; material too porous to hold water.
Clyde (CmB, FmB) (In places mapped with Floyd soils; interpretations for the Floyd soils are given under the Floyd series.)	Good, but often wet.	Not suitable.	Not suitable.	Not suitable.	Not suitable; high content of organic matter; high water table; moderate to high volume change; poor workability.	Poor; high water table and high content of organic matter; highly susceptible to frost action; nearly level.	Fair to good; bottom of reservoir may need to be compacted; thin layer of sand common.

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Fair in upper part and poor in lower part; high water table; low stability when wet; moderate volume change.	Tile drains function well; protection from stream overflow needed.	Good; requires tile drainage before irrigating; subject to flooding; high available moisture capacity.	Diversions helpful in protecting the areas from local runoff; terraces not needed.	Not needed.	Not suitable; subject to flooding and has a high water table.	Severe; wet and subject to flooding and deposition; fair shear strength and moderate to high compressibility.

[illegible]

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Coggon (CoB, CoC2)	Fair to poor.	Not suitable.	Not suitable.	Not suitable.	Good; good bearing capacity and easily compacted to high density.	Good; seepage may occur in some cuts; susceptible to frost action where pockets of water-bearing sand occur.	Good to fair; vertical and horizontal veins of sand are common; bottom of reservoir needs to be scarified and compacted.
Colo (Cs, Ct) (Mapped only with Otter and Ossian soils; interpretations for the Otter and Ossian soils are given under their respective series.)	Good, but often wet.	Not suitable.	Not suitable.	Not suitable.	Very poor; high in content of organic matter; fair to poor bearing capacity; high compressibility; difficult to compact to high density.	Poor; high in content of organic matter; subject to flooding; seasonal high water table; low borrow potential; poor bearing capacity.	Poor; nearly level; subject to flooding.
Dickinson (DcA, DcB DcC, DcD).	Fair to good.	Good; poorly graded fine and medium sands.	Fair to poor.	Not suitable.	Good to excellent; good workability and stability; low volume change on wetting and drying.	Good; protection of the slopes required; loose sand may hinder hauling operations; seepage occurs in places in some deep cuts.	Poor; rapidly permeable material, too porous to hold water.
Donnan (DbB)	Fair	Not suitable.	Not suitable.	Not suitable.	Fair in uppermost 20 to 40 inches; not suitable in the substratum; moderate to high volume change; poor bearing capacity; poor workability when wet.	Poor; seasonal perched water table at a depth of 20 to 40 inches; highly susceptible to frost action; in many places seepage occurs in the cuts.	Good; very slow permeability when compacted; reservoir area not uniform and should be compacted.
Dorchester (De, DgB) (In places mapped with Chaseburg and Volney soils; interpretations for the Chaseburg and Volney soils are given under their respective series.)	Good	Not suitable.	Not suitable.	Not suitable.	Fair in upper part and poor below; soil material has low density; substratum high in content of organic matter; low bearing capacity when wet.	Poor; subject to flooding; low potential as borrow material.	Poor; nearly level; subject to flooding.

properties of soils—Continued

Farm ponds—Con. Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for— Septic tank fields	Foundations for low buildings
Good; moderate stability; slow permeability when compacted; good workability at optimum moisture content.	Generally not needed.	Fair; moderate to moderately slow permeability below a depth of 2½ feet; high available moisture capacity.	In places a stone line below a depth of about 20 inches will interfere with construction; some areas are wet after terraces are installed; cuts should be held to a minimum.	Some limitations; in places a stone line will hinder construction; in places tile drains are needed for vegetation to become established.	Moderate; moderate to moderately slow permeability below a depth of 2½ feet.	Slight; low consolidation; good bearing capacity and shear strength.
Poor; high in content of organic matter; high shrink-swell potential; poor workability.	Needs protection from flooding; tile drains function well.	Good; soil requires drainage before it is irrigated; high available moisture capacity.	In places diversions are beneficial for controlling local runoff and reducing wetness.	Not needed	Not suitable; seasonal high water table; subject to flooding.	Severe; high compressibility but uneven consolidation; high water table; subject to flooding.
Fair to good; pervious, even when compacted; high stability and some volume change; susceptible to piping in places.	Not needed	Good; rapid intake; low available moisture capacity.	Highly erodible; vegetation difficult to establish where cuts expose the sandy substratum.	Highly erodible; vegetation difficult to establish.	Moderate; soils make poor filtering material and may allow unfiltered sewage to travel a long distance.	Slight; good shear strength; very low compressibility; negligible volume change, but may become quick and flow if the soil material is saturated.
Fair to poor; high shrink-swell potential; poor compaction and workability when wet.	All areas may not need drainage.	Poor; adequate drainage needed before irrigation; subsoil is slowly permeable.	Not well suited; a clayey subsoil is at a depth of 20 to 40 inches, and the surface layer is low in fertility; cuts should be held to a minimum.	Not needed in most places; vegetation difficult to establish; tile drains needed on the sides of the waterway.	Severe; slowly permeable below a depth of 20 to 40 inches; seasonal high water table.	Severe; the substratum is clayey and subject to dangerous changes in volume if it is initially dry; moderate compressibility.
Fair in upper part and poor below; low stability when wet; high compressibility.	Protection from flooding needed.	Good; subject to flooding; high available moisture capacity.	Diversions help to protect the soils from local runoff.	Not needed	Severe; subject to flooding and deposition.	Severe; subject to flooding and deposition; moderate to high compressibility.

TABLE 5.—*Interpretations of engineering*

Suitability as source of—	Farm ponds

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Fair to poor; fair stability; high volume change when compacted; poor workability when wet.	Tile drains not needed in most areas.	Fair to poor; highly erodible; has steep slopes; high available moisture capacity.	Not suitable on slopes of more than 12 percent.	Highly erodible, and vegetation difficult to establish.	Severe on slopes that exceed 12 percent; moderate permeability.	Moderate; low stability and low bearing capacity when wet; moderate to high compressibility.
Fair; medium stability; moderate to high expansion	Not needed	Good; moderate intake of water; high available	Well suited on slopes as steep as 12 percent.	Well suited; tile drains needed on the sides of the water-	Slight on slopes of less than 10 percent; moderate permea-	Slight to moderate; fair bearing capacity except

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Floyd (FlB, FmB) (In places mapped with Clyde soils; interpretations for the Clyde soils are given under the Clyde series.)	Good	Not suitable.	Not suitable.	Not suitable.	Poor; high content of organic matter to a depth of about 20 inches; moderate to high shrink-swell potential; moderate to high compressibility in uppermost 3 feet of soil material.	Poor; has a seasonal high water table; high content of organic matter to a depth of 20 inches; highly susceptible to frost heaving; has low borrow potential.	Fair to poor; in places contains layers of coarse-textured material that require sealing to prevent excessive seepage.
Franklin (FnB)	Good	Not suitable.	Not suitable.	Not suitable.	Fair in upper part of profile; good in the glacial till; fair to good bearing capacity; till easily compacted to	Fair; has a seasonal high water table; highly susceptible to frost action.	Fair to poor; bottom of reservoir should be compacted; pockets and strata of sand occur in places

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Fair; fair stability; high content of organic matter; high volume change when soil material is compacted; fair to good compaction at optimum moisture content.	Tile drains function well.	Good; drainage required before irrigating; high available moisture capacity.	Terraces not needed, because of nearly level or gently sloping topography; diversions, properly placed, help to make this soil less wet.	Tile needed on the sides of waterway to control seepage so that vegetation can be established.	Severe; has a seasonal high water table.	Moderate; moderate to high compressibility; uniform consolidation; fair shear strength.
Fair to poor in uppermost 15 to 40 inches of soil material; good below that depth;	Tile drains function well, but not needed in all areas.	Good; high available moisture capacity; in places tile drains re-	Terraces not needed, because of nearly level or gently sloping topography.	Well suited; tile drains needed on the sides of waterway to control seep-	Moderate to severe; has a seasonal high water table.	Moderate; has a seasonal high water table; fair to good bearing capacity; uneven

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Hayfield: Deep (HdA)	Good	Good below a depth of 36 inches.	Fair to good below a depth of 36 inches.	Not suitable.	Fair above a depth of 36 inches; good below that depth; great loss in bearing capacity when material above a depth of 36 inches is wet; moderate volume change to a depth of 36 inches; low volume change below that depth.	Fair to good; nearly level topography; has a seasonal high water table; good potential as borrow material below a depth of 36 inches; high potential frost action.	Not suitable; substratum coarse textured and too porous to hold water.
Moderately deep (HmA).	Good	In places good below a depth of 24 to 36 inches.	In places good below a depth of 24 to 36 inches.	Not suitable.	Fair to a depth of 24 to 36 inches; good below that depth.	Fair to good; nearly level; has a seasonal high water table; good potential as borrow material; high potential frost action.	Not suitable; substratum coarse textured and too porous to hold water.
Huntsville (HuA, HuB).	Very good	Not suitable.	Not suitable.	Not suitable.	Poor; low bearing capacity when wet; high volume change when compacted; high in content of organic matter.	Fair to poor; subject to overflow; high content of organic matter; high compressibility; poor foundation for high fills.	Poor; nearly level; subject to overflow; material used for reservoir area needs to be compacted.

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Fair to a depth of 36 inches; good below that depth; medium stability and moderate volume change in subsoil; high stability and low volume change in substratum; poor resistance to piping.	Tile drains function well; the coarse texture of the substratum increases difficulty of installing tile.	Good; drainage required before irrigating; medium to high available moisture capacity.	Generally not needed; diversions, properly placed, help to protect from local runoff.	Generally not needed.	Moderate to severe; has a seasonal high water table; below a depth of 36 inches, the soil makes poor filtering material.	Moderate; good shear strength; has a seasonal high water table; very low compressibility; low volume change below a depth of 36 inches when soil material is wetted and dried; soil material below a depth of 36 inches may become quick and flow if it is saturated when excavation takes place.
Fair to a depth of 24 to 36 inches; good below a depth of 36 inches; medium stability and moderate volume change in subsoil; high stability and low volume change in substratum; poor resistance to piping.	Tile drains function well; the coarse texture of the substratum increases difficulty of installing tile.	Good; in places drainage is required before irrigating; medium available moisture capacity.	Generally not needed; diversions, properly placed, help to protect from local runoff.	Generally not needed.	Moderate to severe; has a seasonal high water table; below a depth of 24 to 36 inches, the soil makes poor filtering material.	Moderate; good shear strength; has a seasonal high water table; very low compressibility; low volume change when soil material below a depth of 24 to 30 inches is wetted and dried; soil material below a depth of 36 inches may become quick and flow if it is saturated when excavation takes place.
Fair; medium stability; moderate volume change; fair compaction at optimum moisture content; poor compaction if material	Not needed	Good; moderate water intake rate; high available moisture capacity; protection from stream overflow needed	Terraces not needed; well suited to diversions.	No limitations; not needed in most areas.	Slight to moderate; subject to stream overflow of short duration; moderate permeability.	Slight to moderate; fair shear strength and bearing capacity; moderate compressibility; subject to overflow.

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Jacwin (JaA, JaB, JaC, JaD).	Good	Not suitable.	Not suitable.	Not suitable.	Not suitable; shale at a depth of 15 to 30 inches; soil material above the shale is high in content of organic matter and has low density; shale subject to high volume change.	Poor; surface layer high in content of organic matter; seasonal high water table; low borrow potential.	Fair; shale at a depth of 15 to 30 inches; bottom of reservoir may need to be compacted; contains thin strata of limestone in places.
Kato:							
Deep (KdA)	Good	Fair; high water table.	Fair below a depth of 36 to 42 inches; high water table.	Not suitable.	Poor to a depth of 3 feet; very good below that depth; material to a depth of 3 feet is high in content of organic matter and is of low density.	Fair; has a seasonal high water table; surface layer high in content of organic matter.	Bottom of reservoir needs to be compacted; coarse-textured material, too porous to hold water, below a depth of 36 inches; seasonal high water table.
Moderately deep (KaA).	Good	Fair; high water table.	Fair below a depth of 24 to 36 inches; high water table.	Not suitable.	Poor to a depth of 2 feet; material high in content of organic matter and has low density; very good below a depth of 2 to 3 feet; low compressibility and low volume change.	Fair; has a seasonal high water table; surface layer high in content of organic matter.	Bottom of reservoir needs to be compacted; coarse-textured material below a depth of 24 to 36 inches too porous to hold water; seasonal high water table.
Deep, clay shale substratum (KsB, KsC).	Good	Not suitable.	Not suitable.	Not suitable.	Poor to not suitable; shaly substratum within 4 feet of surface; high in content of organic matter; material overlying the shale is of low density.	Poor; seasonal high water table; surface layer high in content of organic matter; highly susceptible to frost action.	Fair; nearly level ln places; suitable for dugout ponds.

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Poor; shale at a depth of 15 to 30 inches; shale has high shrink-swell potential; high volume change; poor workability when wet.	Tile may not drain all areas; proper placement of tile drains and proper back filling are important.	Fair; drainage required before irrigating; subsoil and substratum very slowly permeable.	Diversions, properly placed, help to control local runoff and reduce wetness.	Tile drainage needed to control seepage so that vegetation can be established.	Not suitable; has a seasonal high water table; very slow permeability in shaly material in subsoil and substratum.	Severe; shale subject to dangerous volume change when content of moisture changes.
Fair to good; fair stability and moderate compressibility to a depth of 3 feet; good stability and very low compressibility below that depth; susceptible to piping.	Tile drains function well; has thin layers of coarse-textured material below a depth of 36 inches; soil material may become quick and flow when saturated and hinder installation of the system.	Fair to good; drainage required before irrigating; medium available moisture capacity.	Terraces not needed, because of topography.	Well suited, but tile drains required to prevent seepage where vegetation is to be established.	Moderate; has a seasonal high water table; soils make poor filtering material below a depth of 3 feet.	Moderate; soil material below a depth of 3 feet subject to low volume change on wetting; material below a depth of 2 feet may become quick and flow if it is saturated during excavation.
Fair to good; fair stability to a depth of 2 to 3 feet; compressibility and volume change moderate to a depth of 2 to 3 feet and very low below that depth; susceptible to piping.	Tile drains function well; contains coarse-textured strata below a depth of 2 to 3 feet; soil material may become quick and flow when saturated and hinder installation of the system.	Fair to good; drainage required before irrigating; low to medium available moisture capacity.	Terraces not needed, because of topography.	Well suited, but tile drains required to prevent seepage where vegetation is to be established.	Moderate; has a seasonal high water table; soils make poor filtering material below a depth of 2 to 3 feet.	Moderate; soil material below a depth of 2 to 3 feet subject to low volume change on wetting; material below a depth of 2 to 3 feet may become quick and flow if it is saturated during excavation.
Fair to poor; fair	Tile drains func-	Fair; requires	Terraces not	Well suited, but	Severe; seasonal	Severe; shale is

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Kennebec (LkA) (Mapped only with Lawson soils; interpretations for the Lawson soils are given under the Lawson series.)	Very good	Not suitable.	Not suitable.	Not suitable.	Poor to very poor; high in content of organic matter; low bearing capacity when wet; moderate to high volume change.	Fair to poor; nearly level; subject to flooding; low potential as borrow material; high content of organic matter.	Poor; subject to flooding; nearly level; bottom of reservoir needs to be compacted.
Kenyon (KyB)	Good	Not suitable.	Not suitable.	Not suitable.	Good below a depth of about 1½ feet; fair to good bearing capacity; low compressibility; easily compacted to high density.	Good; seepage may occur in some cuts; good source of borrow material; susceptible to frost action where pockets of water-bearing sand occur.	Good to fair; vertical and horizontal veins of sand are common; bottom of reservoir should be scarified and compacted.
Lamont:							
Sandy loam (LaB, LaC, LaD).	Poor	Good; poorly graded fine and medium sands.	In a few places below a depth of 2 feet.	Not suitable.	Good; low volume change on wetting; good workability and good compaction except where the content of fines is less than 15 percent; highly stable under wheel loads, regardless of the moisture content.	Good; soil material on slopes highly erodible; has good potential as borrow material; in some cuts the sand may be saturated and become quick and flow when an excavation is made.	Poor; rapid permeability; material too porous to hold water without a sealer.
Sandy loam, till subsoil variant (LdB).	Poor	Good to a depth of 15 to 36 inches, but poorly graded fine and medium sands.	Not suitable.	Not suitable.	Good; low compressibility; good bearing capacity and shear strength; good compaction and workability.	Good; seepage may occur in some cuts; good source of borrow material; highly susceptible to frost action where saturated strata occur.	Fair; veins of sand are common; the material in reservoir area should be compacted.

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Poor; fair stability; moderate to high content of organic matter; moderate to	Tile drains function well, but not needed in most areas.	Good; requires protection from flooding; high available moisture	Diversions, properly placed, help to divert local runoff and reduce wetness and deposition	Not needed	Severe; subject to occasional flooding; moderate permeability.	Moderate to severe; occasional flooding; high content of organic mat-

TABLE 5.—*Interpretations of engineering*

	Suitability as source of—			Farm ponds

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Fair; fair stability; high content of organic matter; moderate volume change; poor compaction if material is wet.	Tile drains function well; protection from flooding needed in some areas.	Good; drainage and protection from flooding required before irrigation; high available moisture capacity.	Diversions, properly placed, help to divert local runoff and reduce flooding and wetness.	Satisfactory, but generally not needed.	Severe; seasonal high water table; subject to flooding.	Moderate to severe; subject to flooding; moderate compressibility; uniform consolidation; fair shear strength; subject to frost action; subject to loss of bearing capacity on thawing.
Fair; fair stability; moderate to high shrink-swell potential; moderate compressibility.	Not needed	Not suitable; highly erodible.	Not suitable for terraces; too steep; diversions, properly placed, help to protect soils downslope from local runoff.	Highly erodible	Severe; the slopes exceed 12 percent.	Moderate; for short periods receives local runoff of high velocity.
Fair to good; good stability; low volume	Not needed	Not suitable; highly erodible.	Not suitable for terraces; diversions placed on	Not suitable; highly erodible; estab-	Not suitable	Severe because of the length and steepness

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Nordness (NoD, NoE)	Not suitable.	Not suitable.	Not suitable.	Limestone suitable for crushing below a depth of 15 inches.	Very good where crushed; 15 inches or less of soil material over limestone bedrock.	Fair; 15 inches or less of soil material over hard, level-bedded limestone; generally a great need for cuts and fills; good potential for borrow material.	Not suitable; limestone fractured in most places and too porous to hold water.
Oran (OrA, OrB)	Good	Not suitable.	Not suitable.	Not suitable.	Good to fair below a depth of 2 feet; low compressibility; easily compacted to high density; fair to good bearing capacity.	Fair; nearly level or gently sloping; seasonal high water table; highly susceptible to frost action.	Poor to fair; vertical and horizontal veins of gravelly sand are common; bottom of reservoir should be compacted.

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Poor; limestone at a depth of 15 inches or less; some settling can be expected when large fragments are used in fills.	Not needed	Poor; very low available moisture capacity.	Not suitable; very shallow over bedrock.	Poor; shallow over bedrock.	Not suitable; shallow over fractured bedrock.	None where footings rest on limestone bedrock.
Good to fair; fair	Tile drains	Fair; tile drain-	Terraces not	Good; tile	Severe; seasonal	Moderate;

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Otter (Cs, Ct, OvB, Ow, Ox).	Good, but often	Not suitable.	Not suit-	Not suitable.	Not suitable; high in con-	Poor; seasonal high water	Poor; nearly level; subject

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Poor; fair stability when dry, very low when wet; high in content of organic matter; high compressibility; high volume change; very narrow range of moisture content for suitable compaction.	Needed; tile drains function well; protection from flooding necessary.	Fair; tile drainage and protection from flooding required; high available moisture capacity.	Diversions, properly placed, help to control local runoff and reduce wetness.	Good; not needed in most places.	Not suitable; seasonal high water table; subject to flooding.	Severe; seasonal high water table and subject to flooding; very low bearing capacity when wet; may liquefy and flow if it is saturated when excavation takes place.
Uppermost 30 to 50 inches fair; has moderate stability; high compaction; difficult to compact to high density and has slow permeability; settling can be expected if large fragments of limestone are used in the fills.	Not needed	Fair to moderate available moisture capacity; highly erodible.	Fair on slopes of less than 12 percent; bedrock at a depth of 30 to 50 inches hinders construction in places.	Good	Moderate; bedrock at a depth of 30 to 50 inches; slopes generally exceed 10 percent; permeability moderate above the limestone.	None where footings rest on limestone bedrock.
Not suitable; organic soil material; high water table.	Interceptor tile needed in seepage areas; open intakes or surface ditches needed in ponded areas.	Good; rapid rate of water intake; very high available moisture capacity; drainage required before irrigating.	Not suitable	Not suitable	Not suitable; water table at or near the surface all year.	Not suitable.
Not suitable; organic soil material; high water table.	Open intakes or surface ditches needed in ponded areas; where feasible, tile should be placed in contact with the mineral soil material, below the organic soil material.	Good; rapid rate of water intake; very high or high available moisture capacity; drainage and protection from flooding required before irrigating.	Not suitable	Not suitable	Not suitable; water table at or near the surface.	Not suitable.
Good; moderate stability; easily compacted to high density; slow permeability where com-	Not needed	Good; moderate intake rate; high available moisture capacity.	Cuts should be held to a minimum because of stone line and low fertility of the subsoil.	Good; tile needed on the sides of waterways in many places to control seepage so	Slight; moderate permeability.	Slight; good bearing capacity and shear strength; low compressibility; uneven con-

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Renova (ReB, ReC, ReC2, ReD2, ReD3, ReE2, ReE3).	Fair in areas that are not eroded; poor in eroded areas.	Not suitable.	Not suitable.	Not suitable.	Good below a depth of 18 to 20 inches; good bearing capacity; low compressibility; easily compacted to high density.	Good; seepage may occur in some cuts; good source of borrow material; susceptible to frost action where pockets of water-bearing sand occur.	Fair to good; vertical and horizontal veins of sand are common; bottom of reservoir should be compacted.
Riceville (RfB)	Good to fair.	Not suitable.	Not suitable.	Not suitable.	Good in glacial till below a depth of 15 to 20 inches; good bearing capacity; easily compacted to high density.	Good to fair; seasonal perched water table; susceptible to frost action where pockets of water-bearing sand occur.	Good; sand lenses and pockets of sand are common; bottom of reservoir should be scarified and compacted.
Rockton (RkA, RkB, RkC, RkD).	Good	Not suitable.	Not suitable.	Limestone suitable for crushing below a depth of 15 to 30 inches.	Fair to good to a depth of 15 to 30 inches; good bearing capacity; moderate volume change; limestone bedrock at a depth of 15 to 30 inches; clayey residuum, where present above the limestone, is not suitable.	Fair; hard, level-bedded limestone at a depth of 15 to 30 inches; good potential for borrow material.	Poor; in many places bedrock is fractured and too porous to hold water.
Rowley (RoA, Rw) (In places mapped with Lawson soils; interpretations for the Lawson soils are given under the Lawson series.)	Good	Not suitable.	Not suitable.	Not suitable.	Poor; surface layer high in content of organic matter; high volume change and low bearing capacity when wet; very narrow range of moisture content for suitable compaction.	Fair to poor; seasonal high water table; low potential as borrow material; surface layer high in content of organic matter.	Fair; bottom of reservoir should be compacted.

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Good; moderate stability; easily compacted to high density; slow permeability where compacted; moderate potential for expansion.	Not needed	Good; moderate intake rate; high available moisture capacity.	Cuts should be held to a minimum because of stone line and low fertility of the subsoil.	Good; tile needed on the sides of waterways in many places to control seepage so that vegetation can be established.	Slight; moderate permeability.	Slight; good bearing capacity and shear strength; low compressibility; uneven consolidation.
Good; moderate stability; slow permeability where compacted.	Tile drainage allows field operations to be more timely; close spacing and careful placement of the tile necessary.	Fair; moderately slow permeability below a depth of 2 feet; high available moisture capacity.	Subsoil low in fertility; cuts should be held to less than 2 feet; in some places tile are needed in the channels of the terraces.	Some limitations; stone line at a depth of 2 feet; vegetation difficult to establish; tile are needed on the sides of waterways to control seepage.	Moderate; moderately slow permeability; seasonal perched water table.	Moderate; seasonal perched water table; good bearing capacity and shear strength; low compressibility.
Poor; limited supply of usable material above the bedrock; moderate volume change and good compaction of material over the bedrock.	Not needed	Fair; moderate intake rate; very low to low available moisture capacity.	In places limestone bedrock 15 to 30 inches below the surface hinders construction.	Satisfactory where sufficient cover can be left over the limestone.	Severe; shallow over bedrock; in places cracked bedrock allows unfiltered sewage to travel a long distance.	None where footings can be set on limestone bedrock.
Fair; fair stability; medium to high volume change on wetting; difficult to compact to high density; narrow range of moisture content for good workability.	Tile drains function well.	Fair to good; tile drainage required before irrigating; high available moisture capacity.	Terraces generally not needed; diversions, properly placed, help to control local runoff and reduce wetness.	Good; tile may be needed so that vegetation can be established.	Moderate; seasonal high water table.	Moderate; if soil becomes saturated, it may lose cohesion and settle; uniform consolidation; fair shear strength.

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Sattre:							
Deep (SbA, SbB, SbC2).	Good	Good below a depth of 36 inches.	Good below a depth of 36 inches.	Not suitable.	Fair to a depth of 36 inches; very good in substratum; little or no volume change; good stability at all moisture contents.	Good; generally little need for cuts and fills; good potential as borrow material.	Poor; substratum too porous to hold water.
Moderately deep (SdA, SdB, SdC2, SdD2).	Good	Good below a depth of 24 to 36 inches.	Fair to good below a depth of 24 to 36 inches.	Not suitable.	Fair to a depth of 24 to 36 inches; very good in substratum; low volume change and good bearing capacity; highly stable at all moisture contents.	Good; generally little need for cuts and fills; good potential for borrow material.	Poor; substratum too porous to hold water.
Spillville (Sp)	Very good	Not suitable.	Not suitable.	Not suitable.	Fair; high content of organic matter; moderate volume change on wetting; fair	Fair to poor; subject to flooding; high content of organic matter to a depth of	Poor; subject to flooding; reservoir area needs to be compacted; in places coarse-

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Fair to good; subsoil has medium stability and moderate volume change; good workability; high stability and low volume change in substratum; poor resistance to piping.	Not needed	Good; moderate intake rate; medium to high available moisture capacity.	Cuts should be held to a minimum to prevent exposure of the coarse-textured substratum.	Good; cuts should not expose the coarse-textured substratum.	Slight; moderate permeability; in places below a depth of 36 inches, material poor for filtering allows unfiltered sewage to travel a long distance.	Slight in substratum; good shear strength; very low compressibility; low volume change on wetting and drying.
Fair to good; subsoil has medium stability and moderate	Not needed	Good; moderate intake rate; medium available moisture	Cuts should be held to a minimum to prevent exposure of the coarse-textured	Good; where the coarse-textured substratum is not exposed.	Slight to moderate; in places poor material for filtering below a depth of	Slight in subsoil; good shear strength; very low compressibil-

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Fair; good stability; high in content of organic matter; high volume change; fair to poor resistance to piping.	Not needed	Good; high intake rate; high available moisture capacity.	Satisfactory; diversions help to protect from local runoff.	Satisfactory; not needed in most places.	Not suitable where soil occurs in drainageways; slight in other areas; moderate permeability.	Moderate; moderate to high compressibility; uneven consolidation; fair bearing capacity.
Fair; high content of organic matter; fair stability; moderate volume change.	Tile drains function well.	Good; drainage required before irrigating; high available moisture capacity.	Diversions, properly placed, help to protect from local runoff.	In places tile needed on the sides of drainageway to control seepage.	Severe; seasonal high water table; subject to flooding.	Severe; subject to flooding; moderate compressibility; material below a depth of 4 feet may become quick and flow if it is saturated when excavation is made.
Fair; fair stability; pervious; large fragments in fill can result in settling.	Not needed	Not suitable	Diversions, properly placed, help to protect from local runoff.	Not suitable	Not suitable; subject to flooding of short duration by water of high velocity.	Severe; subject to flooding of short duration by water of high velocity.
Fair; fair stability; pervious; large fragments in fill can result in settling.	Not needed	Not suitable	Diversions, properly placed, help to protect from local runoff.	Not suitable	Not suitable; subject to flooding of short duration by water of high velocity.	Severe; subject to flooding of short duration by water of high velocity.
Fair; semipervious where compacted; moderate stability and volume change; bedrock at a depth of 30 to 50 inches.	Not needed	Fair to good; medium available moisture capacity.	Bedrock at a depth of 30 to 50 inches may hinder construction.	Satisfactory, but generally not needed.	Moderate; in places fractured bedrock allows unfiltered sewage to travel a long distance; in places bedrock interferes with installation.	None where footings rest on limestone bedrock.

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Waukegan: Deep (WdA, WdB).	Good	Good below a depth of 36 to 45 inches.	Good below a depth of 36 to 45 inches.	Not suitable.	Fair to a depth of 36 to 45 inches; very good below that depth; subsoil has moderate vol-	Fair to good; surface layer high in content of organic matter; generally little need	Poor; coarse textured; too porous to hold water.

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Fair to good; subsoil medium in stability and has mod-	Not needed	Good; moderate water intake rate; medium to high avail-	Cuts should be held to a minimum to prevent exposure of the	Satisfactory, but generally not needed.	Slight; moderate permeability; material below a depth of 36	Slight in substratum; good shear strength; very

TABLE 6.—*Engineering test data for soil*

Soil name and location	Parent material	Iowa report No. AADO	Depth	Horizon	Moisture-density [2] Maximum dry density	Moisture-density [2] Optimum moisture
			Inches		*Lb. per cu. ft.*	*Percent*
Bassett loam: 460 feet S. and 175 feet E. of the NW. corner of SW¼ sec. 34, T. 97 N., R. 10 W.	Glacial till.	8409	6–12	A2	109	17
		8410	27–47	IIB22	118	13
		8411	47–72	IIB3	118	12
Clyde silt loam: 215 feet N. and 35 feet E. of the SE. corner of NE¼NW¼ sec. 5, T. 96 N., R. 10 W.	Outwash over till.	8406	0–11	A1	79	32
		8407	27–33	B2g	118	12
		8408	38–56	IIIC2	120	11
Dorchester silt loam: NE¼SW¼ sec. 33, T. 98 N., R. 8 W.	Alluvium.	8400	0–20	C	102	19
		8401	20–30	A1b	94	23
		8402	48–59	B22b	102	18
Fayette silt loam: 250 feet W. and 45 feet S. of the NE. corner of NW¼NE¼ sec. 21, T. 100 N., R. 8 W.	Loess.	8397	0–7	Ap	103	18
		8398	27–39	B22	103	18
		8399	46–80	C1	106	18
Floyd loam: 150 feet N. of the SW. corner of NW¼SW¼ sec. 4, T. 96 N., R. 10 W.	Glacial drift.	8412	0–12	A1	84	28
		8413	29–37	IIB22	(6)	(6)
		8414	41–64	IIB32	114	14
Ossian silt loam: SW¼NW¼ sec. 2, T. 96 N., R. 7. W.	Alluvium.	8394	7–17	C2	104	17
		8395	29–40	B21b	104	17
		8396	47–64	B3b	106	17
Riceville loam: 580 feet N. of the SW. corner of sec. 3, T. 96 N., R. 10 W.	Glacial till.	8391	0–8	A1	94	24
		8392	12–16	B1	107	18
		8393	20–42	IIB22	111	16

[1] Tests performed by the Iowa State Highway Commission in accordance with standard procedures of the American Association of State Highway Officials (AASHO).
[2] Based on AASHO Designation T 99–57, Method A (*1*).
[3] Mechanical analyses according to AASHO Designation T 88–57 (*1*). Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 mm. in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method

samples taken from selected soil profiles [1]

Mechanical analysis [3]									Liquid limit	Plasticity index	Classification	
Percentage passing sieve—					Percentage smaller than—						AASHO [4]	Unified [5]
¾ 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.	0.001 mm.				
		100	93	70	67	31	26	22	30	12	A-6(8)	CL.
98	97	96	90	57	51	32	27	24	32	17	A-6(7)	CL.
	100	99	92	60	56	32	26	22	32	18	A-6(8)	CL.
		100	97	85	82	33	22	16	65	21	A-7-5(16)	MH.
98	96	95	85	58	53	27	23	20	36	21	A-6(9)	CL.
	99	98	89	56	50	25	23	20	29	17	A-6(7)	CL.
			100	97	90	22	16	13	32	9	A-4(8)	ML-CL.
			100	97	89	29	20	14	47	20	A-7-6(13)	ML-CL.
		100	99	93	89	32	26	22	37	17	A-6(11)	CL.
			100	98	89	23	15	10	32	9	A-4(8)	ML-CL

Shown in table 4 is the percentage passing sieves of different sizes. This is the normal range of soil particles passing the respective screen sizes.

Permeability refers to the rate of movement of water through the undisturbed soil. Permeability depends largely on the soil texture and structure.

Available water capacity is the amount of water in a moist soil, at field capacity, that can be removed by plants. The ratings in this column, expressed in inches of water per inch of soil depth, are of particular value to engineers engaged in irrigation.

Shrink-swell potential is a rating of the ability of soil material to change volume when the soil is subjected to changes in moisture. Those soil materials rated high in shrink-swell potential are normally undesirable from the engineering standpoint, since the increase in volume when the dry soil is moistened is usually accompanied by a loss in bearing capacity. In general, soils classed as CH and A–7 have high shrink-swell potential. Clean sand and gravel (single-grain structure) and soils containing a small amount of nonplastic to slightly plastic fines have low shrink-swell potential.

Soil features affecting work on highways

Many of the soils in the northeastern two-thirds of Winneshiek County formed in a thick deposit of loess on the uplands. In the same part of the county, many other soils formed in strongly sloping areas in a thin deposit of loess over limestone. Many of the soils in the

low and the moisture content is high. This high moisture content may make embankments unstable unless it is controlled enough to permit the soil to be compacted to high density. Because of their high in-place density, soils derived from glacial till generally do not have an excessively high moisture content and are more easily compacted than the soils derived from loess.

Soils such as the Bassett have formed in loamy till, mainly in the western part of the county. Those soils are loams and sandy loams and are classified A–6, A–4, or A–2 (CL or SC). Where those soils occur in or adjacent to a grading project, they are normally placed in the upper part of the subgrade throughout unstable areas. Pockets and lenses of sand that in many places are water bearing are commonly interspersed throughout those areas. Where the road grade is only a few feet above such deposits, and where silty till overlies the deposits, frost heaving is likely, unless the soil material is drained or the material above it is replaced with granular backfill or with clayey glacial till.

The soils of bottom lands formed in recent alluvium washed from hills and uplands. The Colo and similar soils have a thick organic surface layer that may consolidate erratically under the load of an embankment. The soils are generally classified A–7 (CL, ML, or OH). They have low in-place density and a high content of moisture. Therefore, if an embankment is to be more than 15 feet high, the soil material should be carefully analyzed to be sure that the soils are strong enough to may be lubricated by moisture from natural infiltration areas.

Conservation engineering [4]

In Winneshiek County engineering work for soil con-

be considered. Tile inlets can be constructed on these bench-type terraces, and the need for a waterway is thus eliminated.

In general, the Fayette, Downs, Tama, and other soils that were derived from loess, that are 3 feet or more

Figure 10.—**In the lower picture is a deep gully across an area occupied by Dorchester-Chaseburg-Volney complex, 2 to 5 percent slopes. Shaping of the gully has just been started. In the upper picture is the area after the gully has been filled, reshaped, and seeded.**

erosion because more acreage can be used for rotation
grazing. Farm ponds furnish water for livestock where

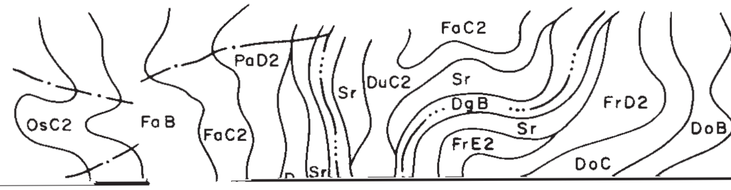
Irrigation.—Irrigation is not of major concern in Winneshiek County, for rainfall is generally more than adequate for the production of all crops. Also, not enough water is generally available to permit extensive irrigation. Table 5 rates the soils according to their suitability for irrigation and indicates features that affect the use of the soils for that use.

Genesis, Classification, and Morphology of Soils

The purpose of this section is to present the outstand-

The principal parent materials in Winneshiek County are loess, glacial drift, alluvium, and wind-deposited sand. Much less extensive parent materials are organic deposits and residuum.

Loess, a silty material deposited by wind, is the most extensive parent material in the county. Loess consists mostly of silt. It does not contain coarse sand, gravel, and boulders, because those materials were too large to be moved by wind, but it does contain a small amount of very fine sand or clay. The large amount of silt-size particles in soil derived from loess give those soils a smooth, floury feel. The thickness of the layer of loess in stable areas ranges from about 1 to 10 feet or more.


FaC2
PaD2
Sr
DuC2
Sr
DgB
FrD2
OsC2
FaB
FaC2
Sr
FrE2
DoB
Sr
DoC

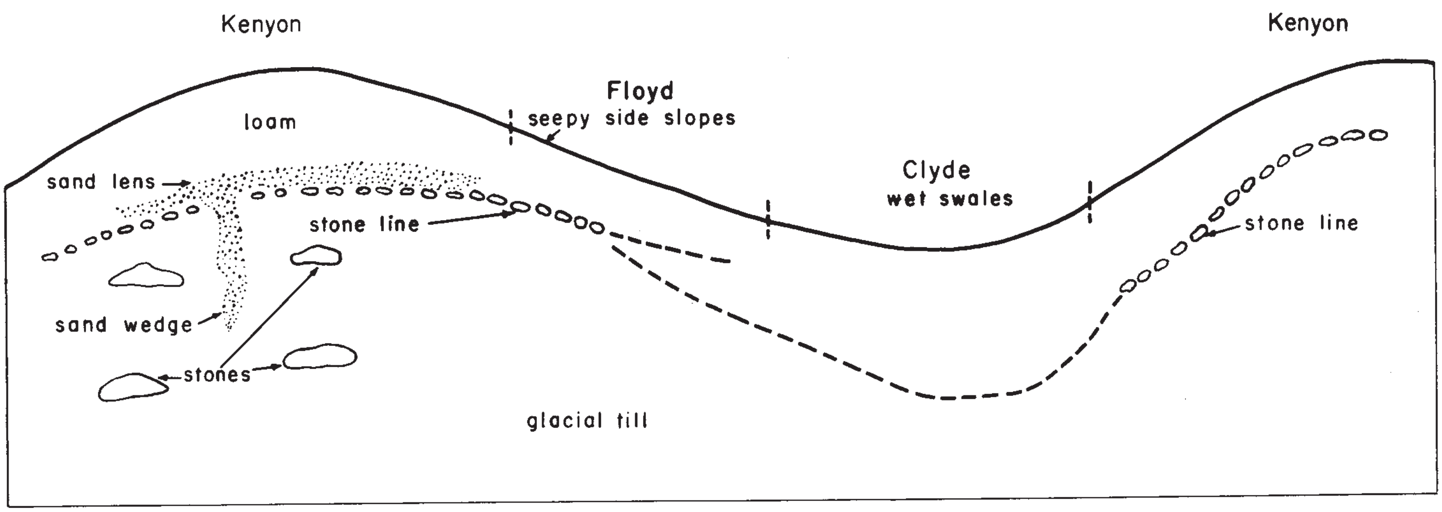


Figure 13.—**Parent material in which the Kenyon, Floyd, and Clyde soils formed.**

soils that formed in recently deposited alluvium are calcareous. Examples of soils formed in calcareous alluvium are those of the Dorchester, Caneek, and Volney series. Those soils have a calcareous surface layer.

Much of the alluvium in this county washed from soils on loess-covered slopes in the uplands. Many of the alluvial sediments are silty and low in content of sand. Examples of silty soils formed in alluvium are those of the Ossian, Otter, Lawson, Colo, Huntsville, Arenzville, and Kennebec series. Loamy soils that also formed in alluvium but that contain more sand than the silty soils are those of the Spillville and Turlin series.

Where sediments accumulate at the base of upland

residuum is generally less than 12 inches thick over bedrock. In soils such as the Dubuque, Palsgrove, Nasset, and Frankville, a deposit of loess covers the thin layer of residuum from limestone.

In soils such as the Calamine and Jacwin, part of the solum is made up of residuum from shale. Generally, however, less than 12 inches of the solum consists of residuum from shale. The residuum commonly has a texture of silty clay or clay. Residuum from limestone commonly has a more reddish hue than that from shale, and the residuum from shale is yellowish.

Deposits of organic matter are the parent material for organic soils (peats and mucks). Organic soils occupy

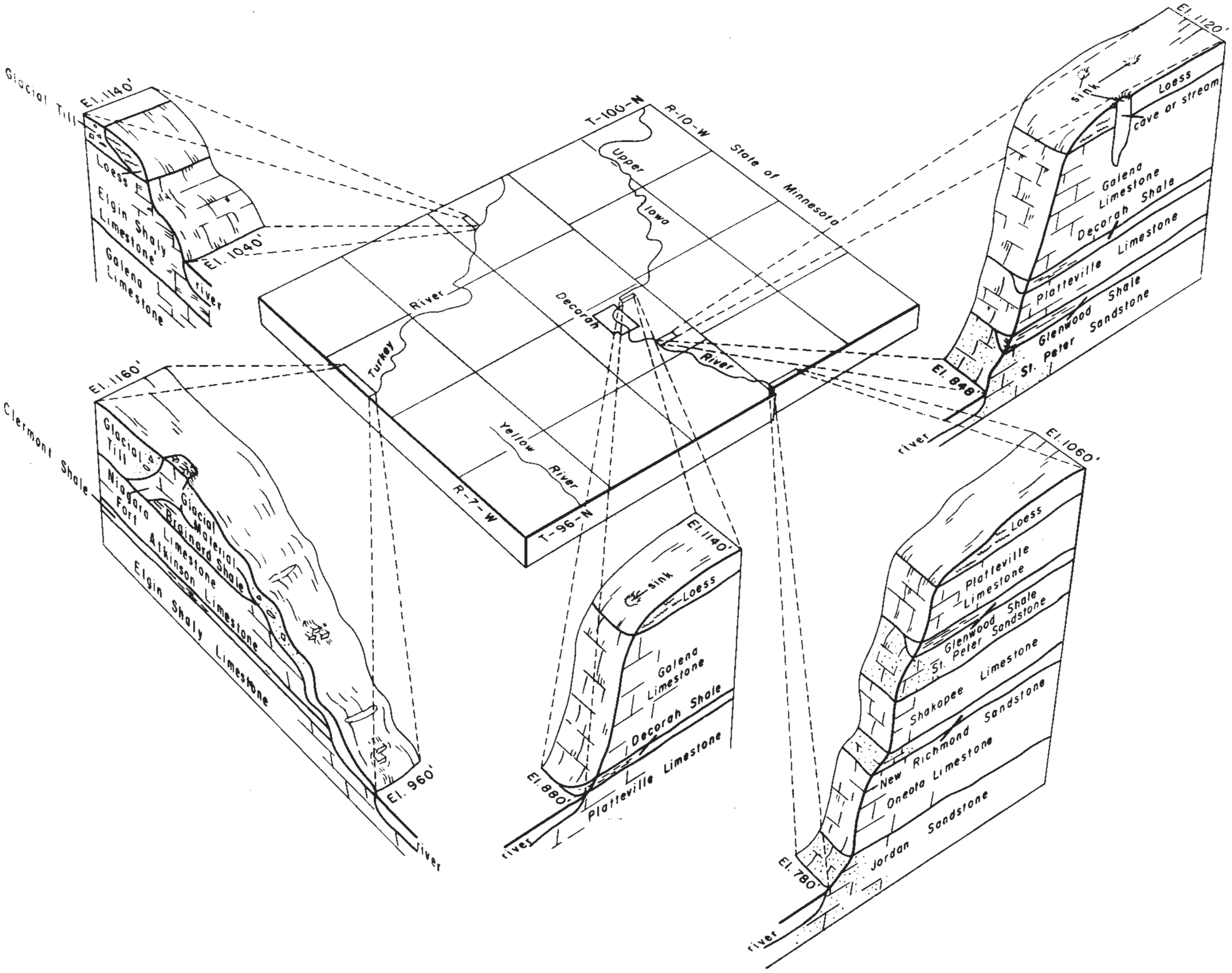


Figure 14.—**Section showing geologic stratigraphy in Winneshiek County.**

Plant and animal life

forest vegetation have a thin, dark-colored surface layer from nearly level to very steep. Relief is an important factor in determining the pattern and distribution of the soils of a landscape, primarily because of its influence on drainage, runoff, and erosion.

A secondary influence that greatly affects the forma-

Classification and Morphology of Soils

Soils are placed in narrowly defined classes so that knowledge about their behavior within farms and counties can be organized and applied. They are placed in been used little in recent years, must be revised in the course of the soil survey program across the country. A proposed new series has tentative status until review of the series concept at State, regional, and national levels of responsibility for soil classification result in a judgment that the new series should be established. Most of the soil series described in this publication have been established earlier. Fourteen of the soil series described in this survey, however, had tentative status when the survey was sent to the printer. They are the Calmar, Caneek, Canoe, Donnan, Festina, Frankville, Jacwin, Marlean, Nasset, Nordness, Orwood, Ossian, Turlin, and Waucoma.

Listed in table 7 for each soil series in Winneshiek County are the family and subgroup of the current system (*11*, *14*). Also shown is the great soil group of the older system of classification (*13*).

Following is a description of the great soil groups of the 1938–49 system that are represented in Winneshiek County.

TABLE 7.—*Classification of the soil series according to the 1938–49 system and the current system*

Soil series	Current classification		1938–49 system
	Family	Subgroup	Great soil group
Arenzville	Fine-silty, mixed, nonacid, mesic	Typic Udifluvent	Alluvial.
Atkinson	Fine-loamy, mixed, mesic	Typic Argiudoll	Brunizem.
Atterberry	Fine-silty, mixed, mesic	Aeric Mollic Ochraqualf	Gray-Brown Podzolic intergrading toward Brunizem.
Backbone	Coarse-loamy, mixed, mesic	Mollic Hapludalf	Gray-Brown Podzolic intergrading toward Brunizem.
Bassett	Fine-loamy, mixed, mesic	Mollic Hapludalf	Gray-Brown Podzolic intergrading toward Brunizem.
Bertrand	Fine-silty, mixed, mesic	Typic Hapludalf	Gray-Brown Podzolic.
Bixby	Fine-loamy over sand or sandy skeletal, mixed over siliceous, mesic.	Typic Hapludalf	Gray-Brown Podzolic.
Burkhardt	Coarse-loamy, over sandy skeletal, siliceous, mesic.	Entic Hapludoll	Brunizem intergrading toward Regosol.
Calamine	Fine, illitic, noncalcareous, mesic	Typic Argiaquoll	Humic Gley (Wiesenboden).
Calmar	Fine-loamy, mixed, mesic	Cumulic Argiudoll	Brunizem.
Camden	Fine-silty, mixed, mesic	Typic Hapludalf	Gray-Brown Podzolic.
Caneek	Fine-silty, mixed, calcareous, mesic	Fluventic Haplaquept	Alluvial.
Canoe	Fine-silty, mixed, mesic	Aeric Mollic Ochraqualf	Gray-Brown Podzolic intergrading toward Brunizem.
Chaseburg	Fine-silty, mixed, mesic	Typic Hapludalf	Gray-Brown Podzolic.
Chelsea	Sandy, siliceous, nonacid, mesic	Alfic Udipsamment	Gray-Brown Podzolic intergrading toward Regosol.
Clyde	Fine-loamy, mixed, noncalcareous, mesic.	Typic Haplaquoll	Humic Gley (Wiesenboden).
Coggon	Fine-loamy, mixed, mesic	Typic Hapludalf	Gray-Brown Podzolic.
Colo	Fine-silty, mixed, noncalcareous, mesic.	Cumulic Haplaquoll	Humic Gley (Wiesenboden) intergrading toward Alluvial soils.
Curran	Fine-silty, mixed, mesic	Typic Ochraqualf	Gray-Brown Podzolic.
Dickinson	Coarse-loamy, siliceous, mesic	Typic Hapludoll	Brunizem.
Donnan	Fine-loamy over clay, mixed over montmorillonitic, mesic.	Aeric Mollic Ochraqualf	Gray-Brown Podzolic intergrading toward Brunizem.
Dorchester	Fine-silty, mixed, calcareous, mesic	Typic Udifluvent	Alluvial.
Dow	Fine-silty, mixed, calcareous, mesic	Typic Udorthent	Regosol intergrading toward Gray-Brown Podzolic.
Downs	Fine-silty, mixed, mesic	Mollic Hapludalf	Gray-Brown Podzolic intergrading toward Brunizem.
Dubuque	Fine-silty, mixed, mesic	Typic Hapludalf	Gray-Brown Podzolic.
Fayette	Fine-silty, mixed, mesic	Typic Hapludalf	Gray-Brown Podzolic.

TABLE 7.—*Classification of the soil series according to the 1938–49 system and the current system*—Continued

Soil series	Current classification		1938–49 system
	Family	Subgroup	Great soil group
Kenyon	Fine-loamy, mixed, mesic	Typic Hapludoll	Brunizem.
Lamont	Coarse-loamy, siliceous, mesic	Typic Hapludalf	Gray-Brown Podzolic.
Lamont, till subsoil variant.	Coarse-loamy, over fine loamy, mixed, mesic.	Mollic Hapludalf	Gray-Brown Podzolic intergrading toward Brunizem.
Lawson	Fine-silty, mixed, mesic	Aquic Cumulic Hapludoll.	Brunizem.
Marlean	Loamy skeletal, mixed, mesic	Typic Hapludoll	Brunizem.

yellowish-brown B horizon 20 to 40 inches thick; and a yellowish-brown C horizon.

The A1 and A2 horizons most commonly have a texture of silt loam or loam, and the B horizon has a texture of silty clay loam or of loam to clay loam. The A1 horizon generally has weak granular structure, and the A2 horizon has thin platy structure. In many places the aggregates in the B horizon have angular blocky structure. The C horizon does not have well-developed structure. The boundaries of horizons in this great soil group are more distinct than those of the Brunizems.

Gray-Brown Podzolic soils are generally more sloping and lower in content of organic matter than Brunizems, and they are likely to be more severely affected by erosion. As in the Brunizem great soil group, a few Gray-Brown Podzolic soils are sandy and are shallow over limestone or gravel. Examples of soils in the Gray- [illegible]

soils are also in the Humic Gley great soil group, but they have some characteristics of Alluvial soils.

Alluvial soils

Alluvial soils are on bottoms and low terraces along streams throughout the county. The largest areas are along the Upper Iowa and Turkey Rivers. These soils formed in water-laid sediments deposited with each flood. Depth to the water table and the frequency of flooding are variable.

Alluvial soils generally do not have distinct horizons. Although some distinct layers are present, they are caused by variations in the kinds of sediments rather than by development of soil horizons. In many places these soils contain layers of sand and silt, and they may also contain light-colored and dark-colored layers. This layering is referred to as stratification. Because of the wide variation in the sediments, Alluvial soils vary [illegible]

Technical Descriptions of the Soil Series

This section is provided for those who need more de-

fragmented limestone. Clay films are evident in the B2 horizons. These soils do not have a C horizon.

The Atkinson soils have a thicker solum than the Rock-

The color of the A1 horizon ranges from black (10YR 2/1) or very dark gray (10YR 3/1) to very dark brown (10YR 2/2), and the thickness of that horizon ranges from 7 to 15 inches. In places colors that have a value of 3 and chromas of 3 or less extend to a depth of 20

B21t—18 to 28 inches, light to medium silty clay loam; grayish-brown (2.5Y 5/2) ped exteriors and grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/4) ped interiors; common, fine, distinct, yellowish-brown (10YR 5/6 to 5/8) mottles; moderate, fine, subangular blocky and angular blocky structure; slightly firm;

highs, ridgetops, and side slopes in the uplands. The native vegetation was trees and prairie grasses.

The Backbone soils have a moderately thick, moderately dark colored or dark colored A1 horizon of loamy sand to sandy loam; an indistinct A2 horizon in areas that have not been cultivated; and B horizons that vary in thickness and that formed mainly in material that has a texture of sandy loam. The lower B horizon, just above the limestone bedrock, consists of a thin layer of clay loam to clay.

The Backbone soils have a thinner, more variable solum than the Chelsea and Lamont soils, and unlike those soils, they are underlain by a uniform layer of bedrock. Also, their surface layer is darker colored than that of the Chelsea soils, and the texture of their upper B horizons is generally sandy loam instead of loamy sand. The Backbone soils are underlain by limestone bedrock instead of by glacial till like that underlying the till subsoil variants of the Lamont soils. Unlike the Dickinson soils, they commonly have an A2 horizon. Also, their B horizons are more variable in thickness than those of the Dickinson soils, and they are underlain by limestone bedrock instead of by sandy material. In contrast to the Nasset, Orwood, Waucoma, and Frankville

The B horizons, which developed in material that has a texture of sandy loam, generally have a color value of 4 and chromas of 3 and 4, but the value is 3 in a few places. In many places the IIB22t horizon has more reddish hues than the horizons above it but has similar chromas and values. In places the IIB22t horizon consists of material weathered from limestone, or it may be a paleo B horizon formed in other material. Clay films are absent, except in the IIB22t horizon. The soil reaction is variable and ranges from neutral to strongly acid.

Bassett Series

In the Bassett series are moderately well drained soils that are gently sloping and sloping. These soils formed in 14 to 24 inches of loam or in 12 to 18 inches of silt loam over clay loam to loam glacial till. They are on convex upland highs, ridgetops, and side slopes. The native vegetation was trees and prairie grasses.

The Bassett soils have a moderately thick, dark-colored A1 horizon of loam or silt loam; a thin, fairly distinct A2 horizon, also of loam or silt loam; and moderately fine textured B horizons that are moderately to strongly defined and that contain a distinct band of pebbles and some mottles. Clay films occur in places in

A2—7 to 13 inches, brown or dark-brown (10YR 4/3) loam and some loam that is very dark gray (10YR 3/1) or dark grayish brown (10YR 4/2); weak, thin,

A21—6 to 9 inches, dark grayish-brown (10YR 4/2) and some brown to dark-brown (10YR 4/3) silt loam; very weak, thin, platy structure; very friable; very strong-

The Bertrand soils are the Gray-Brown Podzolic members of the biosequence that includes the Festina soils, which are also in the Gray-Brown Podzolic great soil group but are intergrading toward the Brunizem great soil group.

Representative profile of Bertrand silt loam in a cultivated field, 670 feet west and 40 feet north of the north

material over leached sand and gravel. These soils are on the convex high parts of poorly defined ridgetops and on side slopes in the uplands. They are also in nearly level areas on benches and on sloping escarpments of benches. The native vegetation was trees.

The Bixby soils have a thin, moderately dark colored A1 horizon, a distinct or somewhat distinct A2 horizon, mon. The combined thickness of the B horizons ranges from 18 to 24 inches, and the thickness varies within short distances. The coarse-textured material is leached to a depth of 60 inches or more. In many places the profile is medium acid throughout.

Burkhardt Series

In the Burkhardt series are soils that are excessively drained. These soils formed in 15 to 24 inches of material that has a texture of sandy loam or light loam and is underlain by leached sand and gravel. They are on convex, high knolls, on ridgetops, and on side slopes in the uplands and are also on benches and on bench escarpments. The native vegetation was prairie grasses.

The Burkhardt soils have a moderately thick, dark-colored A1 horizon of sandy loam to loam, and they have brown, weakly defined B horizons that vary in thickness. The A and B horizons contain some gravel. The underlying material consists of medium and coarse gravelly sand.

The Burkhardt soils have a thicker A1 horizon than the moderately deep Sattre soils. Also, they lack an A2 horizon and their B horizon has a texture of sandy loam

and on foot slopes. The native vegetation was grasses and sedges tolerant of excessive wetness.

The Calamine soils have moderately thick, dark-colored A horizons that have a texture of silt loam grading to silty clay loam. The silty clay loam of the A horizons grades to grayish silty clay in the B. The B horizons developed predominantly in material weathered from shale. They are mottled and contain clay films.

The Calamine soils have B horizons that are finer textured and have lower chroma than those of the Jacwin soils. Also, the B horizons of the Calamine soils developed mainly in material derived from shale, and the Jacwin soils were derived from glacial material underlain by shale. The Calamine soils, unlike the Clyde, have fine-textured B horizons, and their B horizons were derived from shale rather than from loamy, stratified glacial material.

Representative profile of Calamine silty clay loam in a cultivated field, 245 feet north and 55 east of the SW. corner of the NW¼SE¼ sec. 7, T. 97 N., R. 9 W.:

Ap—0 to 6 inches, black (10YR 2/1) silty clay loam to silt loam; weak to moderate, very fine, granular structure; friable; neutral; abrupt, smooth boundary.

Calmar Series

The Calmar series consists of soils that are well drained or moderately well drained. These soils formed in leached, moderately fine textured glacial sediments or in wind-deposited material over hard, fractured limestone. They are on uplands, topographically below areas of soils that are steeper and that consist of a thin covering of soil material over limestone bedrock. Depth to limestone ranges from about 24 to 40 inches. The native vegetation was grasses.

These soils have a thick, dark-colored A horizon of clay loam, and brownish B horizons that vary in thickness. The B horizons contain a few clay films. A thin

The thickness of the residuum, or IIB3t horizon, varies greatly within a short distance. That horizon is typically less than 6 inches thick, but it is as much as 12 inches thick in places. The texture of the IIB3t horizon shows a distinct increase in content of clay over that in the horizons above it. In many places the texture of that horizon is clay, but the texture ranges to silty clay. The limestone bedrock is hard and is typically level bedded. In places it contains numerous vertical and horizontal fractures. Thin, interbedded shale and limestone make up a minor part of the substratum. In general these soils range from slightly acid to medium acid in reaction.

Camden Series

B21—19 to 25 inches, heavy silt loam (estimated 15 to 20 percent fine sand); ped exteriors dark brown or brown (10YR 4/3); ped interiors yellowish brown (10YR

stratified. This material is light colored and is slightly mottled, especially around old root channels. In most that vary in thickness. Some clay fills are evident in root channels or pores.

The solum of the Canoe soils is less variable in thickness than that of the Hayfield soils, and unlike the Rowley soils, the Canoe soils have an A2 horizon. They have a darker, thicker A1 horizon than the Bertrand soils. Unlike the Bertrand soils, they have chromas of 1 and 2 in the upper B horizons.

The Canoe soils have weaker horizonation, less clay in the B horizons, and more variable B/C clay ratios than the Atterberry soils. Also, they have an A2 horizon that is more variable in thickness and have a more variable content of sand than the Atterberry soils, and they were derived from silty alluvium instead of loess.

The Canoe soils are the intermediate members of the biosequence that includes the Rowley soils, which are Brunizems. They are also the somewhat poorly drained analogs of the Festina soils, which are well drained.

Representative profile of Canoe silt loam, 580 feet west and 144 feet north of a fence line bordering a permanent pasture in the SW¼SE¼ sec. 24, T. 99 N., R. 8 W.:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) silt loam; cloddy, breaking to weak, fine, granular structure; friable; medium acid; abrupt, smooth bound-

B3—49 to 60 inches, mottled gray (5Y 5/1) and olive-gray (5Y 5/2) silt loam; olive gray (5Y 5/2) if kneaded; few, fine, distinct mottles of olive brown (2.5Y 4/4) and light olive brown (2.5Y 5/6); weak, medium, prismatic structure; friable to firm, common, very fine, soft oxides of dark reddish brown (5YR 3/2) and dark brown to brown (7.5YR 4/4); slightly acid; gradual, smooth boundary.

C1—60 to 72 inches, light olive-gray (5Y 6/2) silt loam; few, medium, distinct mottles of light olive brown (2.5Y 5/6); massive; friable; contains oxides like those in B3 horizon; slightly acid; abrupt, smooth boundary.

C2—72 to 82 inches, gray (5Y 5/1) loam; massive; friable; contains oxides like those in B3 and C1 horizons; neutral; clear, smooth boundary.

C3—82 to 90 inches, olive-gray (5Y 5/2) sandy loam containing coarse fragments of chert; common, fine to medium, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/6) mottles; olive gray (5Y 5/2) if kneaded; massive; friable; neutral.

The A1 horizon generally has a texture of silt loam. It ranges from 10YR 3/1 to 10YR 3/2 in color and from 6 to 10 inches in thickness. In places, however, a layer of silt loam that has a color of 10YR 4/2 has been deposited. In most places the A2 horizon is distinct, has a color that is predominantly 10YR 4/2, and has platy structure. The combined thickness of the A2 horizons ranges from 8 to 18 inches, and depth to the B1 horizon ranges from 20 to 24 inches. The content of clay

The Chaseburg soils are not calcareous like the Dorchester soils, and they have recognizable B horizons. They are similar to the Arenzville soils but are less stratified, have B horizons, and do not have a dark-colored, buried A horizon below a depth of 20 inches. The Chaseburg soils have lighter colored A horizons

inson soils. They have a lighter colored A1 horizon than the Backbone soils and the till subsoil variant of the Lamont series, and unlike those soils, they have a coarse texture to a depth of 42 inches or more.

Representative profile of Chelsea loamy fine sand, in a cultivated field reached by going from the point where drainageways. The native vegetation was grasses and sedges that are tolerant of excessive wetness.

The Clyde soils have a thick, dark-colored A1 horizon and gleyed B horizons that contain strata of silty and sandy material. They have glacial stones and boulders on the surface and in the solum. Loam to clay loam till is below a depth of 36 inches.

Coggon Series

In the Coggon series are soils that are moderately well drained. These soils formed in 14 to 24 inches of material that has a texture of loam and is underlain by loam to clay loam glacial till. They are gently sloping to sloping and are on convex upland highs, ridgetops, IIB22t—22 to 31 inches, dark-brown (7.5YR 4/4) and some light olive-brown (2.5Y 5/4) sandy clay loam containing some stones and pebbles; moderate, fine and medium, prismatic structure breaking to weak, fine and very fine, subangular blocky structure; friable; thin, brown (10YR 5/3) to olive (5Y 5/3), sandy prism coatings and few, fine, prominent, dark-brown

Representative profile of Colo silt loam in a permanent pasture, sec. 7, T. 98 N., R. 9 W. (Can be reached by going from SE. corner of section, north to creek bank, and 40 feet west on the south bank of the creek.):

A11—0 to 16 inches, black (10YR 2/1) gritty silt loam; very soils, they have a distinct A2 horizon. The Curran soils have a thinner A1 horizon than the Hayfield soils. They also have B horizons that are less variable in thickness, and a thicker solum that contains less sand. In most places coarse-textured material is below a depth of 48 inches.

The Curran soils form a biosequence with the Rowley soils, which are in the Brunizem great soil group, and with the Canoe soils, which are in the Gray-Brown Podzolic great soil group but are intergrading toward Brunizems.

Representative profile of Curran silt loam in a cultivated field, 40 feet east of the east road fence and 12 feet from the north boundary fence in the NE¼NW¼ sec. 36, T. 99 N., R. 9 W.:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) and some very dark gray (10YR 3/1) silt loam; weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A21—8 to 10 inches, gray to light-gray (10YR to 5Y 6/1) silt loam; some dark-brown to brown (7.5YR 4/4) mottles or concretions of an oxide; weak, thin, platy structure; friable; common fine pinhole pores; very fine sand or silt coats on some plates; neutral; clear, smooth boundary.

A22—10 to 15 inches, light brownish-gray (2.5Y 6/2) silt loam; some strong-brown (7.5YR 5/6) mottles or concretions of an oxide; weak, thin, platy structure; friable; common fine pinhole pores; common very fine sand or silt coats on the plates; neutral; clear, smooth boundary.

B11—15 to 22 inches, mottled light brownish-gray (2.5Y 6/2)

higher chroma. The texture of the B2 horizons is light to medium silty clay loam. In places stratified silty and loamy material is below a depth of 40 inches. In the most acid part of the solum, the soil reaction is medium acid.

Dickinson Series

In the Dickinson series are well-drained to excessively drained soils that formed in 24 to 30 inches of sandy loam over leached loamy sand and sand. In most places this moderately coarse textured or coarse textured underlying material is of wind-deposited origin. It consists of glaciofluvial or alluvial material in other places. Gently sloping or sloping areas of these soils are on upland highs, ridgetops, and side slopes, and also on the sloping escarpments of stream benches. The nearly level areas are on benches. The native vegetation was prairie grasses.

These soils have a moderately thick, dark-colored A1 horizon of sandy loam, and B horizons of sandy loam that grades to loamy sand. The soils are free of gravel and cobbles.

The Dickinson soils have a darker, thicker A1 horizon than the Lamont soils, and unlike those soils, they lack an A2 horizon. They differ from the Hagener soils in having a moderately coarse textured upper B horizon. The Dickinson soils have thicker, less variable B horizons than the Backbone soils, and they are not underlain by a uniform layer of limestone or limestone of 2 to a depth of 24 inches. The thickness of the sandy loam ranges from 24 to 30 inches. The B horizons formed in sandy loam and loamy sand, and the size of the particles of sand is fine or medium. The color of the B horizons centers on values and chromas of 3 and 4. Mottling is absent. In places gravel is below a depth of 60 inches. The soils range from medium acid to strongly acid in reaction. The soil material contains

IIB24tb—40 to 52 inches, mottled gray (5Y 5/1 and 6/1) and reddish-brown (2.5YR 4/4) clay; moderate, very fine, subangular blocky structure; very firm; thick, continuous clay films; slightly acid.

The Donnan soils have moderate horizonation. In areas that are not eroded, the A horizons are very dark gray (10YR 3/1), and their combined thickness ranges from 4 to 8 inches. In some cultivated areas, the surof NE¼SW¼ sec. 33, T. 98 N., R. 8 W., then north to south bank of Trout Run Creek:

C1—0 to 20 inches, stratified dark grayish-brown (10YR 4/2) and some very dark gray (10YR 3/1) and brown (10YR 5/3) silt loam; weak, very thin, platy structure and some weak, very fine, granular structure; very friable; weakly calcareous; clear, smooth boundary.

IIA1b—20 to 30 inches, black (10YR 2/1) silt loam; weak, very fine, subangular blocky structure; very friable; neutral; clear, smooth boundary.

IIA3b—30 to 40 inches, very dark brown (10YR 2/2) silt loam; moderate, very fine, subangular blocky structure; very friable; neutral; clear, smooth boundary.

IIB21b—40 to 48 inches, very dark gray (10YR 3/1) silt loam; moderate, very fine and fine, subangular blocky structure; very friable; neutral; diffuse, wavy boundary.

IIB22b—48 to 59 inches, very dark gray (10YR 3/1) and very dark grayish-brown (10YR 3/2) silt loam; moderate, fine to medium, subangular blocky structure; friable; neutral.

Representative profile of Dorchester silt loam in a permanent pasture, 300 feet north of river and 200 feet west of bend in road in northwestern corner of SW¼ sec. 13, T. 98 N., R. 8 W.:

C1—0 to 36 inches, stratified dark grayish-brown (10YR 4/2) and thin layers of brown (10YR 5/3), light brownish-gray, (10YR 6/2), and very dark gray (10YR 3/1) silt loam; weak, very thin, platy structure and some weak, fine, granular structure; very friable; weakly calcareous; moderately alkaline; abrupt, smooth boundary.

IIAb—36 to 47 inches, black (10YR 2/1) loam to silt loam; very weak, fine, subangular blocky structure; very friable; neutral; clear, smooth boundary.

IIA3—47 to 56 inches, very dark grayish-brown (10YR 3/2) and some dark-brown (10YR 3/3) loam to silt loam; weak, very fine, subangular blocky structure; neutral.

The calcareous, stratified sediments of silt loam that make up the upper part of the profile generally have color values of 4 or higher and chromas of 2 or higher. Thin layers of darker colored sediments, however, occur in places. The dark, buried soil that occurs in most areas of Dorchester soils and that has a texture of loam to light silty clay loam is at a depth ranging from 20 to 40 inches. Pebbles, cobbles, or fragments of limestone are absent to a depth of 40 inches or more. The light-colored sediments contain a few yellowish or brownish mottles in places. Although the stratified silty material is calcareous, the buried soil is slightly acid to neutral in reaction.

Dow Series

In the Dow series are well-drained soils formed in calcareous, relict, gleyed (deoxidized) loess. These soils are steep, and they occur with Fayette soils on side slopes in the uplands. The native vegetation was trees.

The Dow soils have a thin, moderately dark colored to light-colored A1 horizon of silt loam. Their B horizon is weakly defined, and they have a calcareous, olive-

The Dow soils of Winneshiek County differ from the Dow soils in other counties in Iowa in that they have a B horizon and are leached of carbonates to a depth of 10 to 20 inches.

Representative profile of Dow silt loam in a cultivated field, 160 feet east and 200 feet north of the SW. corner of the SE¼SE¼ sec. 25, T. 96 N., R. 9 W.:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) and some brown to dark-brown (10YR 4/3) silt loam; weak, very fine, subangular blocky structure; friable; common oxide concretions; neutral; abrupt, smooth boundary.

B—6 to 11 inches, dominantly light olive-gray (5Y 6/2) and some dark-brown (10YR 3/3) and brown to dark-brown (10YR 4/3) silt loam; common iron streaks of yellowish brown (10YR 5/8) and hard iron tubules of dark reddish brown (5YR 3/2, 3/3, and 3/4); weak, very fine, subangular blocky structure; friable; mildly alkaline; clear, wavy boundary.

C—11 to 72 inches, olive-gray (5Y 5/2) silt loam; common iron streaks of yellowish brown (10YR 5/8) and many hard iron tubules of dark reddish brown (5YR 3/2, 3/3, and 3/4); weak, coarse, subangular blocky structure to massive; friable; calcareous.

The thickness of the A horizon ranges from 6 to 12 inches, and the color of that horizon grades from very dark grayish brown (10YR 3/2) to dark grayish brown (10YR 4/2). The areas that are dark grayish brown (10YR 4/2) have been cultivated or are eroded. In places these soils have a very weakly defined A2 horizon or have a slightly leached zone between the A1 and the C horizon.

In most places the profile contains an indistinct B horizon. In areas that are not eroded, the soil material is leached to a depth of 8 to 12 inches. The grayish color of the subsoil is considered to be a relict feature typical of an older and wetter climatic regime. Geologic erosion has removed part of the yellowish-brown oxidized loess and has exposed a zone of gleyed loess. Mottles and tubular iron concretions are common. Depth to calcareous material ranges from 10 to 20 inches.

Downs Series

The Downs series consists of well-drained soils that formed in loess. These soils are gently sloping to strongly sloping and are on convex ridgetops and side slopes in the uplands. The native vegetation was trees and prairie grasses.

The Downs soils have a moderately thick A1 horizon of dark colored or moderately dark colored silt loam and a somewhat distinct A2 horizon. Their B horizons have a brownish color and a texture of silty clay loam, and they are free of mottles to a depth of about 30 inches. Clay films and grainy silt coats are evident in the B horizons.

The Downs soils have a darker, thicker A1 horizon and generally have a less distinct A2 horizon than the Fayette soils. Their solum is less variable in thickness

The Downs soils have a thinner A1 horizon than the Tama soils. They also have an A2 horizon or an abrupt boundary between the A horizon and a B horizon in which grainy coats are evident. The Downs soils, unlike the Atterberry, have chromas of 3 and 4 and no mottles to a depth of 30 inches. They developed in loess that contains less than 15 percent fine sand instead of having between 20 and 40 percent fine and medium sand

Dubuque Series

Soils that are well drained are in the Dubuque series. These soils formed in 15 to 30 inches of loess over a thin layer of residuum and limestone bedrock. They are on gently sloping ridgetops and on sloping to very steep side slopes. The native vegetation was trees.

These soils have a thin, moderately dark colored A1 horizon of silt loam, and they have a distinct A2 horizon

These soils have moderate horizonation. In areas that are not eroded, the A1 horizon ranges from 2 to 4 inches in thickness and from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) in color. In many areas that are cultivated, part or all of the A2 horizon is mixed with the plow layer. In areas that are not eroded, the A2 horizon ranges from 4 to 8 inches in thickness and from dark grayish brown (10YR 4/2) to grayish brown (10YR 5/2) in color. The A horizons have a texture of silt loam.

The B horizons are not mottled and have values of 3, 4, and 5 and chromas of 3 or higher. The texture of the B horizons centers on light silty clay loam. The profile has no loess-derived C horizon above the residuum or limestone bedrock. The limestone residuum ranges from 1 to 6 inches in thickness. Its texture ranges from silty clay loam to silty clay or clay, but a texture of silty clay is most common. The residuum is predominantly reddish, but it is brownish or yellowish in some places. In places the lower B horizon contains chert or small frag-

A22—10 to 16 inches, brown to dark-brown (10YR 4/3) silt loam; weak, thin, platy structure breaking to weak, very fine, subangular blocky structure; very friable; coatings of silt that are light gray (10YR 7/1) when dry and some coatings that are dark brown (10YR 3/3); medium acid; clear, smooth boundary.

B21t—16 to 27 inches, brown to dark-brown (10YR 4/3) light silty clay loam; moderate, fine, subangular blocky structure; friable; few ped coats of dark yellowish brown (10YR 4/4), some of which are clay; some silt coats; common pinhole pores; strongly acid; clear, smooth boundary.

B22t—27 to 39 inches, brown to dark-brown (10YR 4/3) and dark yellowish-brown (10YR 4/4) light silty clay loam; weak, medium, prismatic structure breaking to strong, fine and medium, subangular blocky structure; friable to firm; common, thin, discontinuous, dark yellowish-brown (10YR 3/4) clay films; some silt coats; common fine pinhole pores; strongly acid; clear, smooth boundary.

B3—39 to 46 inches, yellowish-brown (10YR 5/4) silt loam; very weak, fine, subangular blocky structure; friable; some brown to dark-brown (10YR 4/3) ped coats and some silt coats; common pinhole pores; strongly acid; clear, smooth boundary.

loess. They are not calcareous like the Dow soils, and they lack gray colors to a depth of 20 inches. The gray variants of the Fayette series have a thinner, lighter colored A1 horizon than the gray subsoil variants of the Franklin series. Also, unlike the gray subsoil variants of the Franklin series, they have B horizons developed entirely in loess instead of being underlain by glacial till between a depth of 15 and 40 inches.

Representative profile of Fayette silt loam, gray variant, in a cultivated field, 300 feet east and 200 feet north of the SW. corner of SE¼SE¼ sec. 25, T. 96 N., R. 9 W.:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) and dark-brown to brown (10YR 4/3) silt loam; very weak, very fine, subangular blocky structure breaking to granular structure; friable; neutral; abrupt, smooth boundary.

B1t—6 to 13 inches, yellowish-brown (10YR 5/4) and grayish-brown (10YR 5/2) silt loam to silty clay loam; weak, very fine, subangular blocky structure; friable; very few, thin, discontinuous, brown to dark-brown (10YR 4/3) clay films; common fine iron-manganese concretions of an oxide; slightly acid; clear, smooth boundary.

segregations that occur as hard tubules in places. From 5 to 12 percent of the loess is very fine sand and fine sand. In the most acid part of the solum, the soil reaction is medium acid.

Festina Series

In the Festina series are soils that are well drained. These soils formed in medium-textured alluvium derived mainly from areas of soils developed in loess. The texture throughout the profile centers on silt loam. These soils are nearly level or gently sloping and are on benches along the major rivers and their tributaries. The native vegetation was trees and grasses.

The Festina soils have a thin to moderately thick, dark-colored A1 horizon of silt loam; a somewhat distinct A2 horizon; and brownish B horizons that are free of mottles to a depth of 30 inches or more. Most profiles contain very few clay films.

The Festina soils have a thicker, darker colored A1 horizon and a less distinct A2 horizon than the Bertrand soils. They are better drained than the Canoe soils, as evidenced by the higher chroma and general lack of mot-

B3—38 to 47 inches, yellowish-brown (dominantly 10YR 5/6

Also unlike those soils, they are underlain by glacial till tween a depth of 30 and 40 inches. In most places the solum is underlain by a stone line that is just above the till. These soils range from slightly acid to neutral in reaction. The C horizon, where present, generally contains carbonates.

Franklin Series, Gray Subsoil Variants

The gray subsoil variants of the Franklin series are somewhat poorly drained. They formed in 15 to 40 inches of loess or well-sorted material over loam to clay loam glacial till that has moderate structure and contains distinct gray coats. These soils are gently sloping and are in and adjacent to drainageways in the uplands. The native vegetation was trees and prairie grasses.

These soils have a thin to moderately thick, dark-colored A1 horizon of silt loam; an indistinct or distinct A2 horizon that has a texture of silt loam; and mottled B horizons developed in loess and glacial till. The

IIB23—40 to 54 inches, clay loam that contains some pebbles; ped exteriors light gray (10YR 7/1) when moist and white (10YR 8/1) when dry; ped interiors mottled dark brown (7.5YR 4/4) with some strong brown (7.5YR 5/6 and 5/8) and olive gray (5Y 5/2); weak, medium, prismatic structure breaking to moderate, medium, subangular blocky structure; friable to firm; prism surfaces coated with fine white sand; common, fine, concretions of an iron-manganese oxide; slightly acid; clear, wavy boundary.

IIC—54 to 68 inches, mottled yellowish-brown (10YR 5/6 and 5/8) and some olive-gray (5Y 5/2) clay loam containing some pebbles; massive; friable to firm; slightly acid.

These soils have moderate to strong horizonation. The A1 horizon ranges from 4 to 8 inches in thickness and from very dark gray (10YR 3/1) to black (10YR 2/1) in color. The A2 horizon ranges from 4 to 10 inches in thickness and from dark grayish brown (10YR 4/2) to grayish brown (10YR 5/2) in color. In places part of the A2 horizon is incorporated in the plow layer.

The Frankville soils are the intermediate members of a biosequence that includes the Dubuque soils of the Gray-Brown Podzolic great soil group.

Representative profile of a moderately eroded Frankville silt loam in a cultivated field, 580 feet north and 165 feet west of the center of sec. 12, T. 97 N., R. 7 W., (A2 horizon incorporated in the Ap):

Ap—0 to 6 inches, silt loam that is very dark gray (10YR 3/1), with some dark grayish brown (10YR 4/2) and dark brown to brown (10YR 4/3); weak, fine, granu-

The Hagener soils have a dark-colored, moderately thick A1 horizon of loamy sand, and they also have very weakly defined color B horizons of loamy sand and sand. In places dark-colored loamy sand extends to a depth of 20 inches.

The Hagener soils, unlike the Dickinson, have B horizons that formed in loamy sand. They have a thicker, darker colored A1 horizon than the Chelsea soils. In contrast to the Backbone soils and the till subsoil variants of the Lamont series, which have B horizons of

The Hayfield soils have a thinner A1 horizon than the Kato soils, and unlike those soils, they have an A2 horizon. In contrast to the Sattre soils, which are well drained, they are somewhat poorly drained. Also, in the B horizons they have chromas of 2 and mottles instead of having chromas of 3 and no mottles. The Hayfield soils have a thinner A1 horizon than the Waukegan soils, and they have an A2 horizon. Also, they have chromas of 2 and mottles in the B horizons, and they are somewhat poorly drained instead of well drained.

The Hayfield soils form a biosequence with the Kato soils, which are Brunizems.

Representative profile of Hayfield loam, deep, in a cultivated field, 630 feet west of the center of T-road intersection and 45 feet south of the road fence, all from the NE. corner of sec. 28, T. 98 N., R. 10 W.:

Ap—0 to 7 inches, very dark brown (10YR 2/2) loam, about 20 percent mixing of very dark grayish brown (10YR 3/2) and 10 percent dark grayish brown (10YR 4/2), mainly in lower part of horizon; very dark grayish brown (10YR 3/2) if kneaded; soft clods breaking to weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A2—7 to 11 inches, dark grayish-brown (10YR 4/2) to grayish-brown (10YR 5/2) loam; dark brown to olive brown (10YR 4/3 to 2.5Y 4/3) if kneaded; common, fine, distinct, yellowish-brown (10YR 5/6) and few, fine, faint, dark yellowish-brown (10YR 3/4) mottles; weak, thick, platy structure breaking to very weak, fine, subangular blocky structure; friable; common, very dark gray (10YR 3/1) worm casts; neutral; clear, smooth boundary.

B1—11 to 16 inches, mottled grayish-brown (2.5Y 5/2) and brown (10YR 5/3) loam; grayish brown to light olive brown (2.5Y 5/3) if kneaded; common, fine, distinct, yellowish-brown (10YR 5/6) and few, fine, distinct,

(10YR 5/2) and contains some mottles or concretions of an oxide.

The texture of the solum centers on loam, but in places the B horizons have a texture of heavy sandy loam, loam, light sandy clay loam, and light clay loam. The upper B horizons have hues of 10YR and 2.5Y with values of 4 and 5 and chromas of 2 and higher. The lower B horizons have hues of 7.5YR to 10YR. The mottles are yellowish brown, olive brown, and strong brown. The exterior and interior colors are somewhat contrasting in the lower B horizon. The most acid part of the solum is medium acid.

Huntsville Series

The Huntsville series consists of well-drained soils that have a very thick surface layer and weak horizonation. These soils formed in medium-textured, silty alluvium. They are in gently sloping areas at the base of the uplands and on nearly level alluvial fans where water from the uplands drains onto bottom lands and benches. The native vegetation was prairie grasses.

The Huntsville soils have dark-colored, thick A horizons of silt loam and weakly defined, brownish B horizons. The B horizons contain some coatings of organic matter.

Unlike the Lawson soils, which are mottled and have chromas of 2 below the A horizons, the Huntsville soils are free of mottles and have chromas of 3 below the A horizons. In contrast to the Kennebec soils, they have chromas of 3 above a depth of 40 inches. The Huntsville soils have brownish B horizons that are free of mottles, in contrast to the Otter and Ossian soils, which have gleyed, mottled B horizons. They have darker A

B3—52 to 64 inches, dark-brown to brown (10YR 4/3) and some dark-brown (10YR 3/3) silt loam; very weak, very fine, subangular blocky structure to massive; weakly calcareous; friable.

The Huntsville soils have weak to moderate horizonation. In places they have 18 inches or less of recently deposited material on the surface. The A1 horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2) or very dark gray (10YR 3/1) in color and from 20 to 30 inches in thickness. In places to a depth of 40 inches, coatings of organic matter that have a value of 3 or less and chroma of 2 or less mask soil material of higher chroma in the ped interiors.

The B horizons are dark brown (10YR 3/3) or very dark grayish brown (10YR 3/2) grading to brown and dark brown (10YR 4/3) and are free of mottles. No clay films are evident. In many places the boundaries of the horizons are gradual. The texture of the solum centers on silt loam that is low in content of sand (less than 15 percent), but the B horizons have a texture of light silty clay loam in many places. The soil reaction is variable and ranges from medium acid to neutral or mildly alkaline above a depth of 40 inches.

Jacwin Series

In the Jacwin series are soils that are somewhat poorly drained. These soils formed in loamy glacial

B21—19 to 23 inches, very dark grayish-brown (2.5Y 3/2) and some light olive-brown (2.5Y 5/4) and black (10YR 2/1) loam; weak, fine, prismatic structure breaking to weak, very fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

B22—23 to 27 inches, light olive-brown (2.5Y 5/4) and some yellowish-brown (10YR 5/6) sandy clay loam; weak, very fine, subangular blocky structure; friable; neutral; abrupt, wavy boundary.

IIB3—27 to 48 inches, brownish-yellow (10YR 6/6) and greenish-gray (5GY 5/1) heavy silty clay loam or silty clay; moderate to strong, fine, prismatic structure; structure breaks to prismaticlike peds that become finer and finer to where their size is about 1/8 inch by 1/2 inch; very firm; springy when pressed; calcareous.

The A1 horizon ranges from black (N 2/0 to 10YR 2/1) to very dark gray (10YR 3/1) in color and from 10 to 15 inches in thickness. The A3 horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR to 2.5Y 3/2) in color. The texture of the A horizons centers on loam but includes gritty silt loam. The major part of the solum has developed in the loamy overburden above the shale or shale residuum. The overburden ranges from 15 to 30 inches in thickness. The content of sand in the solum ranges from 20 to 45 percent.

The B horizons above the lithologic discontinuity have hues of 10YR and 2.5Y, values of 3 to 5, and chromas of 2 to 6, and they range from loam or sandy clay loam to

Floyd soils, and in contrast to those soils, they have B horizons that are underlain by coarse-textured material.

The Kato soils are the Brunizemic members of a biosequence that includes the Hayfield soils, which are in the Gray-Brown Podzolic great soil group but are intergrading toward Brunizems. They form a hydrosequence with the Sattre soils, which are well drained.

Representative profile of Kato loam, moderately deep, in a cultivated field, 900 feet west of the NE–SW road from the T-road intersection on the east edge of NE¼ NE¼ sec. 29, T. 96 N., R. 9 W., then 75 feet north of road right-of-way:

Ap—0 to 7 inches, black (N 2/0) loam; weak to moderate, fine and coarse, granular structure; friable; mildly alkaline; clear, smooth boundary.

A11—7 to 15 inches, black (N 2/0) loam; very weak, fine, prismatic structure breaking to weak, fine and very fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

B2—15 to 21 inches, very dark grayish-brown (2.5Y 3/2) and some dark grayish-brown (2.5Y 4/2) to olive-gray (5Y 4/2) heavy loam; a few, fine, distinct, yellowish-brown (10YR 5/6) mottles; very weak, fine, prismatic structure breaking to weak, very fine, granular structure; friable; neutral; clear, smooth boundary.

IIC—38 to 44 inches, mixed brownish-yellow (10YR 6/6), yellow (10YR 7/6), and reddish-yellow (7.5YR 6/6) fine sand; very friable to loose; massive; calcareous; clear, wavy boundary.

IIIR—44 inches, shale that has a very thin cap of limestone bedrock.

Three phases of Kato loam are recognized in Winneshiek County. In the first, Kato loam, deep, the soil is underlain by coarse-textured material at a depth between 36 and 42 inches. In the second, Kato loam, moderately deep, the soil is underlain by coarse-textured material between a depth of 24 and 36 inches. In the third, Kato loam, deep, clay shale substratum, the soil is underlain by coarse-textured material between a depth of 36 and 42 inches, and the coarse-textured material overlies fine-textured shale.

The A1 horizon of the Kato soils is black (N 2/0 to 10YR 2/1) and ranges from 12 to 18 inches in thickness. The B1 horizon has color hues that center on 2.5Y, with values of 3 and 4 and chromas of 2. The B horizons are mottled. The colors are variable above the IIB3 horizon. The mottles increase in size and abundance with increasing depth.

The solum of the Kato soils typically has a texture of

IIB3t and IIC horizons. The solum is predominantly friable, but the consistence is friable to firm in some horizons. The most acid part of the solum is very strongly acid.

Lamont Series

In the Lamont series are well-drained to excessively drained soils formed in 24 to 48 inches of material that has a texture of sandy loam and loam. These soils are on nearly level or gently sloping stream benches and on sloping to steep upland ridges and side slopes. The native vegetation was trees.

The Lamont soils have a thin, moderately dark colored A1 horizon of sandy loam; a light-colored A2 horizon; and B horizons that have a texture of sandy loam to light loam and that contain a few clay films. In many places the texture is sand below a depth of 42 inches.

The Lamont soils have a thinner, lighter colored A1 horizon than the Dickinson soils, and unlike the Dickinson soils, they have an A2 horizon. In contrast to the Chelsea soils, which have color B horizons that have a texture of loamy sand and sand and are free of clay films, the Lamont soils have B horizons that have a texture of sandy loam to loam and contain clay films. Their B horizons are more uniform in thickness than those of the Backbone soils, and their solum is not underlain by a layer of residuum and limestone bedrock like that under the solum of the Backbone soils. The Lamont soils have a thinner, lighter colored A1 horizon than the till subsoil variants of the Lamont series, and their B horizons are less variable in thickness. Also, they are not underlain by glacial till above a depth of 40 inches as are the till subsoil variants of the Lamont series.

The Lamont soils are the Gray-Brown Podzolic members of a biosequence that includes the Dickinson soils, which are Brunizems.

Representative profile of Lamont sandy loam in a cultivated field 380 feet south and 80 feet west of the NE. corner of the NW¼SE¼ sec. 8, T. 98 N., R. 7 W.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) and very dark grayish-brown (10YR 3/2) sandy loam; very weak granular structure; very friable; neutral; abrupt, smooth boundary.

A2—7 to 12 inches, dark grayish-brown (10YR 4/2) sandy

The A1 horizon is very dark gray (10YR 3/1) or very dark grayish-brown (10YR 3/2) sandy loam that ranges from 2 to 4 inches in thickness. The A2 horizon is generally dark grayish brown (10YR 4/2) and ranges from 4 to 8 inches in thickness. In areas that have been plowed, part of the A2 horizon is incorporated in the plow layer.

The B horizons generally have color values of 4 and chromas of 3, but the values and chromas are higher at increasing depths. The texture of the B horizons centers on sandy loam to light loam. A few thin, discontinuous clay films are evident in parts of the B horizons. The B3 or C horizon has a texture of sandy loam, loamy sand, or sand. The most acid part of the solum is medium acid to strongly acid. The profile is acid to a depth of 48 inches and below.

Lamont Series, Till Subsoil Variants

The till subsoil variants of the Lamont series are well drained. They formed in moderately coarse textured material that is 15 to 36 inches thick over leached, medium-textured or moderately fine textured glacial till. These soils are on sloping ridges and side slopes in the uplands. The native vegetation was trees and grasses.

These soils have a thin to moderately thick, dark-colored A1 horizon of sandy loam; an indistinct A2 horizon; and brownish B horizons that developed partly in material that has a texture of sandy loam and partly in loamy glacial till. The part of the solum formed in the material that has a texture of sandy loam is free of mottles.

The till subsoil variants of the Lamont series occur with the Bassett and Racine soils. They have a coarser texture and generally more friable consistence in the upper part of their solum than the Bassett, Racine, Kenyon, and Ostrander soils. They also have a thinner A1 horizon than the Kenyon and Ostrander soils, and unlike those soils, they have an A2 horizon. Unlike the Backbone soils, which are underlain by bedrock, the till subsoil variants of the Lamont series have a substratum of glacial till. They are similar to the Lamont soils but are underlain by glacial till at a depth between 15 and 36

B1t—12 to 20 inches, brown to dark-brown (10YR 4/3) sandy loam; dark yellowish brown (10YR 4/4) if kneaded; weak, very fine, subangular blocky structure; very friable; few, thin, discontinuous clay films; common fine, tubular pores; medium acid; clear, smooth boundary.

B21t—20 to 25 inches, dark yellowish-brown (10YR 4/4) light loam to sandy loam; weak, very fine, subangular blocky structure; friable; few, thin, discontinuous clay films; common fine, tubular pores; very strongly acid; clear, smooth boundary.

IIB22t—25 to 32 inches, loam and some pebbles; brown (10YR 5/3) ped exteriors, and yellowish-brown (10YR 5/4) ped interiors; few, fine, faint, yellowish-brown (10YR 5/8) mottles; weak, very fine, subangular blocky structure; friable; common fine, tubular pores; stone line in upper part of horizon; very strongly acid; clear, smooth boundary.

IIB23t—32 to 54 inches, coarse loam; some pebbles; light brownish-gray (2.5Y 6/2) ped exteriors and mixed strong-brown (7.5YR 5/6) and light brownish-gray (2.5Y 6/2) ped interiors; dark yellowish brown (10YR 5/6) crushed; weak, very fine, subangular blocky structure; very friable; few, thin, discon-

Lawson Series

In the Lawson series are somewhat poorly drained soils formed in alluvium that has a texture of silt loam. These soils are nearly level or gently sloping and are at the base of upland slopes that grade to bottom lands and low benches. In some places they are on natural levees. The native vegetation was prairie grasses.

The Lawson soils have thick, dark-colored A horizons of silt loam; grayish, mottled B horizons that also have a texture of silt loam; and stratified silty and loamy C horizons.

In contrast to the Huntsville soils, which have a subsoil that has chromas of 3 and lacks mottles, the Lawson soils have a mottled subsoil that has chromas of 2. Unlike the Kennebec soils, the Lawson soils have colors that have values of 4 and chromas of 2 above a depth of 40 inches. They have a thicker, darker colored A1 horizon than the Canoe soils, and they also lack an A2

A hue of 2.5Y is dominant in the B horizons. The color of the B horizons centers on values of 4 and chromas of 2, and the values commonly increase with increasing depth. In many places the subsoil has common mottles of light olive brown, olive, and olive gray. The texture throughout the solum is generally silt loam, but thin layers of other loamy material occur in places below a depth of 40 inches. The soil reaction ranges

The Marlean soils have a moderately thick, dark-colored A horizon of loam and thin, brownish B horizons of variable thickness that are underlain by fragmented limestone. The subsoil is free of mottles and clay films.

The Marlean soils have a thicker, darker colored A1 horizon than the Nordness soils, and unlike those soils, they lack an A2 horizon. Also, their solum has a higher

Nasset Series

In the Nasset series are soils that are well drained. These soils formed in 30 to 50 inches of loess over lime-

B22t—34 to 37 inches, light silty clay loam; dark-brown (7.5YR 3/2 to 4/2) ped exteriors; dark-brown to brown (10YR 4/3) ped interiors; weak, fine, prismatic structure breaking to weak, very fine, subangular blocky structure; friable to firm; combuque soils. They occur with Dubuque soils and with areas of Steep rock land.

Representative profile of Nordness silt loam in open timber, reached by going 140 feet along road from center of T-road intersection, then 15 feet east of road right-of-way to extreme SW. corner of SE¼ sec. 21, T. 99 N., R. 7 W.:

A1—0 to 2 inches, very dark gray (10YR 3/1) and dark grayish-brown (10YR 4/2) silt loam; moderate, fine, granular structure; friable; neutral; clear, smooth boundary.

A2—2 to 5 inches, dark grayish-brown (10YR 4/2) silt loam; moderate, thin and medium, platy structure breaking to weak, very fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.

B1—5 to 9 inches, dark-brown to brown (10YR 4/3) silt loam; moderate, very fine, subangular blocky structure; friable; common, thin, very dark grayish-brown (10YR 3/2) ped coats; neutral; clear, smooth boundary.

IIB2t—9 to 12 inches, dark-brown (7.5YR 3/2) and reddish-brown (5YR 4/4) silty clay loam; moderate, very fine, subangular blocky structure; friable; few, thin, discontinuous, black (10YR 2/1) clay films; neutral; abrupt, wavy boundary.

IIR1—12 to 18 inches, bed of clean limestone or slabs of limestone; the slabs of rock are 8 to 10 inches and larger in diameter and 2 to 5 inches thick; horizontally between the slabs is a very thin (less than one-fourth inch) accumulation of reddish, calcareous silty clay loam, and vertically as much as 2 inches of red-

pebbles. In parts of the B horizon, there are some clay films or clay flows. The interior and exterior colors of the peds are distinctly contrasting in the B2 and B3 horizons. In many places a stone line lies between the loam sediment and the glacial till.

The Oran soils have a thinner A1 horizon than the Floyd soils, and unlike those soils, they have an A2 horizon. Also, they formed in a thinner layer of loamy sediments over glacial till than did the Floyd soils. Unlike the Bassett soils, they have colors that have a chroma of 2, and they have mottles in the B1 horizon. The combined thickness of the B horizons is less variable in the Oran than in the Hayfield soils. Also, the Oran soils are not underlain by a uniform layer of coarse-textured material like the Hayfield soils. The Oran soils were derived from glacial till instead of alluvium and have a higher content of sand than the Canoe soils, which are silty. Also, unlike the Canoe soils, they contain some stones and pebbles. The Oran soils have a higher content of sand in the upper part of their solum than do the gray subsoil variants of the Franklin series, which have formed in 15 to 40 inches of loess.

The Oran soils form a hydrosequence with the Bassett soils, which are moderately well drained.

Representative profile of Oran loam in a cultivated field, 400 feet north and 65 feet east of the SW. corner

The Oran soils have moderate horizonation. The A1 horizon ranges from 4 to 8 inches in thickness and from black (10YR 2/1) to very dark gray (10YR 3/1) in color. The color of the A2 horizon centers on a value of 4 and a chroma of 2, but the values are lower or higher than 4 in some places. The A2 horizon is generally between 4 and 8 inches thick. In some areas that have been plowed, part of the A2 horizon is incorporated in the surface layer. In the uppermost 14 to 24 inches of the solum, the texture is loam to silt loam.

The texture of the B horizons centers on heavy loam, but it ranges from light clay loam to sandy clay loam. Those horizons contain some stones and pebbles. In many places in the B horizons, the hue is 2.5Y, but the hues range from 10YR in the upper B horizons to 5Y on some exterior coats in the lower B horizon. Color values of 4 grading to 5 and chromas of 2 are most common in the B horizons. The lower B horizon has contrasting exterior and interior colors. The mottles range from yellowish brown to olive gray and grayish brown in color. In the most acid part of the solum, the reaction is strongly acid or very strongly acid. In places, however, the glacial till is calcareous below a depth of 42 inches.

Orwood Series

In the Orwood series are well-drained soils that formed in wind-deposited material that has a texture of loam or silt loam. These soils are gently sloping to steep and are on ridgetops and side slopes in the uplands. The native vegetation was trees and prairie grasses.

The Orwood soils have a thin to moderately thick, dark colored or moderately dark colored A1 horizon of silt loam to loam; an indistinct A2 horizon in areas that are not eroded; and B horizons of brownish silt loam to loam. Some clay films are in the B horizons. The B1 and B2 horizons are free of mottling.

The Orwood soils have a higher content of sand than

B21t—13 to 23 inches, heavy silt loam to loam; brown to dark-brown (10YR 4/3) ped exteriors; dark yellowish-brown (10YR 4/4) ped interiors; moderate, fine, subangular blocky structure; friable; common, fine, inped tubular pores; distinct, discontinuous, dark-brown (10YR 3/3) clay films and a few black oxide stains on the peds; neutral; clear, smooth boundary.

B22t—23 to 29 inches, silt loam to loam; brown to dark-brown (10YR 4/3) ped exteriors; dark yellowish-brown (10YR 4/4) ped interiors; moderate, fine, subangular blocky structure; friable; common, thin, discontinuous, dark-brown (10YR 3/3) clay films and a few black oxide stains on the ped surfaces; common, fine, inped tubular pores; medium acid; clear, smooth boundary.

B31t—29 to 42 inches, loam; brown to dark-brown (10YR 4/3) ped exteriors; dark yellowish-brown (10YR 4//4) ped interiors; weak, medium, subangular blocky structure and some tendency toward prismatic structure; friable; thin, distinct, discontinuous clay films and a few black oxide stains; common, fine, inped tubular pores; prism surfaces have prominent, very thin coatings of sand grains that are very pale brown (10YR 7/3) when dry and that can be seen only when soil material is dry; medium acid; clear, smooth boundary.

B32—42 to 50 inches, silt loam; dark yellowish-brown (10YR 4/4) to yellowish-brown (10YR 5/4) ped exteriors; dark yellowish-brown (10YR 4/4) ped interiors; weak, medium to coarse, prismatic structure; friable; many, fine, inped tubular pores; prism surfaces have distinct coatings of sand grains that are very pale brown (10YR 7/3) when dry and that can be seen only when soil material is dry; medium acid; clear, smooth boundary.

C—50 to 60 inches, yellowish-brown (10YR 5/4) silt loam; massive; friable.

The Orwood soils have moderate horizonation. The A1 horizon ranges from 4 to 8 inches in thickness, from very dark brown (10YR 2/2) to very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) in color, and from silt loam to loam in texture. Where an A2 horizon is present, it is 2 to 4 inches thick and is mainly dark grayish brown (10YR 4/2) but contains some material that is very dark grayish brown (10YR 3/2). In areas that are cultivated or that are eroded, the A2 horicent sand. They are on nearly level first bottoms and in upland drainageways. The native vegetation was grasses and sedges that are tolerant of excessive wetness.

The Ossian soils have an A1 horizon of dark or moderately dark colored silt loam. This A1 horizon is separated from a distinctly gleyed and mottled B horizon of silt loam by an abrupt boundary.

The texture and horizon development of the Ossian soils are similar to those of the Otter soils. The Ossian soils have a thinner A horizon than the Otter, however, and they have gleyed colors above a depth of 20 inches. The Ossian soils have a thinner A horizon than the Rowley soils, and unlike the Rowley soils, they have distinctly gleyed B horizons. They have a thinner A horizon than the Huntsville soils. Also, they have gleyed B horizons and are poorly drained instead of well drained. In contrast to the Kennebec soils, which are dark colored to a depth of 40 inches or more, the Ossian soils are dark colored to a depth of about 18 inches. Also, they have more strongly defined B horizons than the Kennebec soils. The Ossian soils have less sand throughout the solum than the Clyde soils, which formed in glacial material.

Representative profile of Ossian silt loam along the Yellow River in a cultivated field, 725 feet south and 115 feet east of the northwest corner of sec. 12, T. 96 N., R. 7 W.:

Ap—0 to 7 inches, black (N 2/0) heavy silt loam; cloddy but breaks to weak, medium, subangular blocky structure; friable; neutral; abrupt, smooth boundary.

A12—7 to 15 inches, black (N 2/0) heavy silt loam; moderate, fine, granular structure; friable; neutral; gradual, smooth boundary.

A13—15 to 18 inches, black (10YR 2/1) heavy silt loam; black (10YR 2/1) to very dark gray (10YR 3/1) if kneaded; moderate, fine and very fine, granular structure; friable; few, fine, distinct, olive-gray (5Y 5/2) peds or mixings; neutral; gradual, smooth boundary.

B1g—18 to 23 inches, very dark gray (2.5Y 3/1) and 10 percent olive-gray (5Y 5/2) silt loam to silty clay loam; weak, fine and very fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

B2g—23 to 32 inches, dark-gray (5Y 4/1) to olive-gray (5Y 5/2) silt loam to silty clay loam; olive gray (5Y 5/2) to olive (5Y 5/3) if kneaded; weak, medium, prismatic structure breaking to weak, fine, subangular blocky structure; friable; few, patchy, dark ped surfaces; neutral; gradual, smooth boundary.

B3g—32 to 42 inches, silt loam to light silty clay loam; olive-

of 1 or 2, and a hue of 5Y are typical in the B horizons, but the range of color includes a hue of 2.5Y. In many places yellowish-brown mottles occur throughout the B horizons.

Soils that lack a gleyed horizon immediately below the A horizons are considered to be outside the range of the Ossian series. Throughout the solum, the texture is centered on silt loam. The range of texture includes light silty clay loam, however, and soil material that is approximately 25 to 35 percent clay and generally less than 10 percent sand. In most places the solum is free of stratification. Coarse-textured underlying material is generally below a depth of 5 feet. The soils range from neutral to slightly acid in reaction.

Ostrander Series

The Ostrander series consists of well-drained soils that formed in friable, loamy glacial material and glacial till. A pebble band separates the loamy overburden from the glacial till. These soils are gently sloping to sloping and are on upland highs or ridgetops and on convex side slopes. The native vegetation was prairie grasses.

The Ostrander soils have moderately thick, dark-colored A horizons of loam. They have brownish B horizons of loam to clay loam that are free of mottles above a depth of 30 inches. The B and C horizons are friable, and contrasting exterior and interior colors are not pronounced in those horizons. In places there are a few clay films, but their B/A clay ratio is low. Cobbles and pebbles are common in the solum below the pebble band.

The Ostrander soils have more brownish IIB3t and IIC horizons than the Kenyon soils, and they lack the grayish mottles that are slightly evident in the profile of the Kenyon soils. They have a thicker, darker colored A1 horizon than the Renova and Racine soils, and they lack the A2 horizon that is typical in the profiles of the Renova and Racine soils. The Ostrander soils have a thicker solum than the Rockton and Atkinson soils, and they are not underlain by limestone and limestone residuum like those soils. They have a thicker solum than the Waukegan soils, and they are underlain by finer textured material than those soils.

The Ostrander soils form a biosequence with the Racine soils, which are in the Gray-Brown Podzolic great soil group but are intergrading toward Brunizems, and with the Renova soils, which are in the Gray-Brown Podzolic great soil group.

B11t—18 to 22 inches, brown to dark-brown (10YR 4/3) loam; weak, very fine, subangular blocky structure; friable; common, thin, discontinuous, dark yellowish-brown (10YR 4/4) clay films; medium acid; abrupt, smooth boundary.

IIB12t—22 to 24 inches, pebble band; pebbles 1 to 3 inches in diameter embedded in soil material; other characteristics similar to those of B11t horizon.

IIB21t—24 to 34 inches, dark yellowish-brown (10YR 4/4) light clay loam; some stones and pebbles; weak, fine, prismatic structure breaking to weak, very fine and fine, subangular blocky structure; friable; common, thin, discontinuous, brown to dark-brown (10YR

development than do the Rowley soils. The Otter soils are not gleyed like the Ossian soils above a depth of 20 inches. They have a texture of silt loam to a depth of 40 inches or more, rather than silty clay loam like that in the Colo soils.

Representative profile of Otter silt loam in a permanent pasture, 315 feet south and 60 feet west of the NE. corner of the NW¼NE¼ sec. 14, T. 98 N., R. 10 W.:

A11—0 to 8 inches, very dark gray (10YR 3/1) and black (10YR 2/1) silt loam; weak, very fine, subangular

Representative profile of a moderately eroded Palsgrove silt loam that has slopes of 11 percent and that has the A2 horizon incorporated in the Ap, in a cultivated field 750 feet east and 360 feet north of the SW. corner of the SE¼ sec. 14, T. 100 N., R. 8 W.:

- Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam; weak granular structure; friable; when dry, common coatings of white silt or very fine sand noted; slightly acid; abrupt, smooth boundary.
- B1—6 to 11 inches, brown to dark-brown (10YR 4/3) and dark yellowish-brown (10YR 4/4) silt loam; weak, very fine, subangular blocky structure; friable; when dry, common coatings of white silt or very fine sand noted; few, thin, discontinuous clay films; strongly acid; clear, smooth boundary.

[illegible]

the B horizon that contains the most clay has a more reddish hue than indicated in the profile described as typical. In places the lower B horizon contains fragments of limestone. The most acid part of the solum is strongly acid.

Peaty Muck

Peaty muck consists of an accumulation, 10 inches or more thick, of partly decomposed plant remains that are underlain by gleyed, moderately fine textured mineral material. Seepage and a high water table have made the soil material very wet. Peaty muck is on first bottoms, in depressions, and on slightly elevated highs in broad drainageways in the uplands.

[illegible]

soils are on gently sloping upland highs or ridgetops and on sloping to steep, convex side slopes. The native veg-

IIB23t—34 to 44 inches, yellowish-brown (10YR 5/8) and some grayish-brown (2.5Y 5/2) sandy clay loam; some stones and pebbles; yellowish brown (10YR

The Renova soils form a biosequence with the Ostrander soils, which are in the Brunizem great soil group, and with the Racine soils, which are in the Gray-Brown

places. Stones and pebbles are common below the lithologic discontinuity. In places a few, fine, yellowish-brown, strong-brown, and grayish-brown mottles are be-

IIB23t—42 to 56 inches, gray (5Y 5/1) and strong-brown (7.5YR 5/8) light clay loam; weak, medium, prismatic structure breaking to weak, medium, subangular blocky structure; some vertical cleavage; firm; thin, continuous, gray (5Y 5/1) clay films; common very dark brown (10YR 2/2) clay fills; slightly acid.

The Riceville soils have strong horizonation. The A1 horizon ranges from 4 to 8 inches in thickness and from black (10YR 2/1) to very dark gray (10YR 3/1) in

are in that great soil group but are intergrading toward Brunizems.

Representative profile of Rockton loam in a cultivated field, center of the SW¼SE¼NE¼ sec. 15, T. 98 N., R. 10 W.:

Ap—0 to 7 inches, black (10YR 2/1) loam; moderate, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A12—7 to 18 inches, black (10YR 2/1) loam; few pebbles;

The Roseville soils have a thinner A1 horizon than the Waucoma soils, and they have a more distinct A2 horizon in many places. They have a thinner, lighter colored A1 horizon than the Atkinson soils, and they have a distinct A2 horizon that is lacking in the Atkinson soils. The Roseville soils have a thicker solum (30 to 50 inches thick) than the Whalan soils, which have a solum 15 to 30 inches thick. They also have a thicker solum, a thinner A1 horizon, and a more distinct A2 horizon than the Winneshiek soils. In contrast to the Palsgrove soils, which were derived from loess, the Roseville soils have a solum that is 20 to 45 percent sand.

The B horizons of the Roseville soils are more variable

tles below a depth of 30 inches. In most places a thin layer (1 to 8 inches thick) of moderately fine textured or fine textured material lies above the limestone bedrock. However, profiles without this layer are not excluded from the Roseville series. This moderately fine textured or fine textured layer above the bedrock may be a paleo B horizon, or it may be weathered limestone. The soil reaction centers on strongly acid but is variable.

Rowley Series

The Rowley series consists of somewhat poorly drained soils that formed in silty alluvium. These soils are nearly level or gently sloping and are on low benches

B31t—30 to 41 inches, mottled grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/4) silt loam; grayish brown (2.5Y 5/2) to light olive brown (2.5Y 5/4) if kneaded; weak, fine, prismatic structure; friable; nearly continuous, olive-gray (5Y 5/2) exterior coats; few, thin, discontinuous clay films; few, fine, soft, black concretions of an oxide; medium acid; gradual, smooth boundary.

B32t—41 to 46 inches, mottled olive-gray (5Y 5/2) and some light olive-brown (2.5Y 5/6) silt loam; light olive brown (2.5Y 5/4) if kneaded; weak, coarse, sub-

and they have a thinner A1 horizon and a less distinct A2 horizon than those soils.

The Sattre soils are the intermediate members in a biosequence that includes the Waukegan soils, which are in the Brunizem great soil group, and the Bixby soils, which are in the Gray-Brown Podzolic great soil group.

Representative profile of Sattre loam, deep, 200 feet north of the north road fence, in a cultivated field, 650 tent of sand above the leached sand and gravel ranges from 25 to 45 percent, and most of the sand is fine or medium in size. The sandy underlying material is leached below a depth of 60 inches. In the most acid part of the solum, the reaction is strongly acid.

Spillville Series

In the Spillville series are moderately well drained soils that formed in dark-colored loam alluvium. These soils are nearly level and are on first bottoms. The native vegetation was prairie grasses.

The Spillville soils have very thick, dark-colored A horizons of loam. Their subsoil is dark colored and loamy to a depth of 40 inches or more.

The Spillville soils have thicker A1 horizons than the Turlin and Terril soils. Also, their colors have values

Tama Series

The Tama series consists of well-drained soils that formed in loess. These soils are on nearly level or gently sloping ridgetops and on sloping or strongly sloping side slopes in the uplands. The native vegetation was prairie grasses.

The Tama soils have a moderately thick, dark-colored A1 horizon of silt loam; brownish B horizons of light silty clay loam; and C horizons that have a texture of silt loam. Mottling is absent in the B2 horizon. In most places the profile contains a very few, very thin clay films.

The Tama soils have a thicker A1 horizon than the Downs soils, and unlike the Downs soils, they lack an A2 horizon. In contrast to the Atterberry soils, they are well drained, lack an A2 horizon, and have a chroma of 3 and the most acid part of the solum, the soil reaction is medium acid to strongly acid.

Terril Series

In the Terril series are soils that are well drained or moderately well drained. These soils formed in loamy alluvium that contains more than 20 percent, but less than 50 percent, fine and medium sand. They are nearly level and are on first bottoms along small drainageways, on alluvial fans at the base of the uplands, or on low calcareous alluvial deposits that contain from 20 to 50 percent fine and medium sand. The alluvium was derived mainly from areas where the soils developed in glacial material. The soils are nearly level and are on first bottoms near the base of upland slopes. The native vegetation was grasses.

The Turlin soils have very thick, dark-colored A horizons of loam. They have weakly defined, mottled B horizons, also of loam.

The Turlin soils are similar to the Terril soils in the

3/2) to dark grayish brown (2.5Y 4/2) between a depth of 20 and 40 inches. In some places, however, the colors have a hue of 10YR. The texture throughout the solum is centered on loam. Mottles are common below the A horizon, but the A3 horizon also has some mottling in places. In many places stratification is not evident with-

Waucoma Series

In the Waucoma series are well-drained soils formed in loamy glacial material over limestone bedrock. In many places these soils have a thin zone of moderately fine textured or fine textured material above the bedrock. Depth to bedrock or to residuum weathered from

loess. Their B horizons are more variable in combined thickness than those of the Renova soils. Unlike the Renova soils, they are underlain by residuum and by limestone bedrock. The Whalan soils are not underlain by sand and gravel as are the Bixby soils.

The Whalan soils form a biosequence with the Winneshiek soils, which are in the Gray-Brown Podzolic great soil group but are intergrading toward Brunizems, and with the Rockton soils, which are Brunizems.

Representative profile of Whalan loam in a timbered field, 660 feet north and 20 feet west of the SE. corner of the NE¼SE¼ sec. 4, T. 97 N., R. 10 W.:

A1—0 to 2 inches, black (10YR 2/1) loam to silt loam; weak, fine, granular structure; very friable; medium acid; abrupt, smooth boundary.

A2—2 to 7 inches, dark grayish-brown (10YR 4/2) loam to silt loam; weak, thin, platy structure; very friable; medium acid; clear, smooth boundary.

B11—7 to 10 inches, brown (10YR 5/3) loam to silt loam; weak, very fine, subangular blocky structure; very friable; medium acid; clear, smooth boundary.

B12—10 to 15 inches, brown to dark-brown (10YR 4/3) loam that contains some pebbles; weak, very fine, subagular blocky structure; very friable; medium acid;

in turn, is underlain by limestone bedrock. They are on nearly level or gently sloping, moderately low to high structural benches, on gently sloping upland ridgetops, and on steep side slopes. The native vegetation was trees and prairie grasses.

The Winneshiek soils have a thin to moderately thick, dark colored or moderately dark colored A1 horizon that has a texture of loam; an indistinct to distinct A2 horizon; and B horizons of loam to clay loam that vary in thickness. The B horizons developed predominantly in glacial material. The lower B horizon, however, formed in moderately fine textured or fine textured residuum. In places the B horizons contain clay films. Pebbles and a few stones are evident.

The Winneshiek soils have a thicker, darker colored A1 horizon and a less distinct A2 horizon than the Whalan soil. They have thinner B horizons than the Waucoma soils. Their solum contains a larger proportion of sand than that of the Frankville soils, and it contains some stones and pebbles that are absent in the solum of the Frankville soils. Also, the Winneshiek soils formed in glacial material and residuum instead color and from 4 to 9 inches in thickness. The A2 horizon is dark grayish brown (10YR 4/2) and dark brown to brown (10YR 4/3), and it ranges from 3 to 6 inches in thickness. The A horizons generally have a texture of loam, but in places these soils have a thin surface layer that has a texture of silt loam.

The B horizons formed mainly in glacial material, but partly in a layer of residuum that is generally between 1 and 6 inches thick. The color of the B horizons centers on a hue of 10YR and values and chromas of 3 and 4. In many places the part of the solum formed in

the Upper Iowa River to rise to the highest level ever recorded for that stream. It also caused damaging flooding at Decorah, when Dry Run overflowed.

In this county a measurable amount of precipitation is received on an average of about 110 days each year. Precipitation of 0.1 of an inch or more is received on about 40 days during the growing season and on a total of about 62 days each year. Rainfall is most abundant during the peak of the growing season. Occasionally, drought develops to some extent during that season. Usually, however, drought occurs late in the season, when once each century. In exposed areas winds of such high velocity may reach the ground.

Tornadoes are most frequent in this county in May [illegible]

An area about 4 miles wide, extending from the town of Conover north and east of the ridge on which the towns of Conover and Ridgeway are located, is in the part of the county drained by the Upper Iowa River

[illegible]

TABLE 8.—*Summary of temperatures and precipitation*

[Based on a 30-year period,

Month	Precipitation (in inches): Average	Greatest daily: Inches	Greatest daily: Year	Snow and sleet: Average	Snow and sleet, Greatest monthly: Inches	Snow and sleet, Greatest monthly: Year	Snow and sleet, Greatest daily: Inches	Snow and sleet, Greatest daily: Year	Temperature (° F.), Average: Daily maximum	Temperature (° F.), Average: Daily minimum	Temperature (° F.), Average: Monthly
January	1. 08	1. 80	1946	8. 9	24. 0	1937	10. 5	1949	27. 9	7. 1	17. 5
February	. 88	1. 46	1948	7. 2	22. 2	1936	10. 0	1937	31. 2	9. 8	20. 5
March	2. 01	1. 97	1956	10. 6	28. 3	1959	13. 0	1959	41. 5	20. 9	31. 2
April	2. 57	2. 12	1941	1. 3	9. 0	1952	6. 0	1949 [2]	58. 8	34. 5	46. 7
May	4. 12	7. 70	1941	(3)	3. 2	1947	3. 2	1947	71. 1	46. 0	58. 6
June	4. 94	6. 40	1942	0	0	--------	0	--------	80. 2	56. 4	68. 3
July	4. 24	4. 50	1933	0	0	--------	0	--------	85. 7	59. 7	72. 7
August	4. 33	4. 40	1940	0	0	--------	0	--------	83. 4	57. 8	70. 6
September	3. 42	4. 08	1946	0	(4)	1942	(4)	1942	74. 8	49. 1	62. 0
October	2. 03	2. 68	1942	(3)	. 3	1952	. 3	1952	63. 5	37. 8	50. 7
November	1. 89	2. 30	1958	4. 5	13. 5	1947	12. 0	1934	44. 7	24. 5	34. 8
December	1. 07	1. 30	1932	7. 1	19. 9	1950	8. 0	1932	31. 6	13. 1	22. 4
Year	32. 59	7. 70	1941	39. 6	28. 3	1959	13. 0	1959	57. 9	34. 7	46. 3

[1] Degree-days based on 65° F. The heating degree-days for a day are determined by subtracting the average daily temperature from 65. These daily values are totaled to obtain the number of degree-days in a month. For example, to determine the average degree-days for January in an 8-year period, determine the total of degree-days for each January in that period and divide by eight.

at Decorah Station, Winneshiek County, Iowa

from 1931 through 1960]

Temperature (° F.)—Continued	Average	Average number of days with—		
Extreme			Maximum temperature	Minimum temperature
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 9.—*Frequency of rains of stated duration and intensity in Winneshiek County*

Frequency [1]	Duration of—						
	½ hour	1 hour	2 hours	3 hours	6 hours	12 hours	24 hours
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Once in—							
1 year	1. 0	1. 3	1. 5	1. 7	1. 8	2. 2	2. 6
2 years	1. 2	1. 5	1. 8	1. 9	2. 2	2. 6	3. 0
5 years	1. 5	1. 9	2. 2	2. 4	2. 8	3. 3	3. 8
10 years	1. 7	2. 1	2. 6	2. 7	3. 3	3. 9	4. 4
25 years	1. 9	2. 5	2. 9	3. 2	3. 7	4. 3	5. 0
50 years	2. 1	2. 7	3. 2	3. 6	4. 2	4. 9	5. 6
100 years	2. 4	3. 0	3. 6	3. 9	4. 7	5. 5	6. 3

[1] Expresses the frequency of the specified number of inches of rainfall at given time intervals. For example, 1.0 inch of rain can be expected to fall in one-half hour once each year (100 percent probability), but 2.4 inches can be expected to fall in one-half hour only once n 100 years (1 percent probability).

Table 10.—*Probabilities of last freezing temperatures in spring and first freezing temperatures in fall*

Probability	Dates for given probability and temperature				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than	Mar. 11	Mar. 20	Apr. 5	Apr. 17	Apr. 27
3 years in 10 later than	Mar. 21	Mar. 31	Apr. 14	Apr. 26	May 8
5 years in 10 later than	Mar. 28	Apr. 7	Apr. 20	May 3	May 16
7 years in 10 later than	Apr. 4	Apr. 14	Apr. 26	May 10	May 24
9 years in 10 later than	Apr. 14	Apr. 25	May 5	May 19	June 4
Fall:					
1 year in 10 earlier than	Oct. 24	Oct. 6	Sept. 28	Sept. 17	Sept. 8
3 years in 10 earlier than	Nov. 2	Oct. 18	Oct. 9	Sept. 26	Sept. 18
5 years in 10 earlier than	Nov. 9	Oct. 26	Oct. 17	Oct. 3	Sept. 25
7 years in 10 earlier than	Nov. 16	Nov. 3	Oct. 25	Oct. 10	Oct. 2

creased and the size of farms has increased. Occasionally, by clearing a wooded area, a fairly small acreage is added to the area that is cultivated. Most of the cultivated acreage that is added, however, consists of areas that were formerly wet land but that have been drained.

Many of the farmers are using their land to better advantage than they formerly did. The practices used to control erosion help to conserve the soils. Because of lack of erosion control in the past, however, the soils in about a quarter of the cultivated acreage have lost more than half of their surface layer. In about half of this same acreage, between a quarter and a half of the surface layer has been lost.

In the following paragraphs, some facts about the agriculture of the county are given. The figures are mainly from the 1960 Assessor's Annual Farm Census of Iowa.

Crops.—The acreage of the various crops grown in this county is constantly changing. For example, the acreage

the main farm-to-market roads have been surfaced with bituminous material. All State and Federal highways are concrete, except for one short spur that is surfaced with bituminous material.

Two concrete highway systems cross the county from east to west and one crosses from north to south. A second north-south system extends about halfway across the county from the north and joins one of the east-west systems.

Recreational Facilities

This county has high potential for recreation. It is a scenic area. The bluffs and outcrops of bedrock, as well as the hills, valleys, springs, and rivers, are all picturesque. The many trees and their multicolored leaves in fall have great esthetic value.

The streams are fed by cool springs and are clear and fast moving. They are ideally suited to trout and are well stocked. An increasing number of persons fish the

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Glossary

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available moisture capacity. The difference between the amount of water in a soil at field capacity and the amount in the same soil at the permanent wilting point. Commonly expressed as inches of water per inch depth of soil. (Also called moisture-holding capacity or water-holding capacity.)

Bench position. A high, shelflike position.

Biosequence. A sequence of soils whose properties are functionally related to differences in organisms as a soil-forming factor.

Bottom land. The normal flood plain of a stream and the old alluvial plain that is seldom flooded. (See Bottoms, first, and Bottoms, second.)

Bottoms, first. The normal flood plain of a stream; land along the stream subject to overflow.

Bottoms, second. An old alluvial plain, generally flat or smooth, that borders a stream but is seldom flooded.

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.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent; will not hold together in a mass.

Friable.—When moist, crushes easily under gentle to moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken

A horizon.—The mineral horizon at the surface. It has an accumulation of organic matter, has been leached of soluble minerals and clay, or shows the effects of both.

B horizon.—The horizon in which clay minerals or other material has accumulated, that has developed a characteristic blocky or prismatic structure, or that shows the effects of both processes.

C horizon.—The unconsolidated material immediately under the true soil. In chemical, physical, and mineral composition, this material is presumed to be similar to the material from which at least part of the overlying solum has developed.

Leaching, soil. The removal of materials in solution by the passage of water through soil.

Moisture-holding capacity. See Available moisture capacity.

Mulch tillage. Tillage of the soil and treatment of the crop residue in ways that leave plant material within or on the soil surface to form a mulch.

Parent material. The weathered rock or partly weathered soil material from which soil has formed; horizon C in the soil profile.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability, soil. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Reaction. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline.	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline.	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Sand. As a soil separate, individual rock or mineral fragments ranging from 0.05 to 2.0 millimeters in diameter. Most sand grains consist of quartz, but they may be of any mineral composition. As a textural class, soil that is 85 percent or more sand and not more than 10 percent clay.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting upon parent material, as conditioned by relief over periods of time.

Solum, soil. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in a mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structural bench. A degradational feature in which the underlying, nearly horizontal strata (limestone, other kinds of bedrock,

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace (structural). An embankment or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surplus runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Toposequence. A sequence of soils whose properties are functionally related to topography as a soil-forming factor.

Variant. A soil that has many characteristics of the series in which it is placed but that differs in at least one important characteristic, indicated by its name. The acreage of a variant is of too small extent to justify establishing a new series. A new series may be designated and replace the variant, however, if sufficient acreage is later found.

Water-holding capacity. See Available moisture capacity.

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