SOIL SURVEY OF

Warren County, Iowa

United States Department of Agriculture
Soil Conservation Service
In cooperation with
Iowa Agriculture and Home Economics Experiment Station and
Cooperative Extension Service, Iowa State University, and the
Department of Soil Conservation, State of Iowa

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

Major fieldwork for this soil survey was completed in the period 1968–72. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1972. This survey was made cooperatively by the Soil Conservation Service, the Iowa Agriculture and Home Economics Experiment Station and Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa. It is part of the technical assistance furnished to the Warren County Soil Conservation District. Funds appropriated by Warren County were used to defray part of the cost of this survey.

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

HOW TO USE THIS SOIL SURVEY

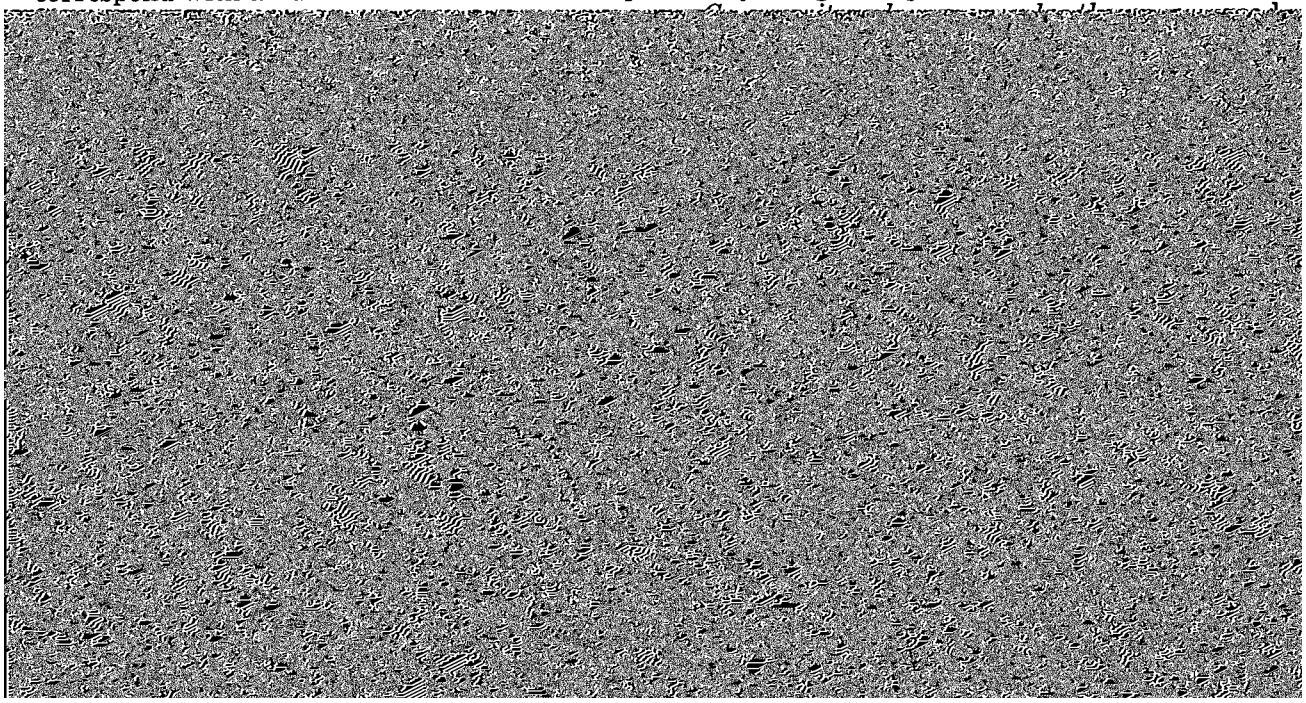
THIS SOIL SURVEY contains information that can be applied in managing farms, and woodland; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Warren County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map ability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units and the environmental planting groups.

Foresters and others can refer to the section "Environmental plantings," where the soils of the county are grouped according to their suitability for growing trees and shrubs.



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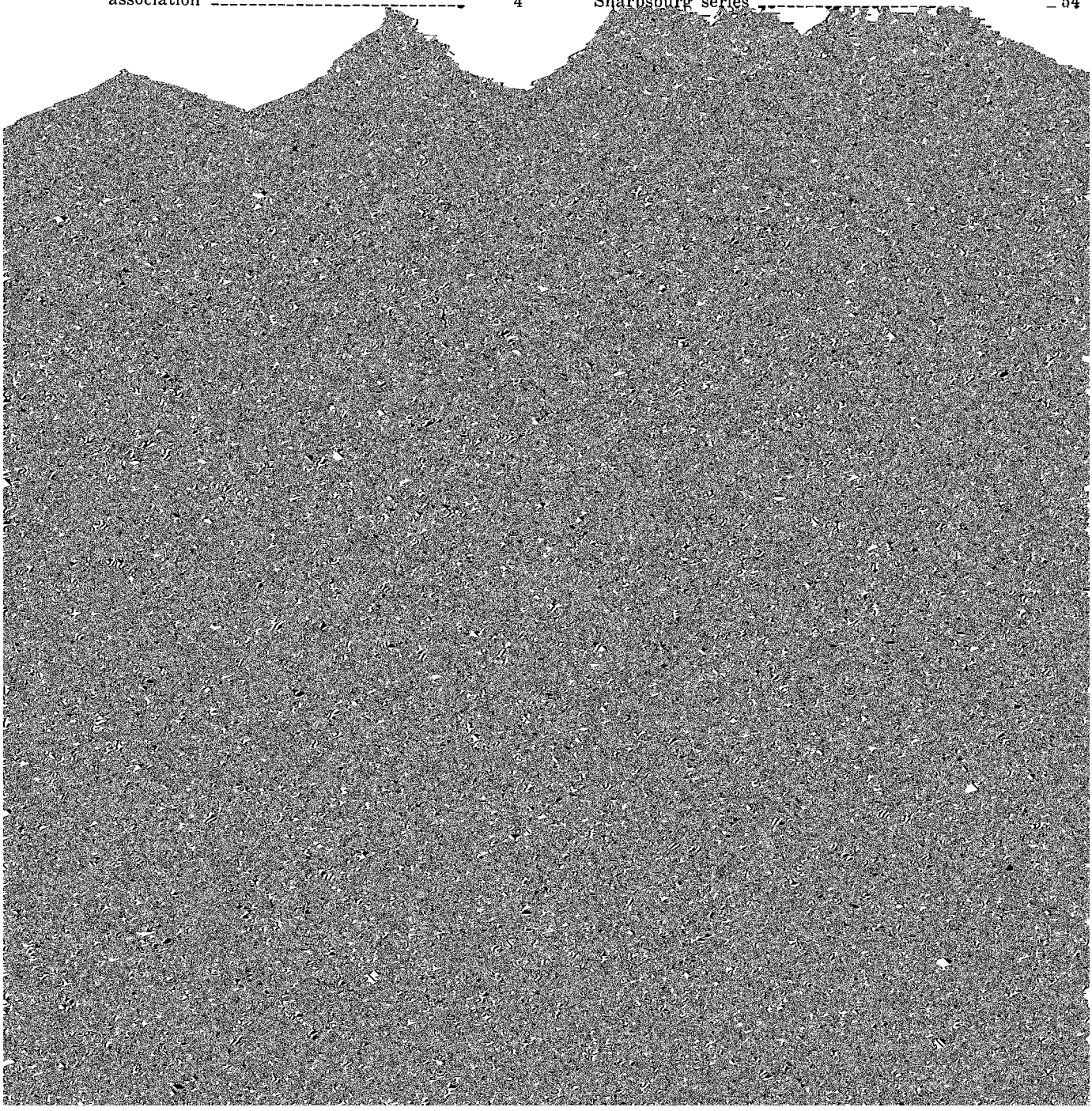

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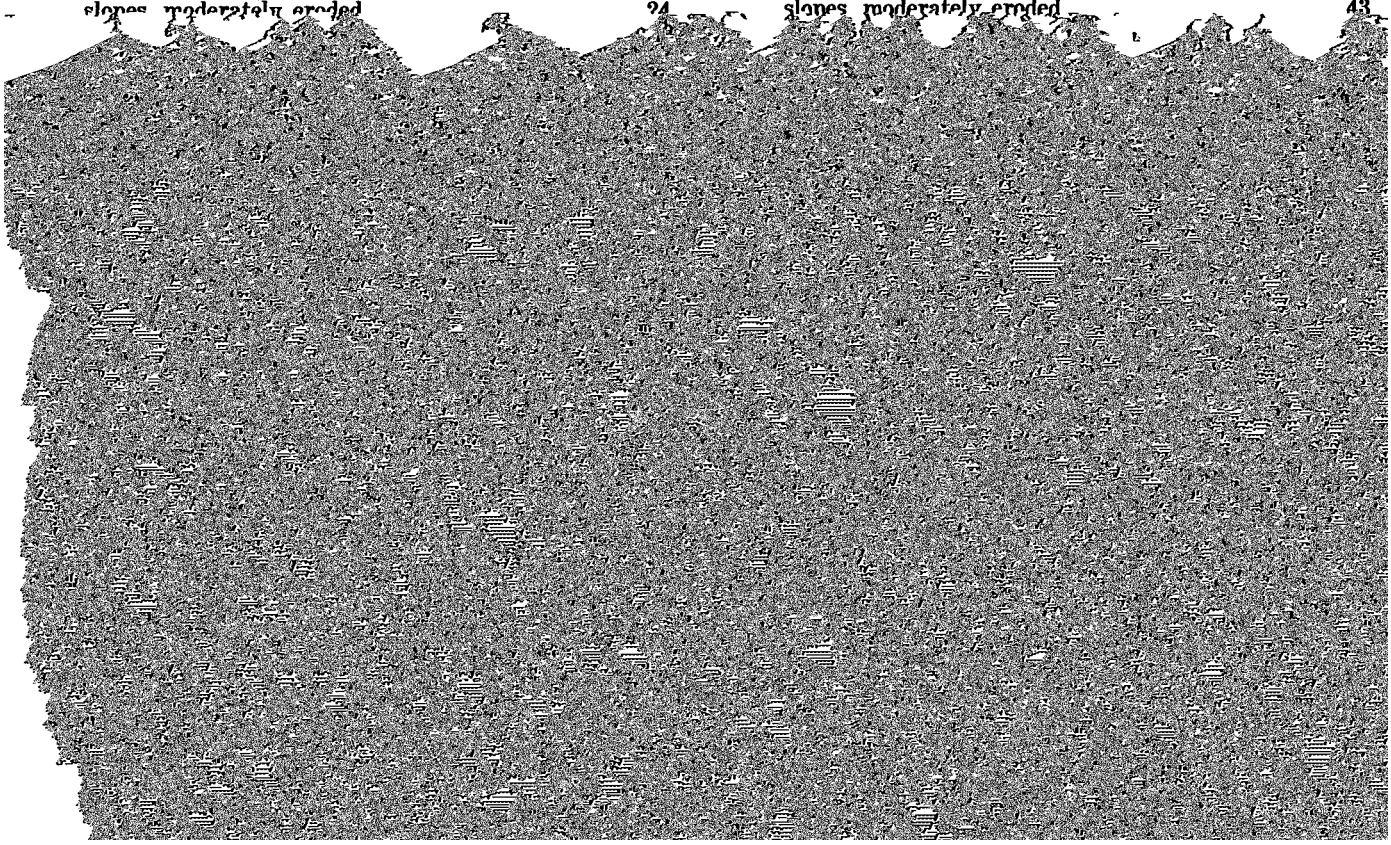

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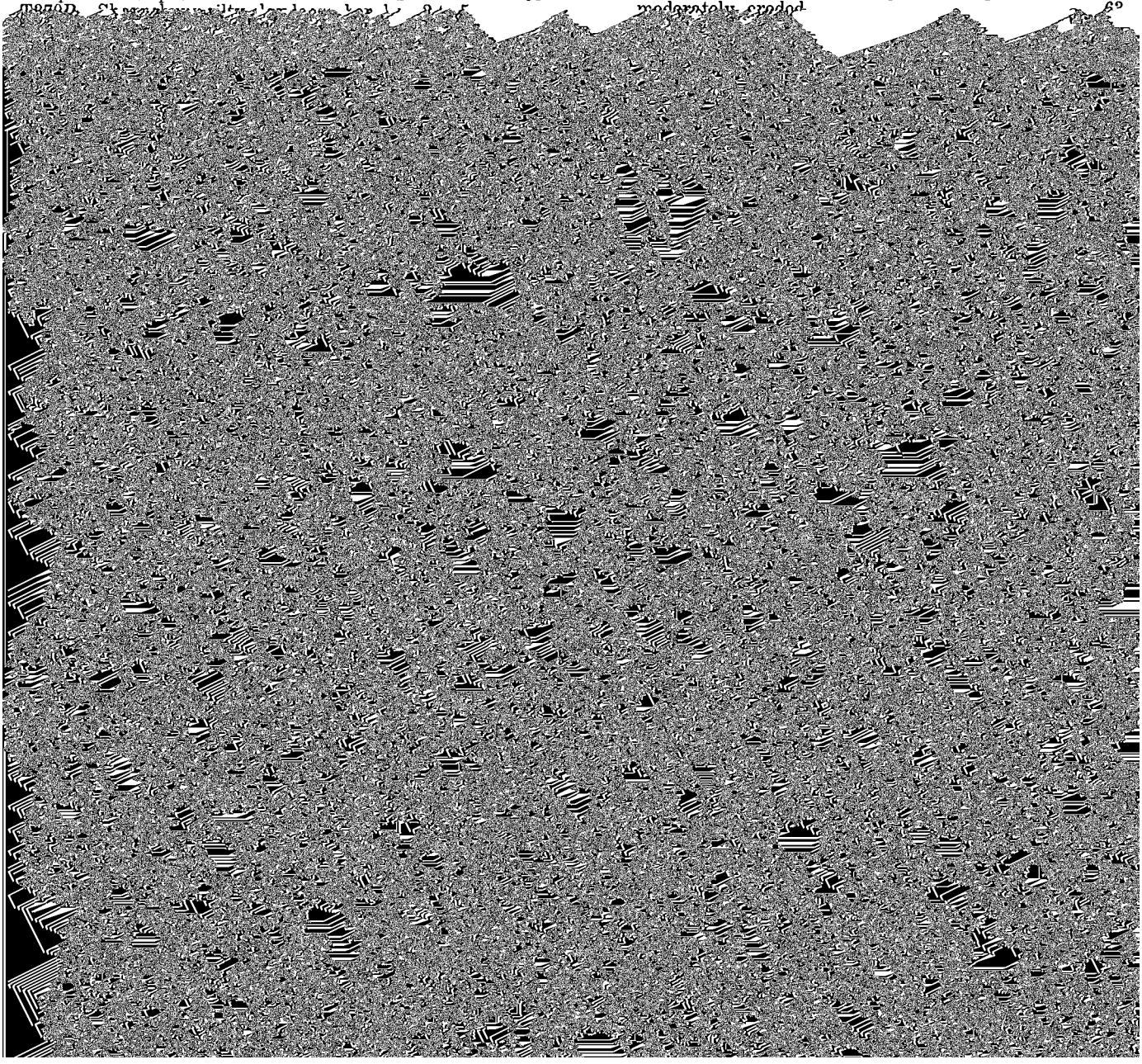

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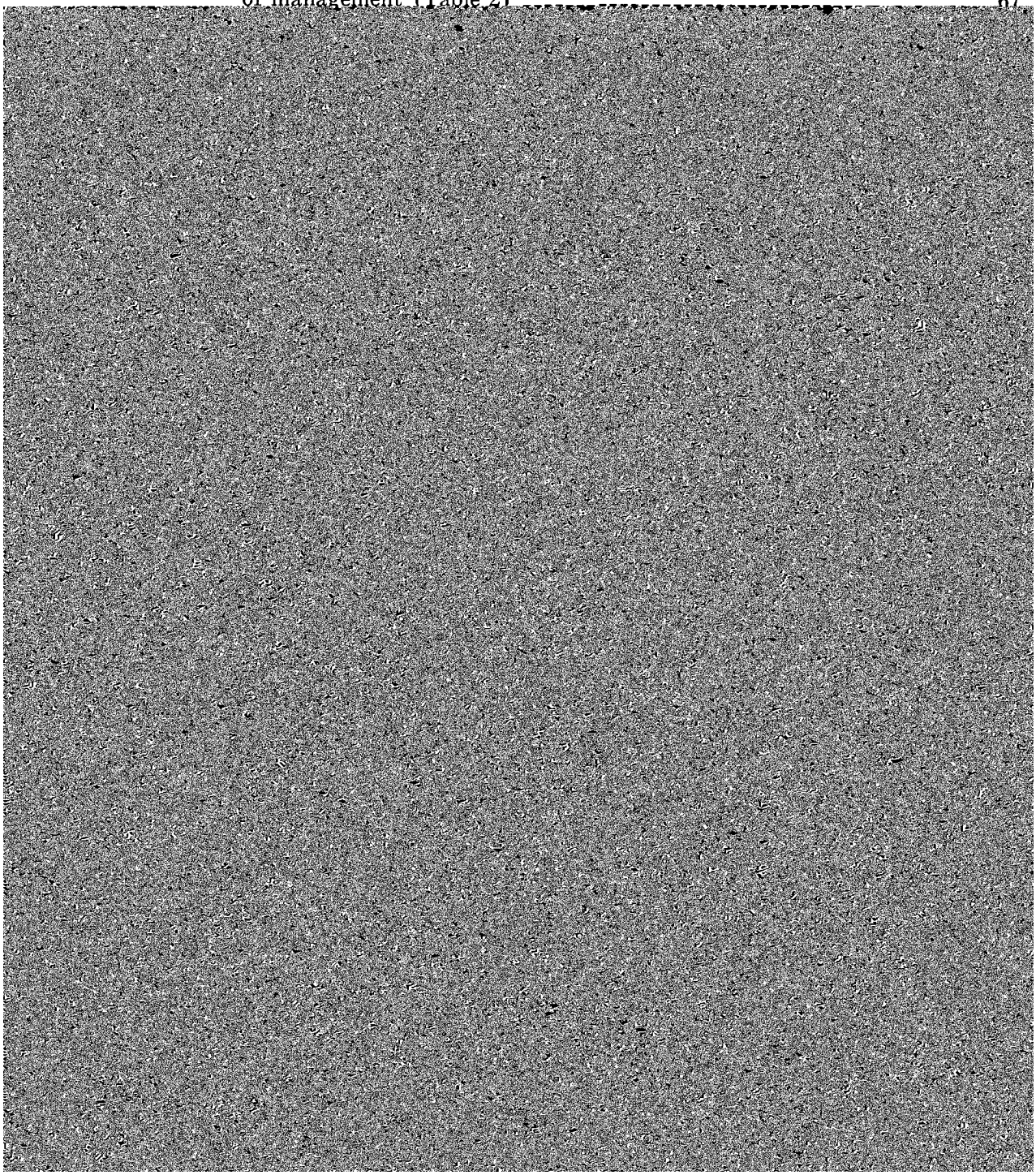


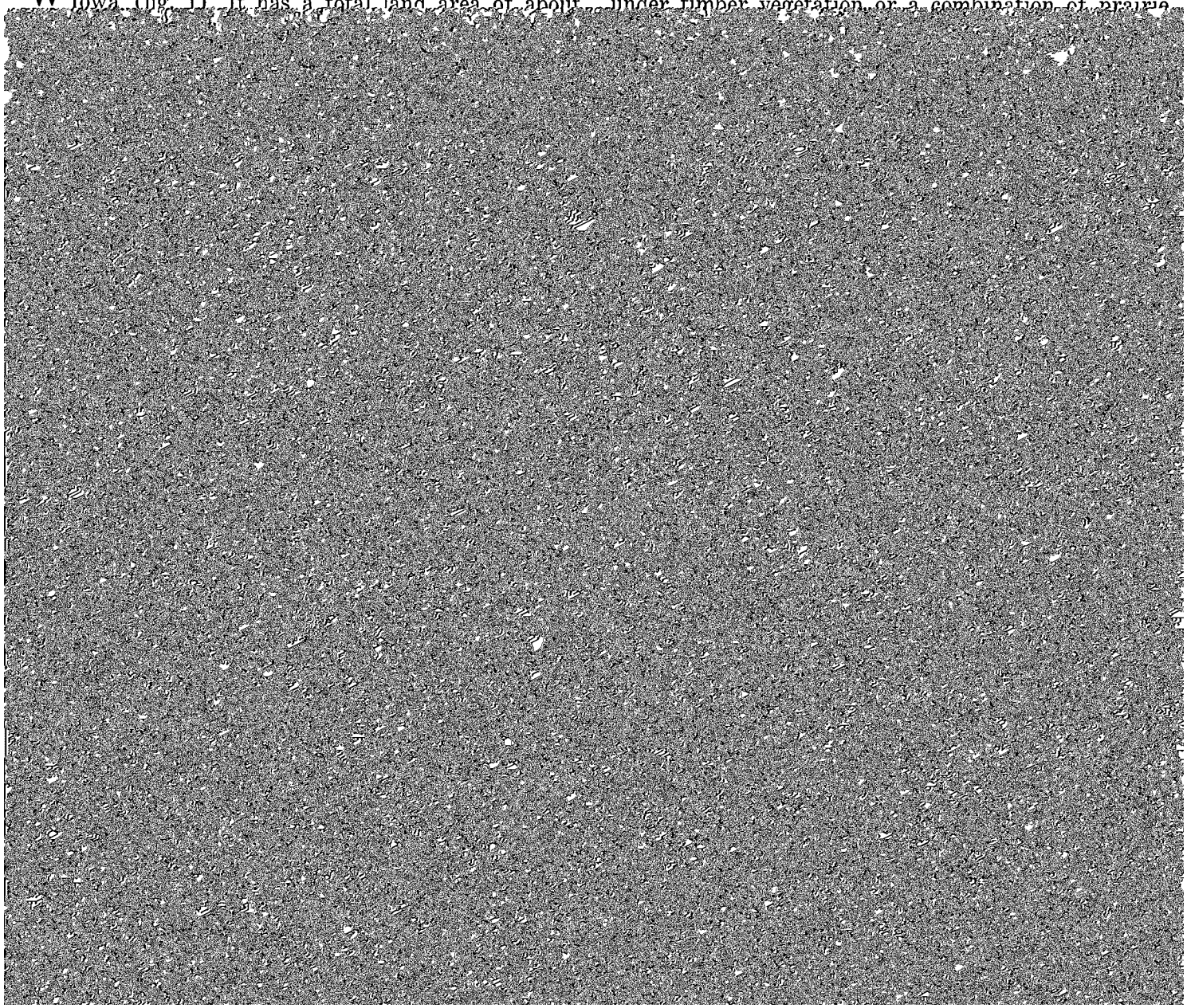
SOIL SURVEY OF WARREN COUNTY, IOWA

BY ARTHUR A. BRYANT AND JOHN R. WORSTER, SOIL CONSERVATION SERVICE

FIELDWORK BY ARTHUR A. BRYANT, ELTON L. KING, DAVID L. REEVES, AND MICHAEL J. WIEMANN, SOIL CONSERVATION SERVICE [1]

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE IOWA AGRICULTURE AND HOME ECONOMICS EXPERIMENT STATION AND COOPERATIVE EXTENSION SERVICE, IOWA STATE UNIVERSITY, AND THE DEPARTMENT OF SOIL CONSERVATION, STATE OF IOWA

WARREN COUNTY is in the south central part of Iowa (fig. 1). It has a total land area of about

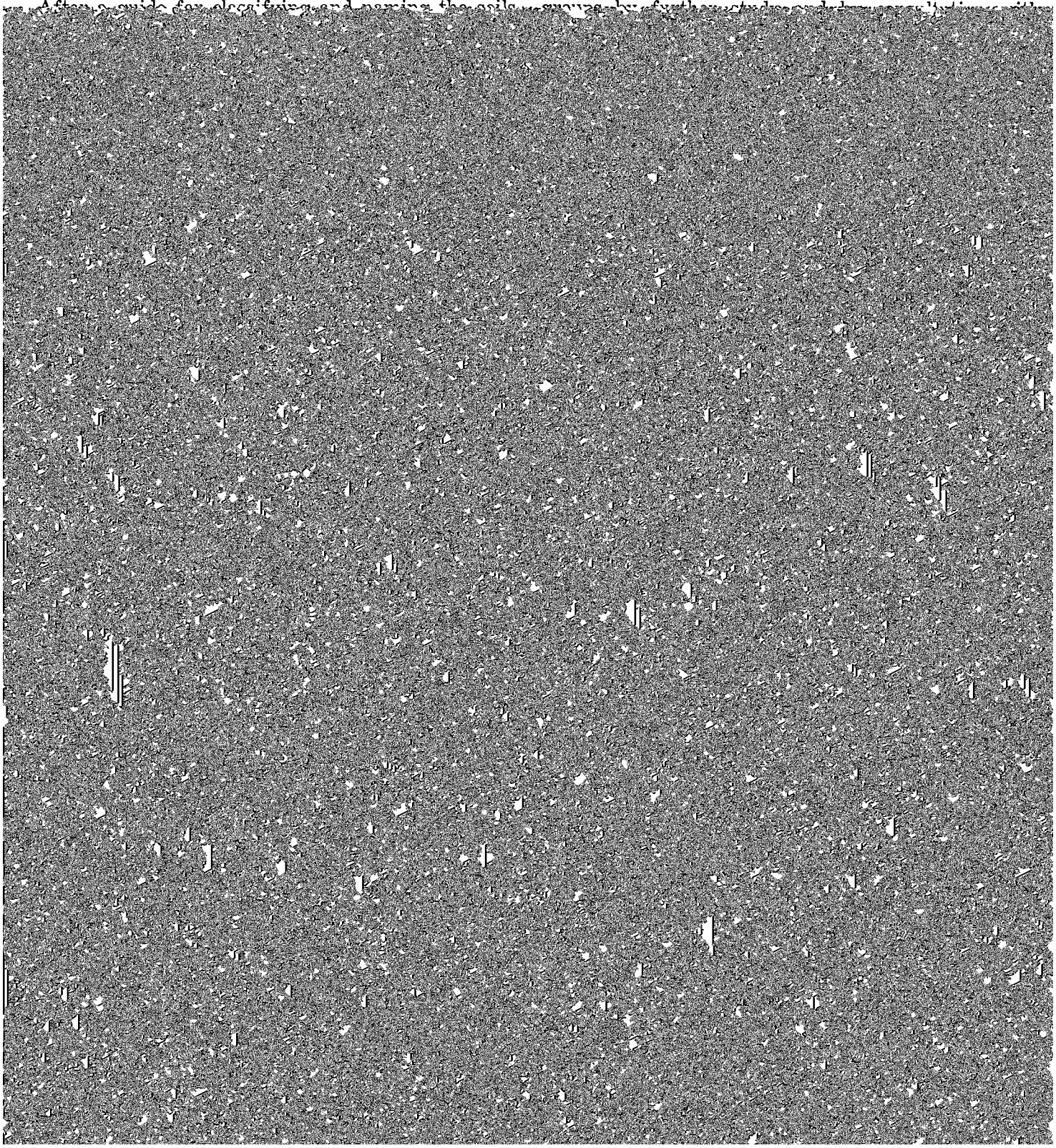


formed under prairie vegetation. The others formed under timber vegetation or a combination of prairie

of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Sharpsburg silty clay loam, 2 to 5 percent slopes, is one of several phases within the Sharpsburg series.

After a guide for classifying and naming the soils [illegible] research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these



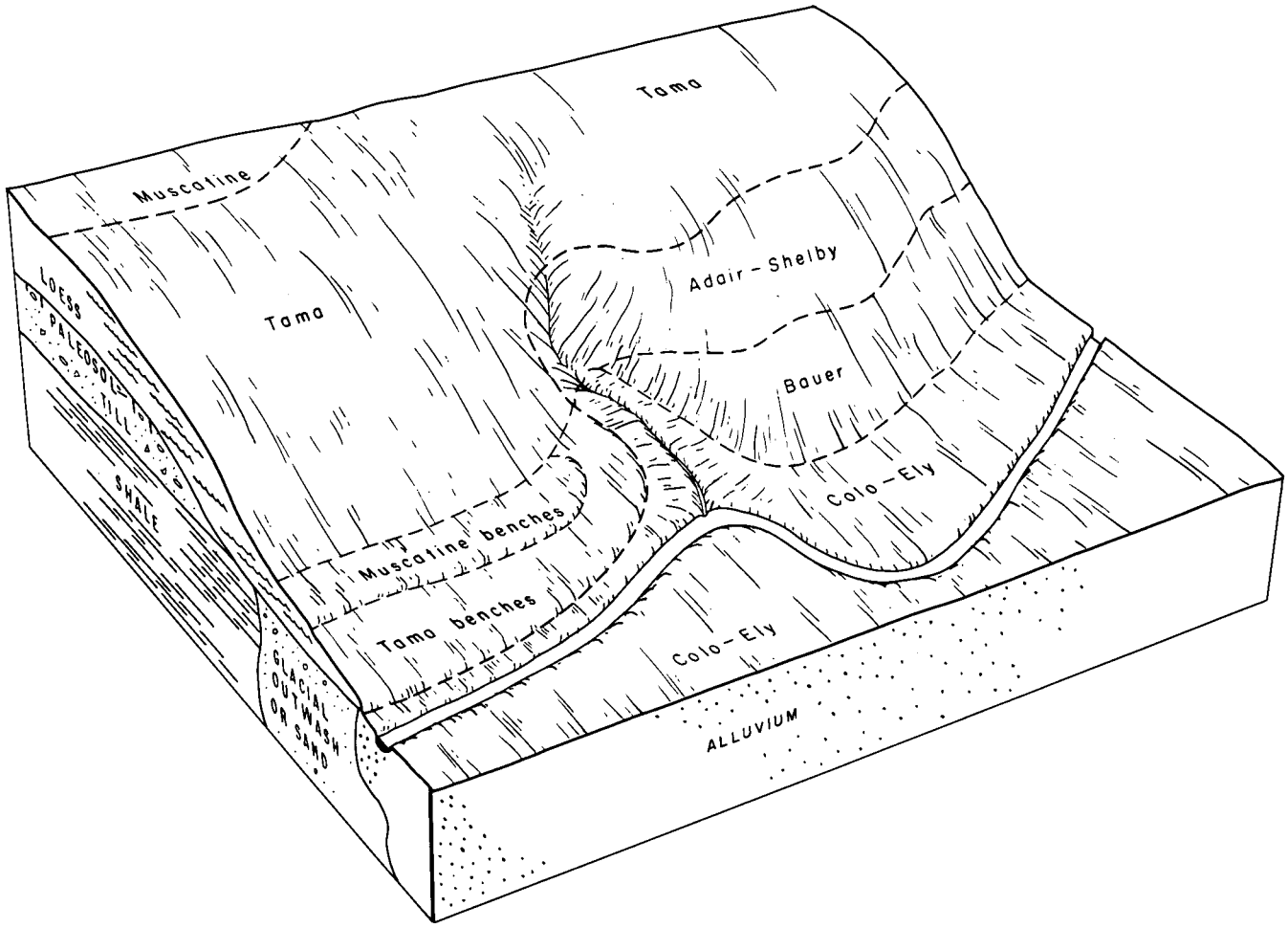


Figure 2.—**Relationship of slope and parent material to soils of the Tama association.**

This association makes up about 3 percent of the county. It is about 80 percent Tama soils, 7 percent Muscatine soils, and 13 percent Adair, Shelby, Bauer, Colo, and Ely soils.

Tama soils are on convex ridgetops, side slopes, and benches. These soils are nearly level to strongly sloping and are well drained. Typically, the surface layer is very dark brown silty clay loam about 13 inches thick. The subsoil is dark brown and dark yellowish brown silty clay loam.

Muscatine soils are on broad ridgetops and benches. These soils are nearly level and are somewhat poorly drained. The surface layer is thicker than in Tama soils. The subsoil is very dark grayish brown and dark grayish brown silty clay loam.

Adair and Shelby soils are strongly sloping to steep. They are on side slopes of glacial till. Bauer soils are strongly sloping to steep. They are on side slopes of residual shale. Colo and Ely soils are gently sloping. They are in waterways and on small stream bottoms.

The soils of this association are well suited to cultivated crops and are among the most productive soils in the county (fig. 3). Corn and soybeans can be grown intensively on the nearly level and gently sloping soils. Some steeper areas are used for hay and pasture. Farms are mostly diversified; but some are cash grain and some are livestock farms.

The main concern of management is controlling water erosion. Available water capacity is mainly high.

2. Downs-Fayette association

Nearly level to steep, well drained soils that formed in loess on uplands and on high stream benches

This association consists mostly of gently sloping and moderately sloping soils that formed in loess on convex ridgetops and strongly sloping to steep soils that formed in loess on side slopes (fig. 4). Gently sloping and moderately sloping, loess-covered stream benches make up only 2 percent of this association. Areas of this association border the south side of the Des Moines River and the sides of the South and Middle Rivers where they enter the Des Moines River flood plain.

This association makes up about 4 percent of the county. It is about 45 percent Downs soils, 25 percent Fayette soils, and 30 percent soils of minor extent.

Downs soils are nearly level to moderately steep. They are on convex ridgetops, side slopes, and benches

Figure 3.—**Typical landscape in an area of Tama association. The soils formed in loess, and the side slopes are intensively cultivated.**

and are well drained. The surface layer is very dark brown silt loam about 7 inches thick, and the subsurface layer is dark grayish brown silt loam about 5 inches thick. The subsoil is brown to yellowish brown silty clay loam.

Fayette soils are gently sloping to steep. They are on convex ridgetops and side slopes and are well drained. They have a surface layer of very dark gray silt loam about 4 inches thick. The subsurface layer is dark grayish brown silt loam about 7 inches thick. The subsoil is brown silt loam and dark yellowish brown and yellowish brown silty clay loam.

Of minor extent in this association are Gara, Gosport, Lindley, Colo, and Ely soils and Steep rock land. Gara and Lindley soils are strongly sloping to very steep and are on glacial till side slopes. Gara soils are associated with Downs soils, and Lindley soils are associated with Fayette soils. Gosport soils are strongly sloping to very steep and are on mainly shale side slopes bordering major streams, but some sandstone crops out at the surface. Colo and Ely soils are in valleys.

The soils of this association are better suited to hay, pasture, and woodland than to most other uses. Many areas are in woodland. Most of the nearly level to moderately sloping soils are used for cultivated crops. Farms are diversified.

The main concerns in management are controlling water erosion and maintaining tilth. Content of organic matter is moderate to very low, and puddling and crusting of the surface is of concern in maintaining tilth. Available water capacity is high in most soils of this association.

3. Macksburg-Sharpsburg-Winterset association

Nearly level to moderately sloping, moderately well drained to poorly drained soils that formed in loess on summits of uplands and on high stream benches

This association consists mostly of nearly level soils on stable ridge summits (fig. 5) and gently sloping and moderately sloping soils on ridge shoulders and at the heads of drainageways. Nearly level to moderately sloping soils on high stream benches make up 3 percent of this association.

This association makes up about 9 percent of the county. It is about 40 percent Macksburg soils, 25 percent Sharpsburg soils, 12 percent Winterset soils, and 23 percent soils of minor extent.

Macksburg soils are nearly level to gently sloping and are somewhat poorly drained. They have a thick surface layer of black and very dark brown silty clay loam and a subsoil of very dark grayish brown to olive gray, mottled silty clay loam.

Sharpsburg soils are nearly level to moderately slop-

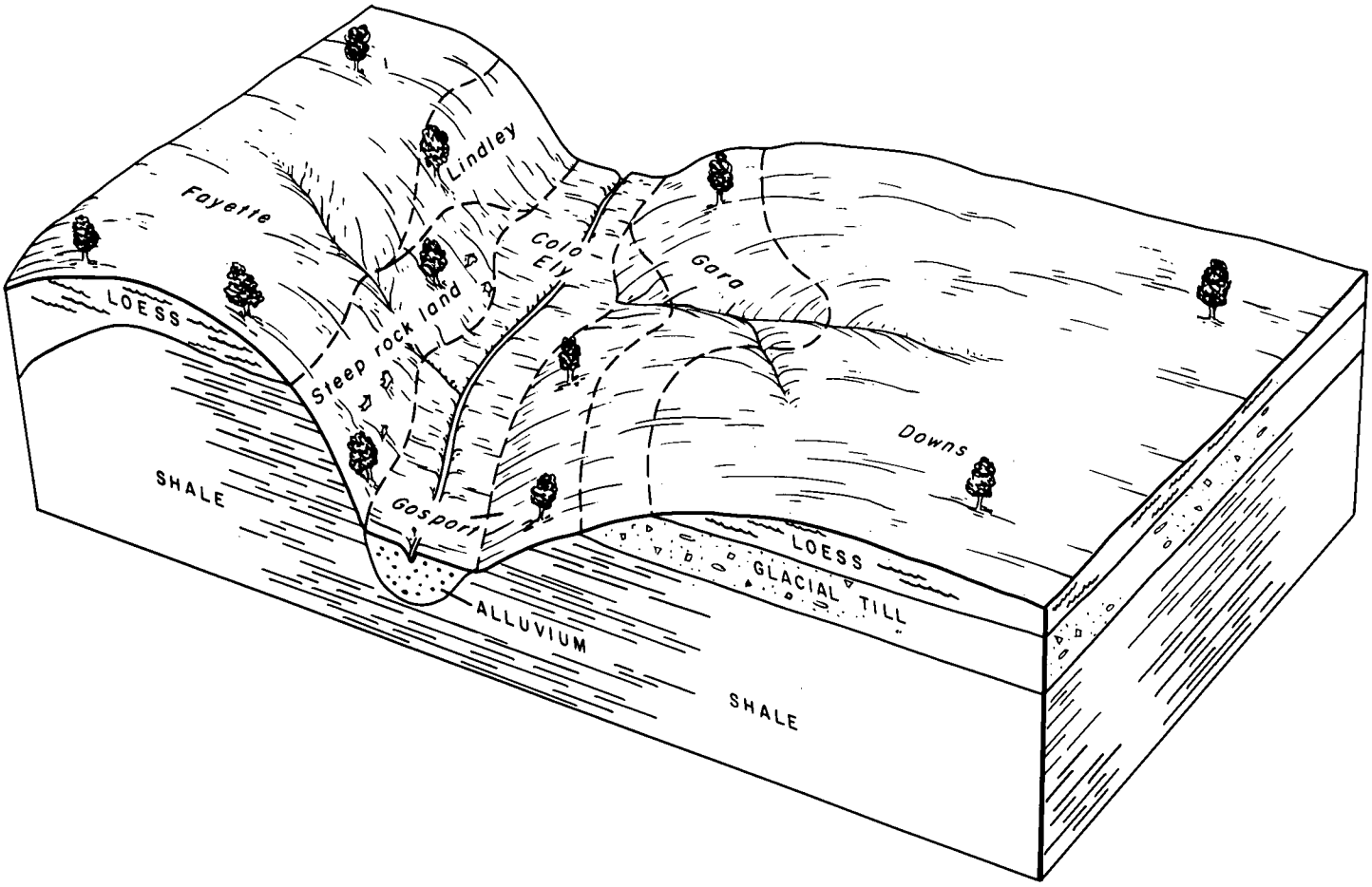


Figure 4.—**Relationship of slope and parent material to soils of the Downs-Fayette association.**

ing and are moderately well drained. They have a surface layer of very dark brown and very dark grayish brown silty clay loam about 16 inches thick and a subsoil of brown to yellowish brown silty clay loam.

Winterset soils occupy the most nearly level areas of this association and are poorly drained. They have a surface layer of black silty clay loam that is thicker than the surface layer of other soils in this association. The subsoil is mottled very dark gray, dark gray, gray, and olive gray silty clay loam.

Soils of minor extent in this association are Clarinda, Clearfield, Nira, and Sperry soils. The poorly drained, moderately sloping Clarinda soils formed in gray clayey glacial till and occupy the lower part of the heads of drainageways. The poorly drained to somewhat poorly drained Clearfield soils and the moderately well drained Nira soils are gently sloping and moderately sloping. They occupy the upper part of the heads of drainageways and are above the Clarinda soils. Sperry soils are in depressional areas on the ridge summits and are poorly drained to very poorly drained.

The soils of this association are well suited to crops and are among the most productive soils in the county. The main concerns in management are control of water erosion and improvement of drainage. Available water capacity is high in most soils of this association.

4. Sharpsburg-Lamoni association

Gently sloping to strongly sloping, moderately well drained and somewhat poorly drained soils that formed in loess and glacial till

This association consists mostly of gently sloping to strongly sloping, loess-covered ridgetops and side slopes (fig. 6). Nearly level to moderately sloping loess-covered high stream benches make up about 5 percent of this association.

This association makes up about 16 percent of the county. It is about 52 percent Sharpsburg soils, 18 percent Lamoni soils, and 30 percent soils of minor extent.

Sharpsburg soils are gently sloping to strongly sloping and are on convex ridgetops and the upper part of side slopes. They are moderately well drained. They have a surface layer of very dark brown and very dark grayish brown silty clay loam about 16 inches thick

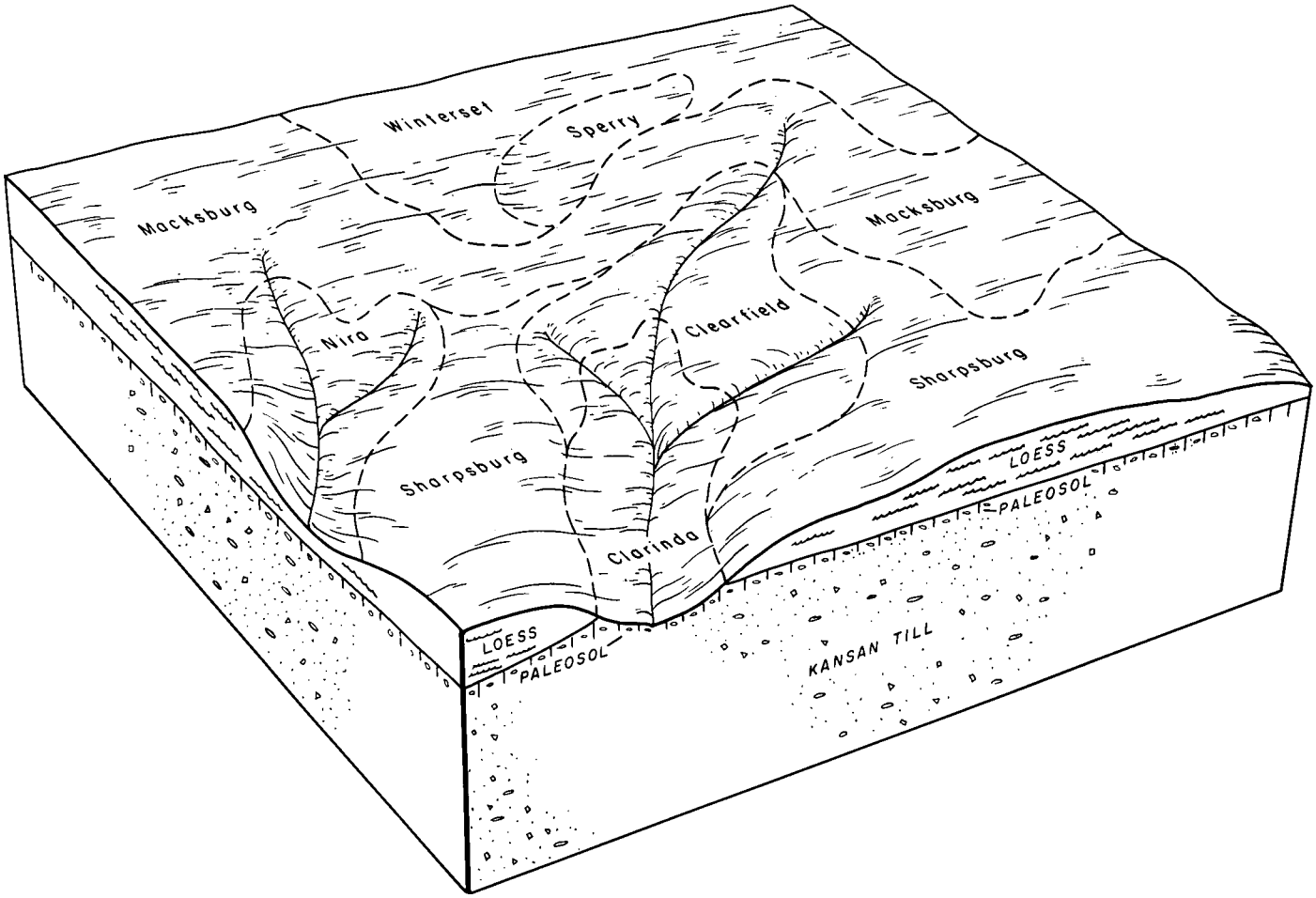


Figure 5.—**Relationship of slope and parent material to soils of the Macksburg-Sharpsburg-Winterset association.**

and on convex side slopes at the upper end of drainageways. They are somewhat poorly drained. They have a surface layer of black silty clay loam about 11 inches thick and a subsoil of very dark gray to yellowish brown and olive gray clay loam and clay.

The soils of minor extent in this association are Adair, Bauer, Colo, Ely, Macksburg, and Shelby soils. Adair and Shelby soils are strongly sloping to steep and are on glacial till side slopes. Bauer soils are strongly sloping to moderately steep and are on shale side slopes. Colo and Ely soils are nearly level or gently sloping and are on waterways and small stream bottoms. Macksburg soils are nearly level to gently sloping and are on stable ridgetops.

poorly drained soils that formed in loess and glacial till

This association consists mostly of nearly level to strongly sloping soils on loess-covered ridgetops and side slopes and strongly sloping to very steep soils that formed in glacial till (fig. 7). Nearly level to moderately sloping soils on high loess-covered stream benches make up 3 percent of this association, and moderately sloping to moderately steep soils that formed in old alluvium derived from glacial material make up about 6 percent.

This association makes up about 36 percent of the county. It is about 25 percent Ladoga soils, 15 percent

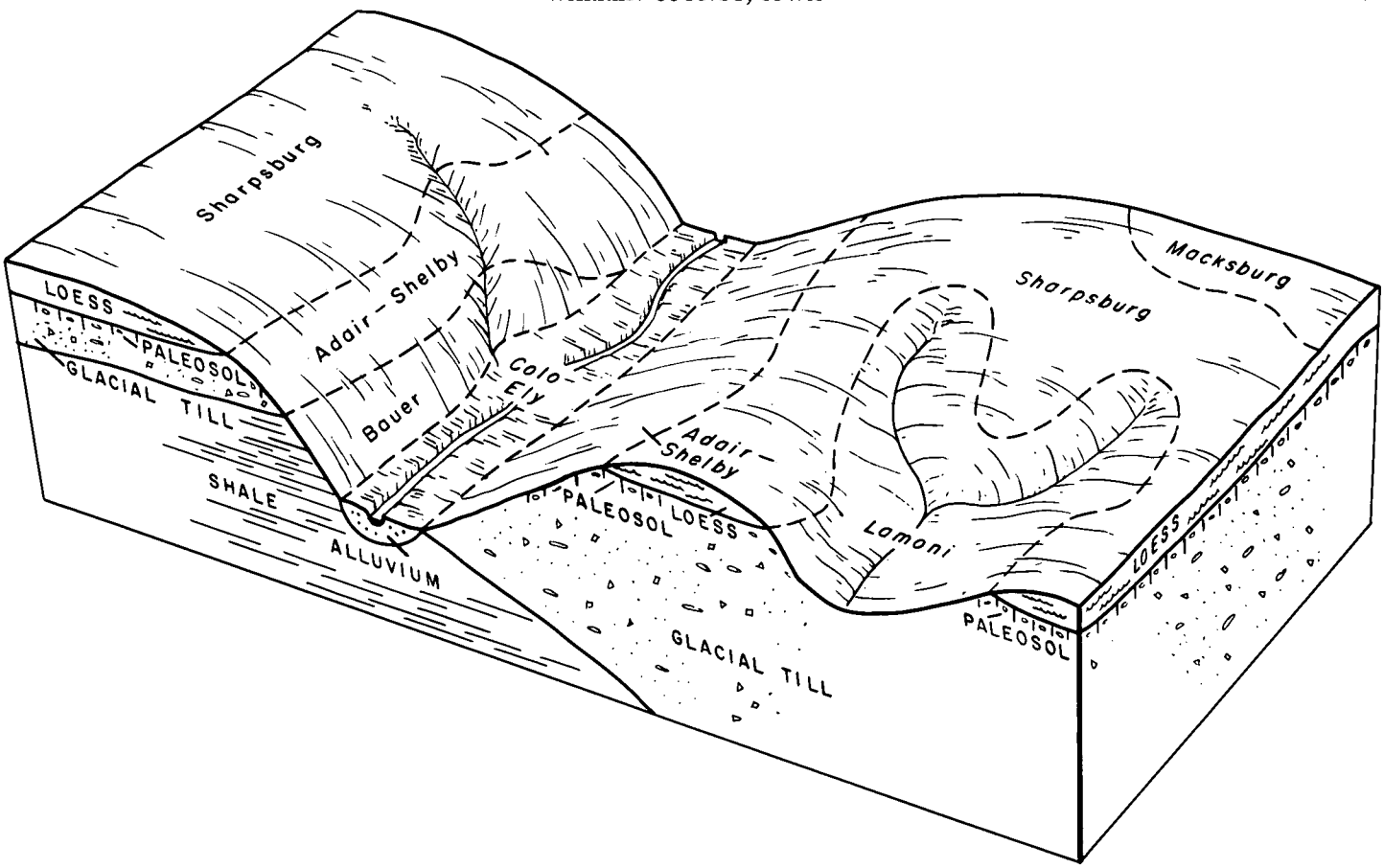


Figure 6.—**Relationship of slope and parent material to soils of the Sharpsburg-Lamoni association.**

layer is dark grayish brown loam about 6 inches thick. The subsoil is brown and yellowish brown clay loam.

Armstrong soils are strongly sloping to moderately steep and formed in weathered, reddish glacial till. They are moderately well drained to somewhat poorly drained. The surface layer is very dark grayish brown loam about 6 inches thick. The subsurface layer is dark grayish brown silt loam about 3 inches thick. The subsoil is brown, dark yellowish brown, and yellowish brown clay and clay loam.

Soils of minor extent in this association are Clinton, Colo, Ely, Gosport, Lindley, Keswick, Mystic, and Caleb soils.

Clinton soils are moderately well drained. They are gently sloping to moderately steep, and they formed in loess under timber. Colo and Ely soils are in gently sloping waterways and small stream bottoms. Gosport soils are strongly sloping to very steep and are on shale side slopes. Lindley and Keswick soils are strongly sloping to very steep and are on glacial till side slopes. They formed under timber. Mystic and Caleb soils formed in old alluvium derived from glacial material. They are moderately sloping to moderately steep and they are on side slopes and scarps of stream terraces and on uplands that grade to stream bottoms.

The nearly level to moderately sloping soils of this association are suited to row crops. The steeper soils the steep and very steep soils are better suited to pasture, and woodland. Much of this association is used for hay, pasture, and woodland (fig. 8). Farms are diversified, and beef herds are common.

The main concerns in management are controlling erosion and maintaining fertility. Gullies are common in the association, and they hamper the use of large farm machinery. Content of organic matter is moderate to low, and puddling and crusting of the surface is a concern in maintaining tilth. Available water capacity is high in most soils of this association.

6. Grundy-Arispe-Winterset association

Nearly level to moderately sloping, moderately well drained to poorly drained soils that formed in loess on upland divides, ridgetops, and high stream benches

This association consists mostly of nearly level and gently sloping soils on stable ridge summits (fig. 9). Gently sloping and moderately sloping soils on high stream benches make up less than 1 percent of this association. Moderately sloping soils are on ridgetops and sides of less stable ridges.

This association makes up about 7 percent of the county. It is about 30 percent Grundy soils, 30 percent Arispe soils, 20 percent Winterset soils, and 20 percent soils of minor extent.

Grundy soils are gently sloping and are somewhat

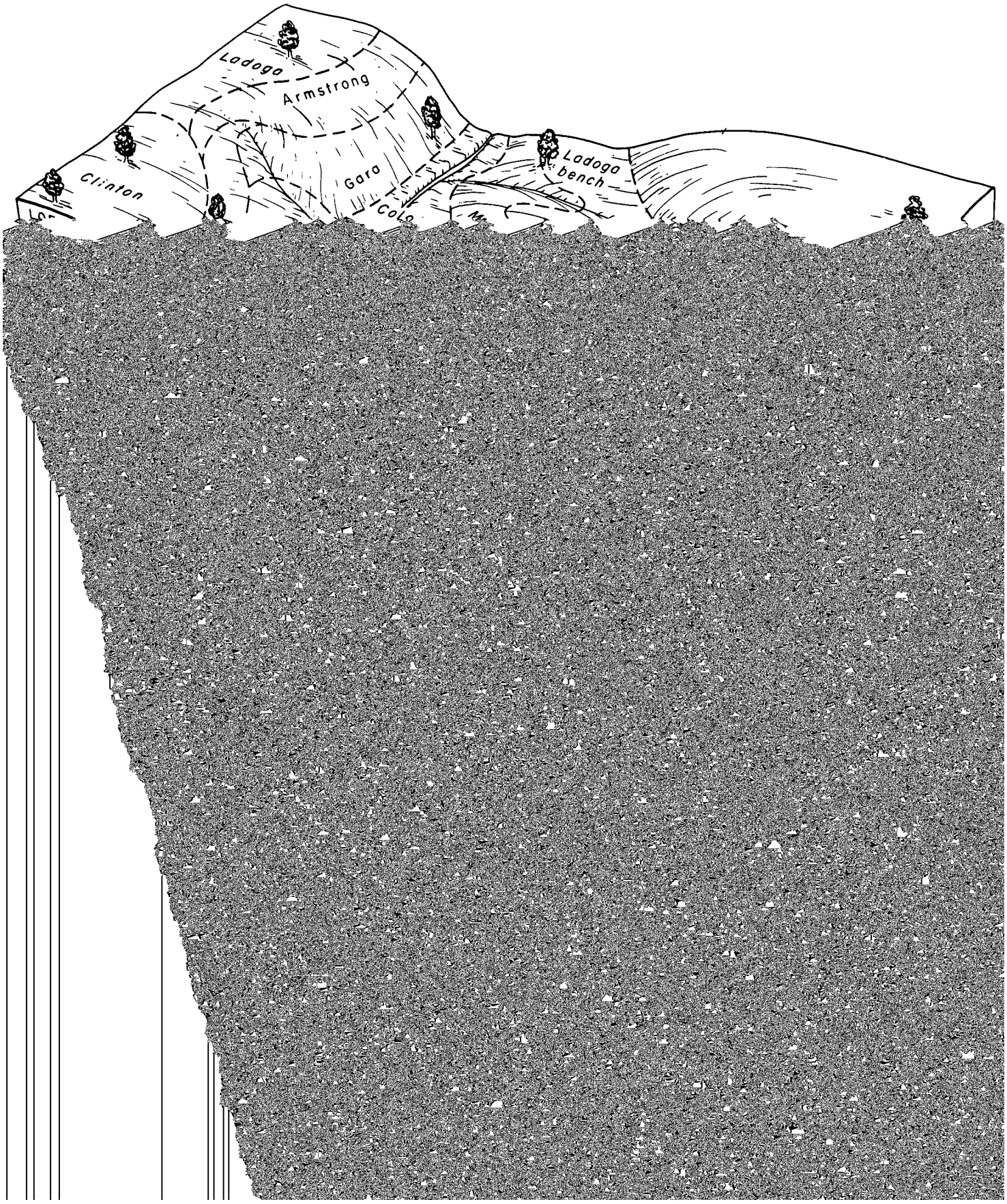
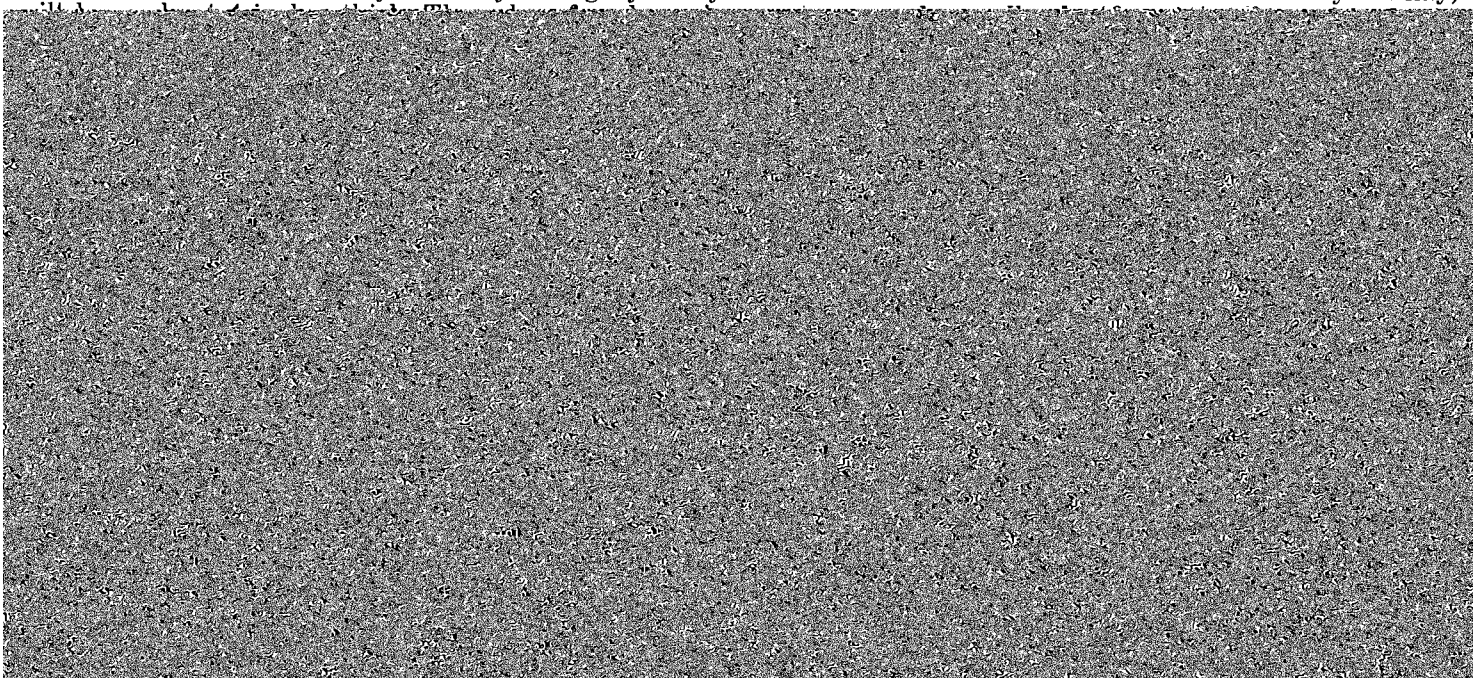

Ladoga
Armstrong
Clinton
Gara
Ladoga
bench

Figure 8.—**Typical landscape in an area of Ladoga-Gara-Armstrong association. The landform is rough, and trees are in a large part of the areas.**

Gosport soils are strongly sloping to very steep soils and are on convex side slopes. They are moderately well drained. The surface layer is very dark gray heavy

Weller soils are similar to Pershing soils, but have a thinner surface layer.

The soils of this association are used mostly for hay,



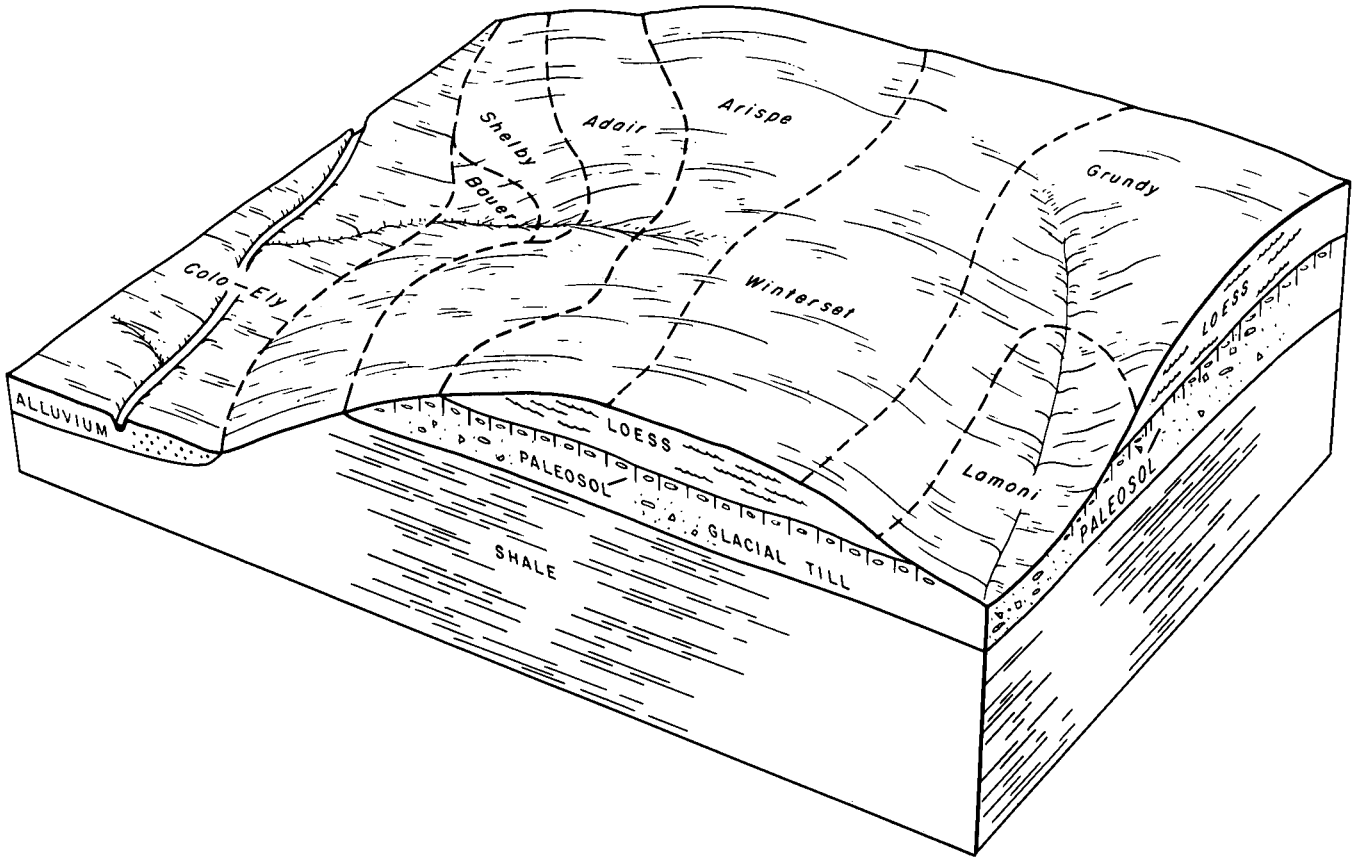


Figure 9.—**Relationship of slope and parent material to soils of the Grundy-Arispe-Winterset association.**

Zook soils are nearly level, are poorly drained, and are on first bottoms. The surface layer is 36 inches thick; the upper part is black silty clay loam, and the lower part is black silty clay. The subsoil is very dark gray silty clay and silty clay loam.

Figure 10.—**Typical landscape in an area of Grundy-Arispe-Winterset association. Fall plowing is a common practice in management.**

Wabash soils are nearly level, are very poorly drained, and are back from the stream channel near the base of uplands. The surface layer is 36 inches thick; the upper part is black silty clay loam or silty clay, and the lower part is black silty clay. The subsoil is dark gray silty clay.

Nodaway soils are nearly level, are moderately well drained, and are near stream channels or former stream channels. The surface layer is very dark grayish brown silt loam about 5 inches thick. The substratum is stratified very dark grayish brown to grayish brown silt loam.

Of minor extent in this association are Amana, Bremer, Colo, Kennebec, and Nevin soils and Alluvial land. Alluvial land varies in texture and drainage. It is next to old stream meanders or along current stream channels. Amana soils are somewhat poorly drained and are on first bottoms near the original stream channel and on old stream channel levees. Bremer soils are poorly drained and are on second bottoms. Colo soils are poorly drained and are on first bottoms. Kennebec soils are moderately well drained and are on first bottoms near the stream channel and on old stream levees. Nevin soils are somewhat poorly drained and are on second bottoms.

The soils of this association are used for intensive rowcropping. Some areas are in pasture and timber. Cash grain farming is the major enterprise.

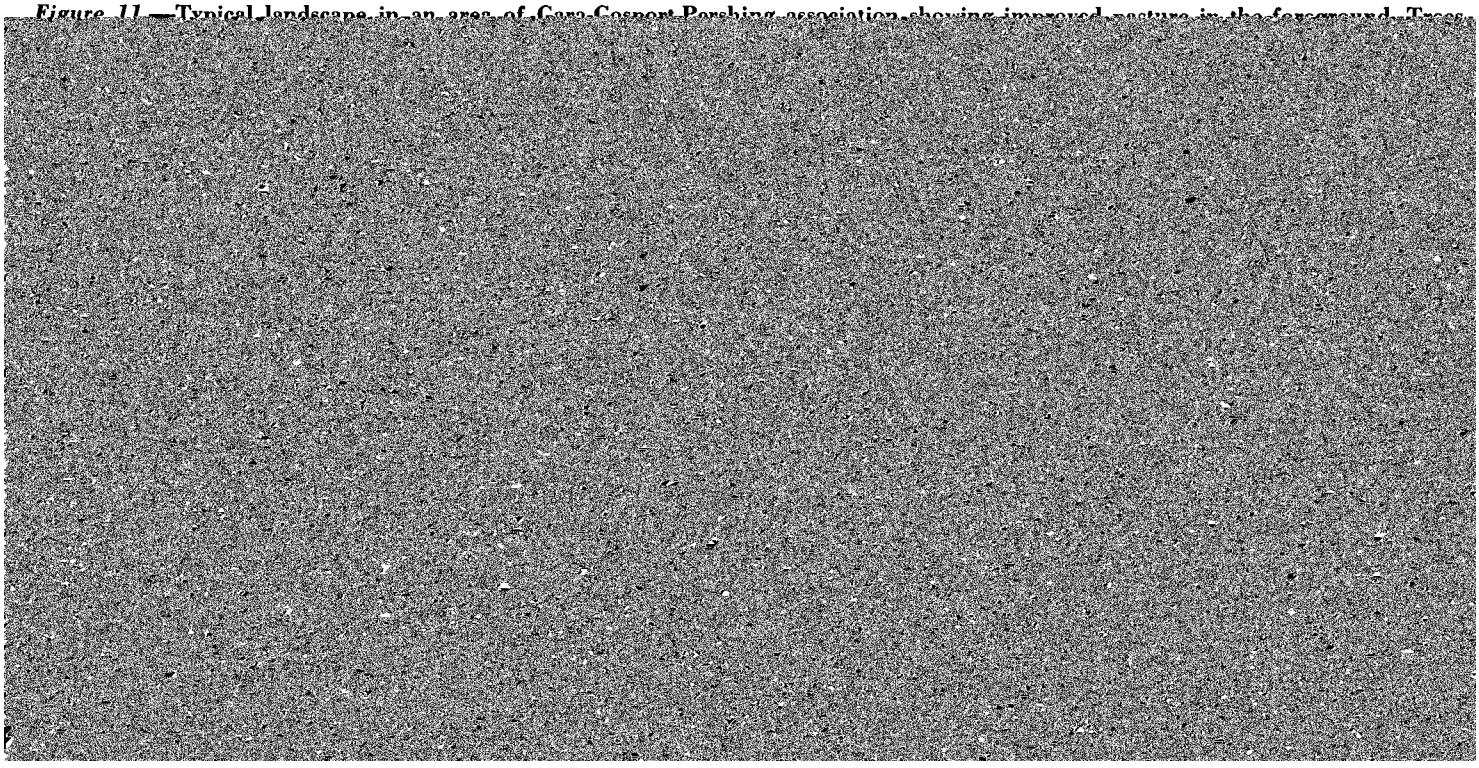


Figure 11.—Typical landscape in an area of Gara-Cosport-Pershing association showing improved pasture in the foreground. Trees

series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

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

As mentioned in the section "How this survey was made," not all mapping units are members of a soil

(10YR 3/2) silt loam; weak fine granular structure; friable; medium acid; abrupt smooth boundary.

C—6 to 25 inches; stratified very dark gray (10YR 3/1) and dark grayish brown (10YR 4/2) silt loam; weak thin platy structure; friable; medium acid; clear smooth boundary.

IIA11b—25 to 30 inches; black (10YR 2/1) medium silty clay loam; weak fine subangular blocky structure parting to weak fine granular; friable; medium acid; clear smooth boundary.

IIA12b—30 to 44 inches; black (10YR 2/1) heavy silty clay loam; weak medium prismatic structure parting to moderate very fine and fine subangular blocky; friable; few fine dark oxides; slightly acid; clear smooth boundary.

IIA13b—44 to 60 inches; black (10YR 2/1) heavy silty clay loam; moderate medium prismatic structure parting to moderate fine

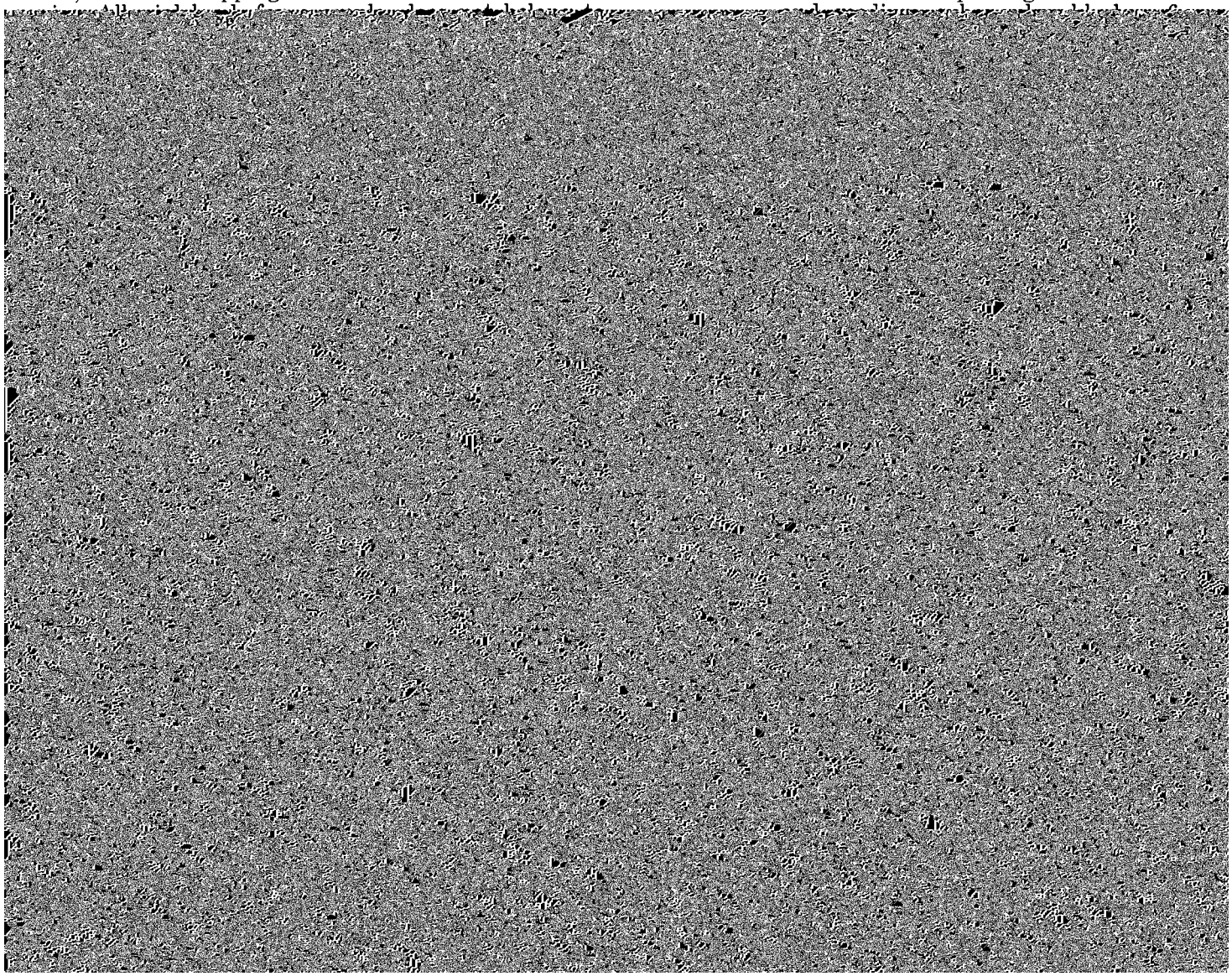


TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Mapping unit	Acres	Percent
Ackmore silt loam, 0 to 2 percent slopes	1,000	0.3
Adair clay loam, 9 to 14 percent slopes, moderately eroded	1,050	.3
Adair-Shelby clay loams, 9 to 14 percent slopes, moderately eroded	8,400	2.3
Adair-Shelby clay loams, 14 to 18 percent slopes, moderately eroded	4,200	1.2
Adair-Shelby clay loams, 14 to 18 percent slopes, severely eroded	445	.1
Alluvial land	1,840	.5
Alluvial land, channeled	1,510	.4
Amana silt loam, 0 to 2 percent slopes	4,100	1.1
Arbor loam, 9 to 14 percent slopes	400	.1
Arispe silty clay loam, 5 to 9 percent slopes	635	.2
Arispe silty clay loam, 5 to 9 percent slopes, moderately eroded	6,340	1.7
Armstrong loam, 9 to 14 percent slopes		
Fayette silt loam, 9 to 14 percent slopes, moderately eroded	955	.3
Fayette silt loam, 14 to 18 percent slopes, moderately eroded	725	.2
Fayette silt loam, 18 to 25 percent slopes, moderately eroded	335	.1
Gara loam, 9 to 14 percent slopes, moderately eroded	885	.2
Gara loam, 14 to 18 percent slopes, moderately eroded	11,020	3.0
Gara loam, 18 to 25 percent slopes, moderately eroded	9,540	2.6
Gara loam, 25 to 40 percent slopes	1,000	.3
Givin silt loam, 0 to 2 percent slopes	675	.2
Gosport silt loam, 9 to 14 percent slopes	1,105	.3
Gosport silt loam, 14 to 18 percent slopes	5,080	1.4
Gosport silt loam, 18 to 35 percent slopes	6,850	1.8
Gosport soils, 14 to 18 percent		

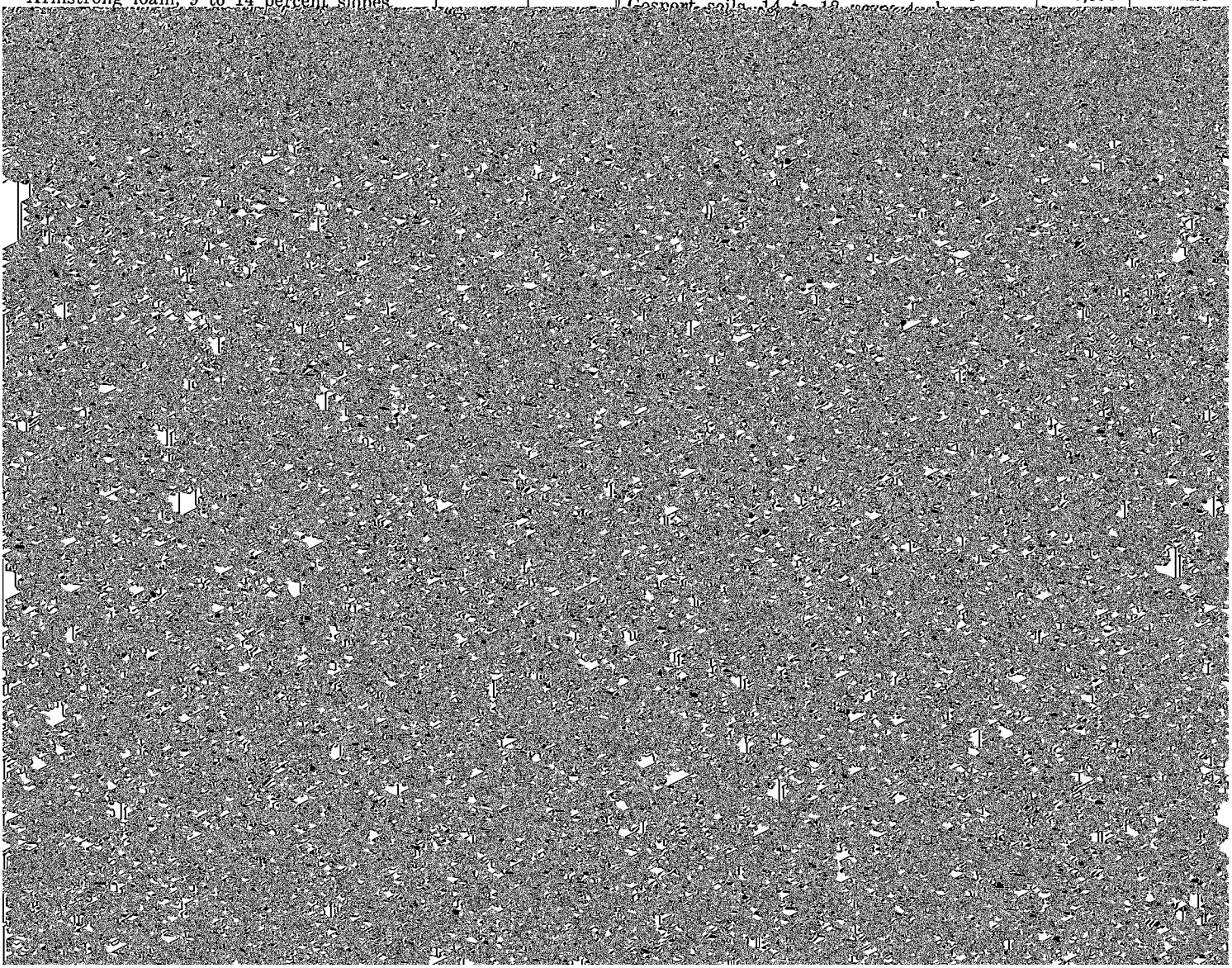


TABLE 1.—*Approximate acreage and proportionate extent of the soils*—Continued

Mapping unit	Acres	Percent
Nevin silty clay loam, 0 to 2 percent slopes	2,650	.7
Nevin silty clay loam, 2 to 5 percent slopes	440	.1
Nira silty clay loam, 2 to 5 percent slopes	350	.1
Nira silty clay loam, 5 to 9 percent slopes, moderately eroded	2,100	.6
Nodaway silt loam, 0 to 2 percent slopes	4,450	1.2
Nodaway silt loam, channeled, 0 to 2 percent slopes	2,505	.7
Olmitz loam, 2 to 5 percent slopes	470	.1
Olmitz loam, 5 to 9 percent slopes	1,000	.3
Pershing silt loam, 2 to 5 percent slopes	415	.1
Pershing silt loam, 5 to 9 percent slopes, moderately eroded	4,160	1.1
Pershing silt loam, 9 to 14 percent slopes, moderately eroded	475	.1
Sharpsburg silty clay loam, 0 to 2 percent slopes	1,000	.3
Sharpsburg silty clay loam, 2 to 5 percent slopes	14,455	4.0
Sharpsburg silty clay loam, 5 to 9 percent slopes	1,800	.5
Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded	22,500	6.2
Sharpsburg silty clay loam, 9 to 14 percent slopes, moderately eroded	2,970	.8
Sharpsburg silty clay loam, benches, 0 to 2 percent slopes	350	.1
Sharpsburg silty clay loam, benches, 2 to 5 percent slopes	2,800	.8
Sharpsburg silty clay loam, benches, 5 to 9 percent slopes	1,745	.5
Shelby clay loam, 9 to 14 percent slopes, moderately eroded	500	.1
Shelby clay loam, 14 to 18 percent slopes, moderately eroded	1,155	.3
Shelby clay loam, 18 to 25 percent slopes, moderately eroded	605	.2
Sperry silt loam, 0 to 1 percent slopes	175	(1)
Steep rock land	375	.1
Strip mines	240	.1
Tama silty clay loam, 0 to 2 percent slopes	245	.1
Tama silty clay loam, 2 to 5 percent slopes	2,560	.7
Tama silty clay loam, 5 to 9 percent slopes, moderately eroded	3,015	.8
Tama silty clay loam, 9 to 14 percent slopes, moderately eroded	1,210	.3
Tama silty clay loam, benches, 2 to 5 percent slopes	915	.2
Vesser silt loam, 0 to 2 percent slopes	430	.1
Vesser silt loam, 2 to 5 percent slopes	380	.1
Wabash silty clay loam, 0 to 2 percent slopes	5,900	1.6
Wabash silty clay, 0 to 2 percent slopes	1,700	.5
Watkins silt loam, 1 to 4 percent slopes	380	.1
Weller silt loam, 2 to 5 percent slopes	135	(1)
Weller silt loam, 5 to 9 percent slopes, moderately eroded	535	.1
Winterset silty clay loam, 0 to 2 percent slopes	9,050	2.5
Wiota silt loam, 0 to 2 percent slopes	520	.1
Wiota silt loam, 2 to 5 percent slopes	395	.1
Zook silty clay loam, 0 to 2 percent slopes	21,880	6.0
Gravel pit	50	(1)
Made land	120	(1)
Water[2]	275	.1
Total	365,980	100.0

[1] Less than 0.05 percent.
[2] Bodies of water 20 acres or larger.

loam subsoil extends to a depth of 42 inches; it is brown and reddish brown in the upper part, brown in the middle part, and yellowish brown in the lower part. The substratum is yellowish brown clay loam.

Permeability is slow, and available water capacity is moderate to high. The subsoil is very low in available phosphorus and potassium.

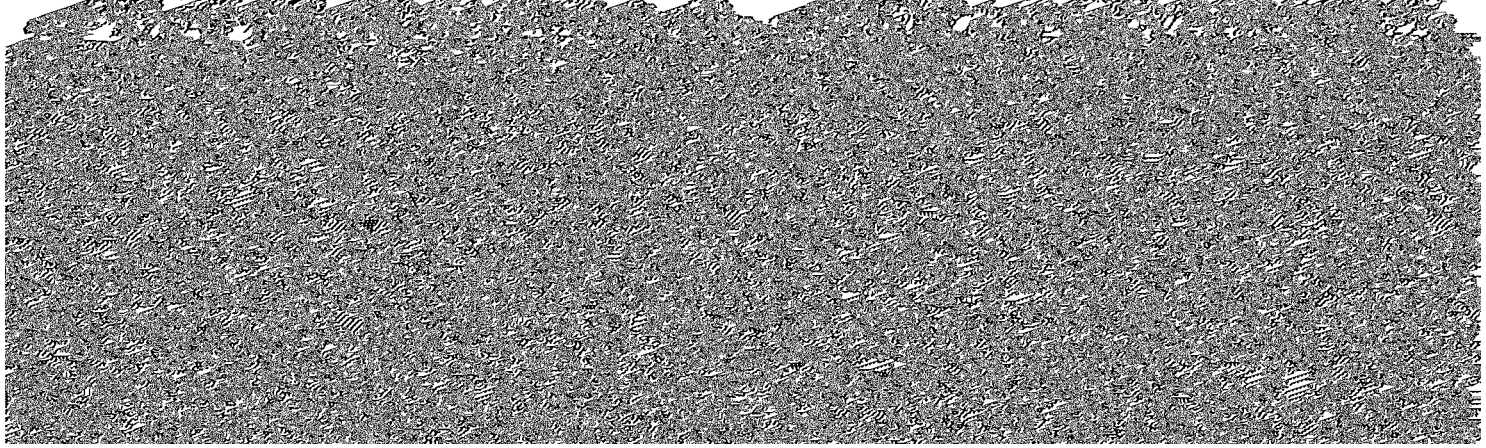
Adair soils are used mainly for row crops and pasture. The major hazard is erosion, and the major limitation is wetness.

Representative profile of Adair clay loam, 9 to 14

structure; firm; thick continuous clay films; pebble band at a depth of 14 inches; slightly acid; clear smooth boundary.

IIB22t—16 to 23 inches; mixed dark reddish brown (2.5YR 3/4) and brown (10YR 5/3) heavy clay loam; moderate fine subangular blocky structure; firm; thick continuous clay films; slightly acid; clear smooth boundary.

IIB23t—23 to 26 inches; brown (10YR 5/3)



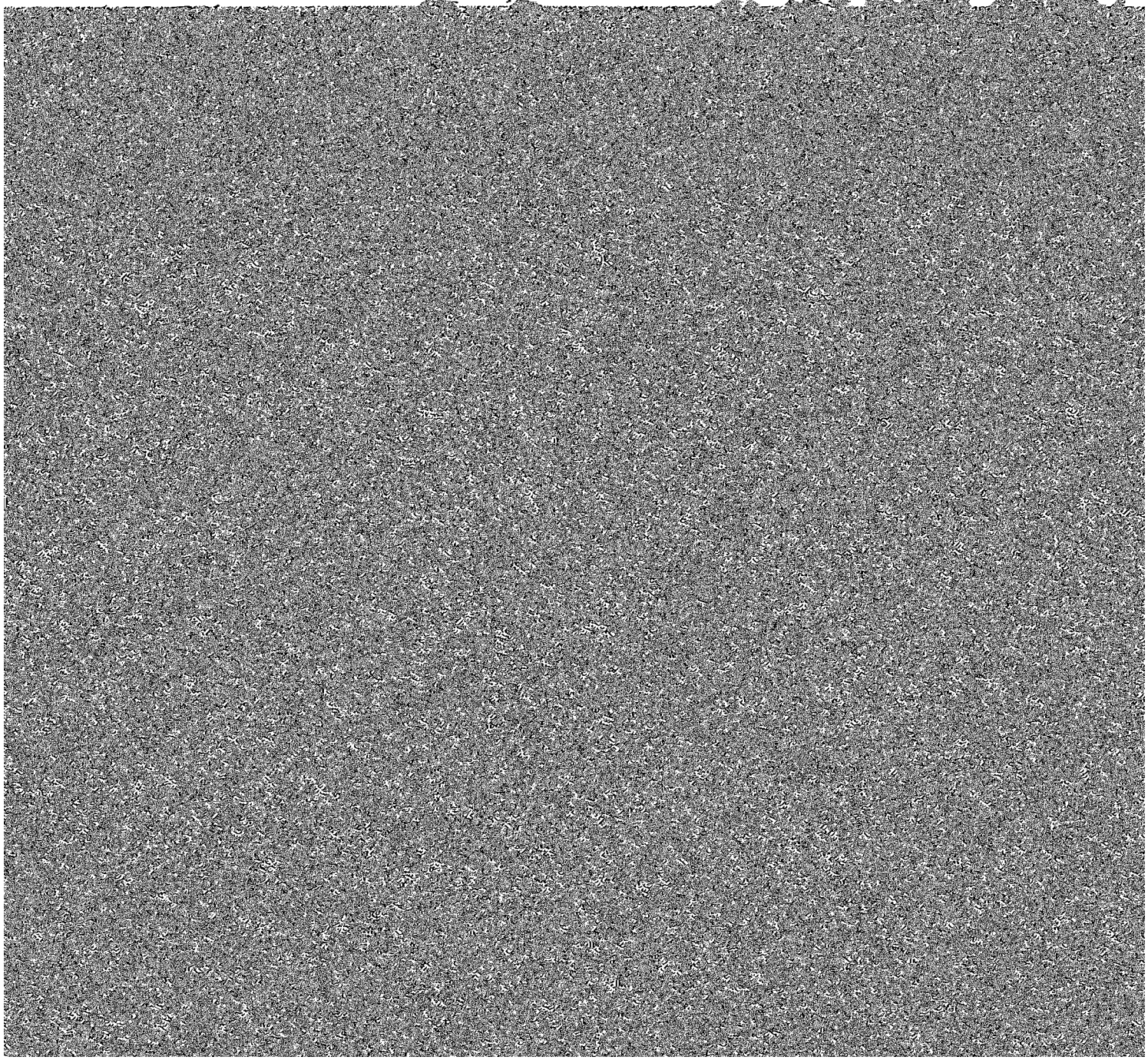
IIB3—32 to 42 inches; yellowish brown (10YR 5/6) clay loam; common fine prominent gray (10YR 6/1) mottles and few fine prominent reddish brown (5YR 4/4) mottles; weak medium prismatic structure parting to weak fine subangular blocky; firm; slightly acid; gradual smooth boundary.

IIC—42 to 60 inches; yellowish brown (10YR 5/4) clay loam; gray (10YR 6/1) veins; common fine and medium distinct yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure; firm; slightly

as 24 inches overlies the reddish subsoil. Also included are spots of severely eroded soils and spots of gray clay, which are indicated on the soil map by special symbols.

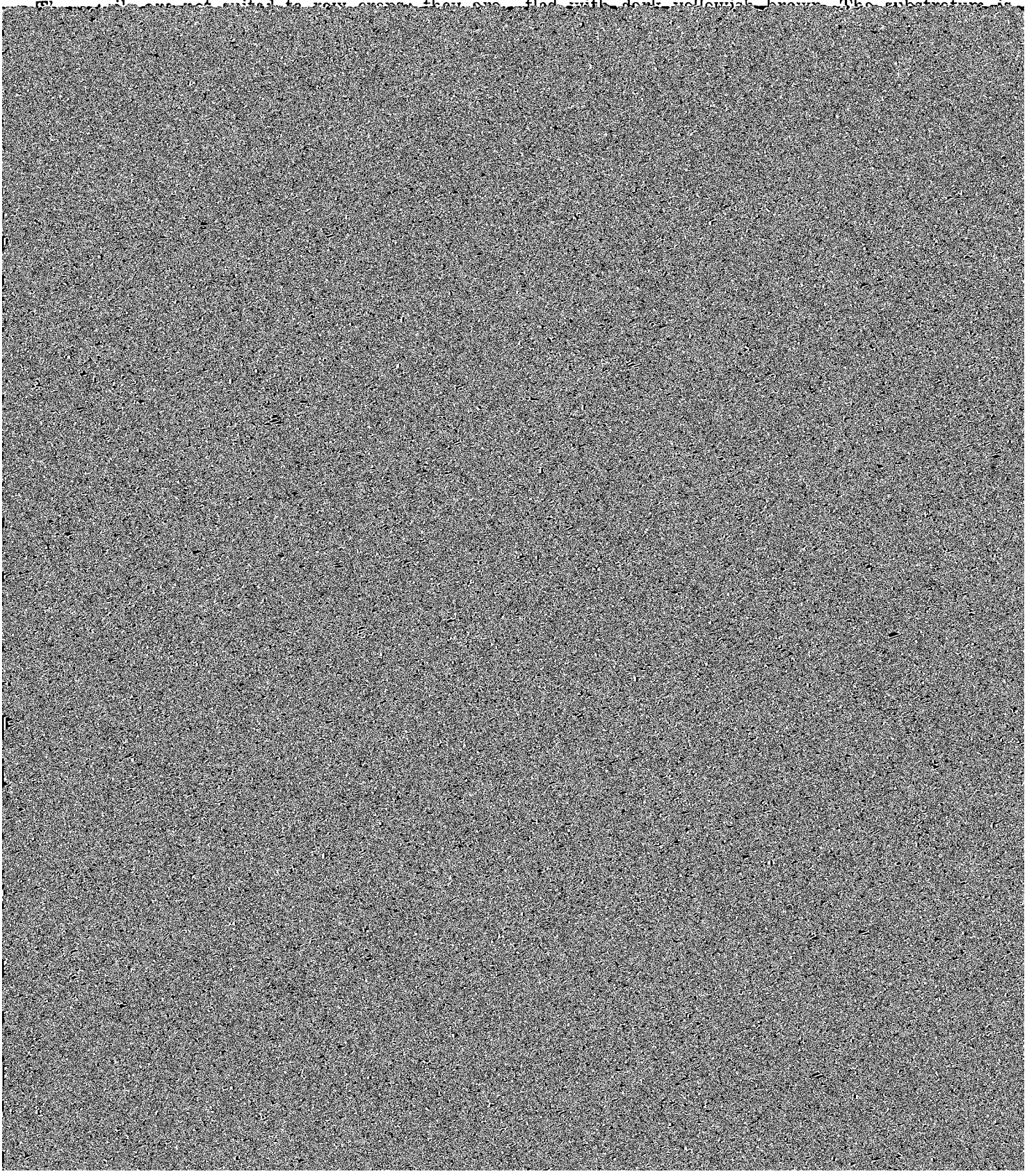
This Adair soil is poorly suited to row crops; it is better suited to small grain, hay, and pasture than to most other uses. It is susceptible to erosion. During wet seasons, seeps occur near the contact of the loess and till along the upper edge of areas. The organic matter content is moderate to low. Capability unit IVe–2; environmental planting group 1.

93D2—Adair-Shelby clay loams, 9 to 14 percent slopes, moderately eroded. These strongly sloping soils are on convex side slopes on uplands. This complex is



outcrop, which are indicated on the soil map by a special symbol.

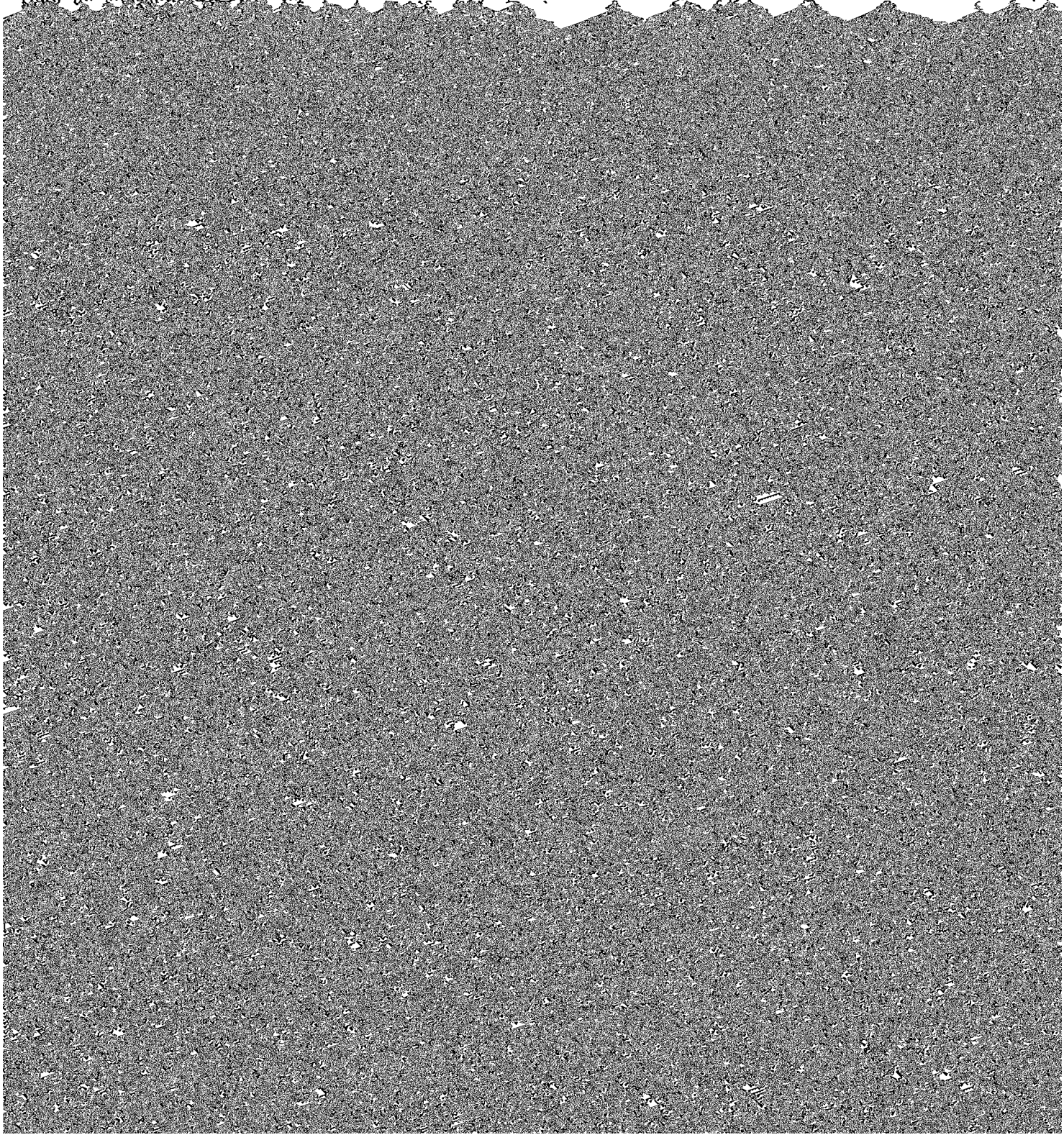
about 16 inches thick. The subsoil extends to a depth of 44 inches; it is dark grayish brown silt loam mot-



which are indicated on the soil map by a special symbol.

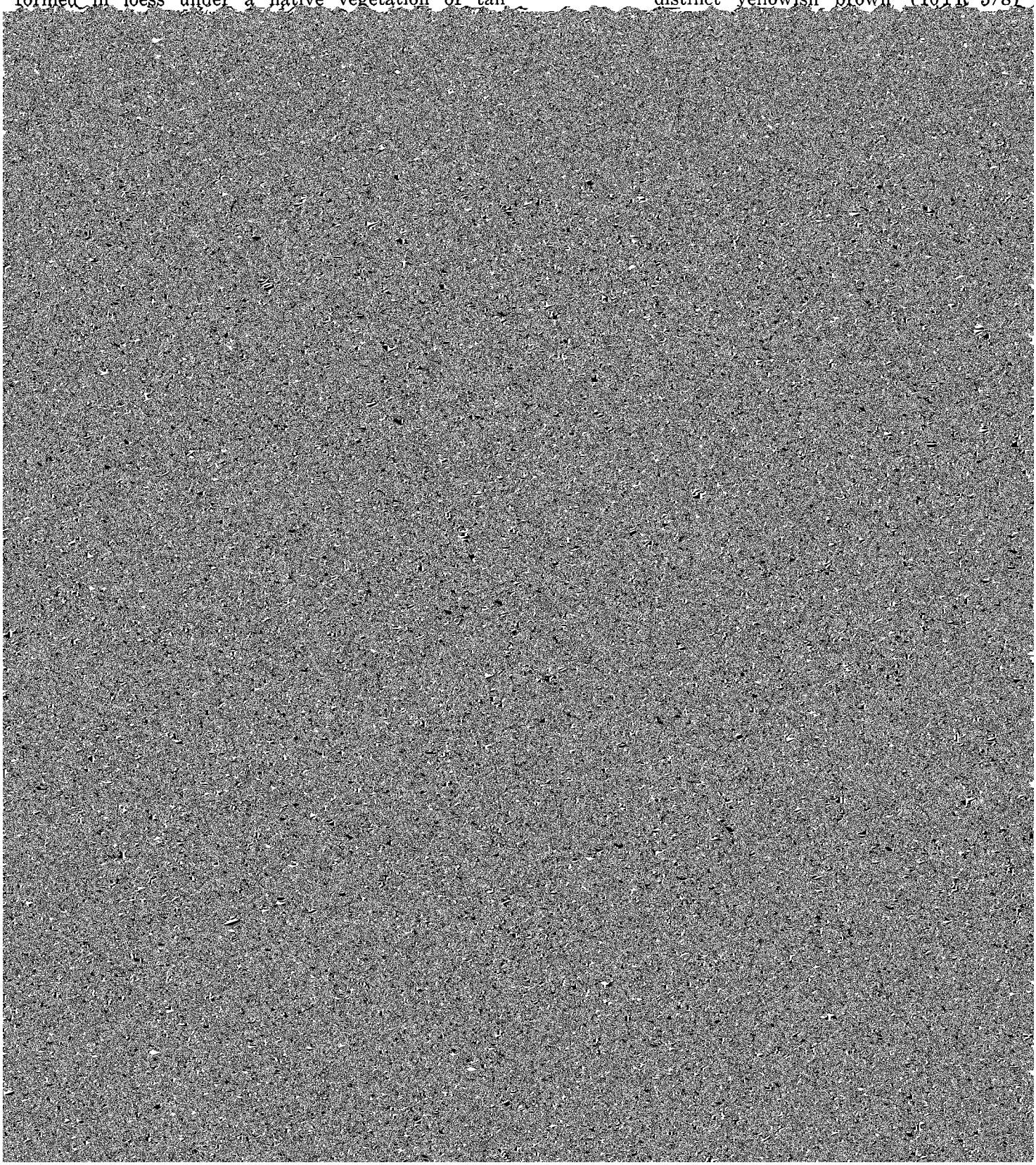
This Amana soil is well suited to intensive row crops. In many places it is underlain by material that is moderately rapidly permeable. Crops are more quickly affected by moisture stress in dry periods on this soil

IIB23t—29 to 35 inches; yellowish brown (10YR 5/4) medium clay loam; grayish brown (2.5Y 5/2) faces of peds; few fine faint yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate fine subangular blocky;



ing, somewhat poorly drained to moderately well drained soils. These soils are on the upper and middle parts of side slopes adjacent to the upland flats. They formed in loess under a native vegetation of tall

B31t—36 to 43 inches; grayish brown (2.5Y 5/2) medium silty clay loam; dark grayish brown faces on some peds; common fine distinct yellowish brown (10YR 5/8)



soils that formed in glacial till. The soil is susceptible to erosion. The organic matter content is high. Capability unit IIIe–1; environmental planting group 1.

23C2—Arispe silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on short convex ridges and the upper part of side slopes on uplands. Areas are long or are irregular in shape. Typically, they are about 5 to 15 acres in size. This soil has a profile similar to the one described as representative of the series, but erosion has removed part of the dark colored surface layer and in most places some material from the brown, finer textured subsoil has been mixed into the plow layer.

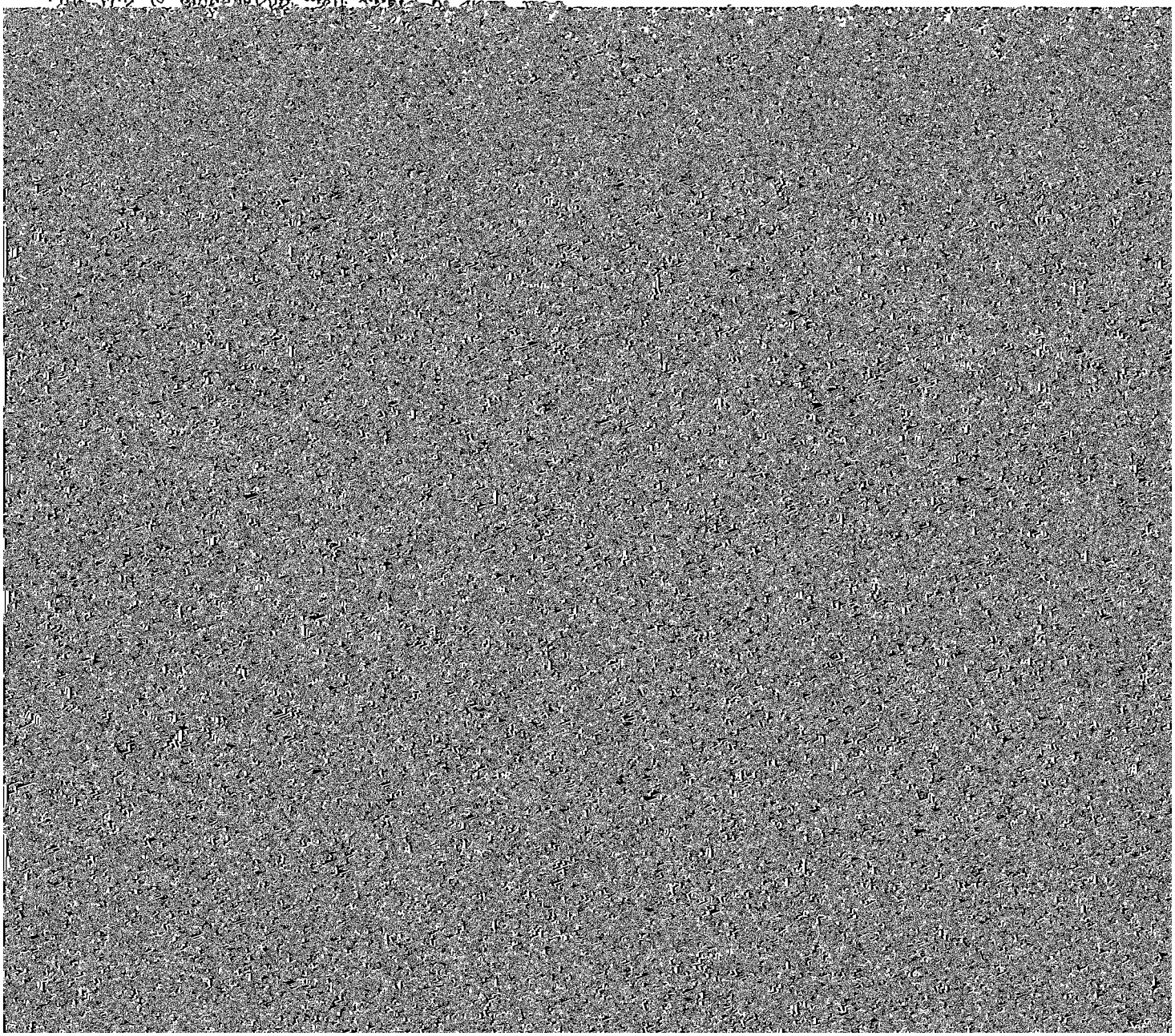
Included with this soil in mapping are a few areas of strongly sloping Arispe soils. Also included are some spots of reddish, clayey soil and wet soils, which are indicated on the soil map by special symbols.

This soil is moderately well suited to [illegible]

brown (10YR 7/3) dry; weak thin platy structure; friable; thick continuous gray silt coatings; medium acid; abrupt smooth boundary.

B1—9 to 14 inches; dark yellowish brown (10YR 4/4) clay loam; weak fine subangular blocky structure; friable; thick discontinuous gray silt coatings; strongly acid; clear smooth boundary.

IIB21t—14 to 18 inches; brown (7.5YR 4/4) clay; few fine distinct grayish brown (10YR 5/2) mottles and common fine distinct yellowish red (5Y 4/6) mottles; moderate fine angular and subangular blocky structure; firm; thin continuous clay films; thick discontinuous gray silt coatings; medium acid; clear smooth bound-



093F3 does not have a dark colored surface layer thick brown subsurface layer has been mixed into the plow

field, 300 feet west and 1,120 feet north of the southeast corner of the SW¼ sec. 13, T. 76 N., R. 24 W.:

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam; weak fine granular structure; friable; slightly acid; clear smooth boundary.

B21—7 to 13 inches; brown (10YR 4/3) silty

one described as representative of the series; however, in many areas, plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are areas of Bauer soils that have a 7 to 10 inch thick surface layer and some areas where slopes are less than 9 percent. Also included are spots of red clay, spots of gray clay, glacial till outcrops, sand spots, seepy wet

silty clay loam about 18 inches thick. The subsoil extends to a depth of 47 inches. It is very dark gray silty clay loam in the upper part, dark gray silty clay in the middle part, and gray silty clay in the lower part. The substratum is grayish brown silty clay loam.

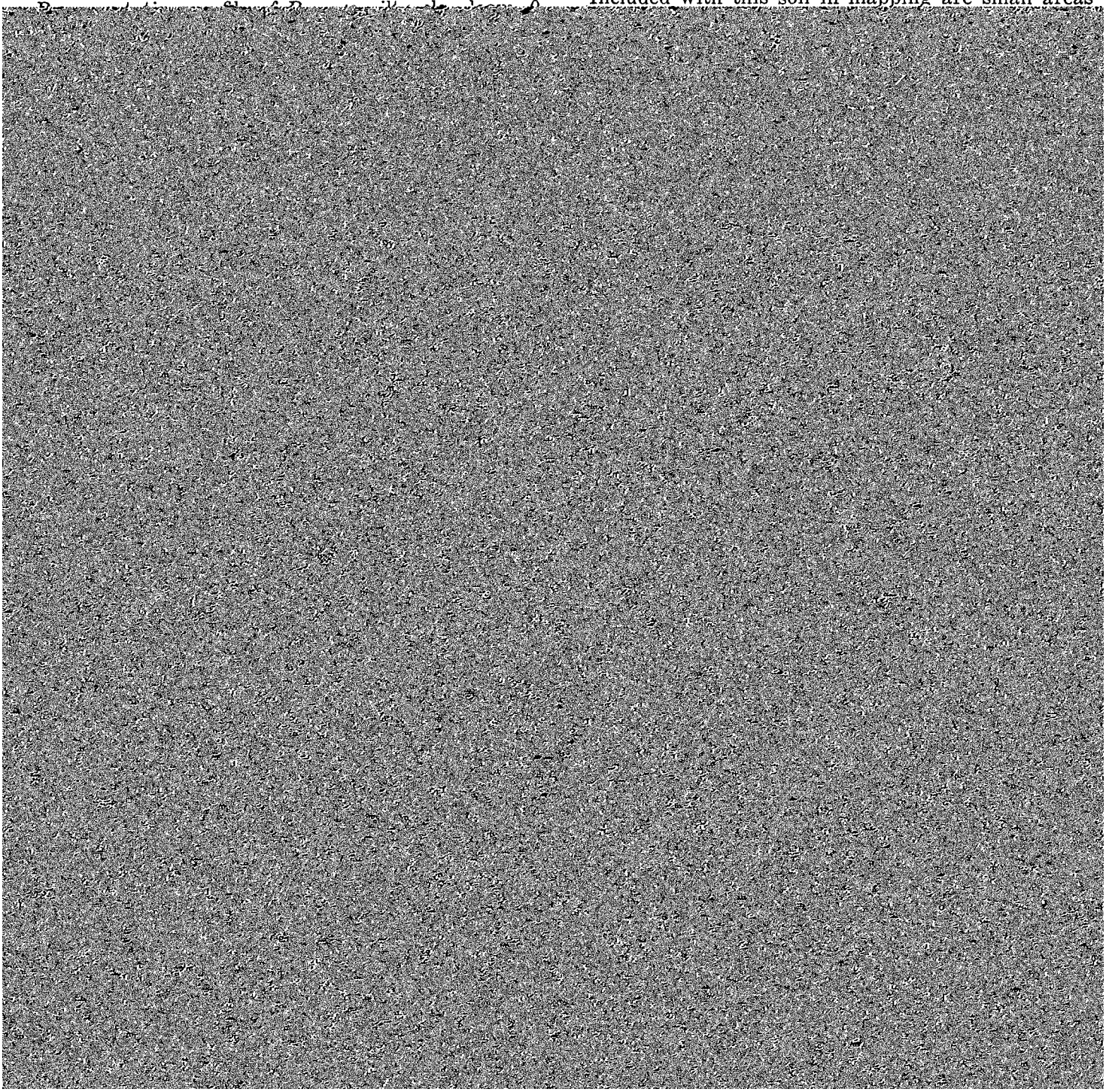
Permeability is slow, and available water capacity is high. The subsoil is low in available phosphorus and potassium.

Bremer soils are used mainly for row crops. Some areas are in hay and pasture. The major limitation is wetness.

Bremer soils are associated on the landscape with Colo, Wabash, Zook, and Nevin soils, and they formed in parent material similar to those soils. They have a thinner surface layer than Colo, Wabash, and Zook soils. They have more clay and a grayer subsoil than Nevin soils.

43—Bremer silty clay loam, 0 to 2 percent slopes. This nearly level soil is on second bottoms along the major streams. Areas are broad and irregular in shape. They range from a few acres to many acres in size.

Included with this soil in mapping are small areas



angular blocky; firm; thin continuous clay films; few fine dark oxides; medium acid; clear smooth boundary.

B23t—27 to 33 inches; yellowish brown (10YR 5/6) light clay loam; weak medium prismatic structure parting to weak medium subangular blocky; firm; thin discontinuous clay films; thin discontinuous gray silt coatings; few fine dark oxides; medium acid; clear smooth boundary.

B31t—33 to 39 inches; yellowish brown (10YR 5/6) sandy clay loam; yellowish brown (10YR 5/4) faces of peds; few fine distinct gray (5Y 5/1) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; thin discontinuous clay films on vertical faces of peds; thick continuous gray silt coatings; few fine dark oxides; medium acid; clear smooth boundary.

B32—39 to 45 inches; yellowish brown (10YR 5/6) sandy loam; yellowish brown

described as representative of the series; however, in many places plowing has mixed material from the subsoil into the surface layer.

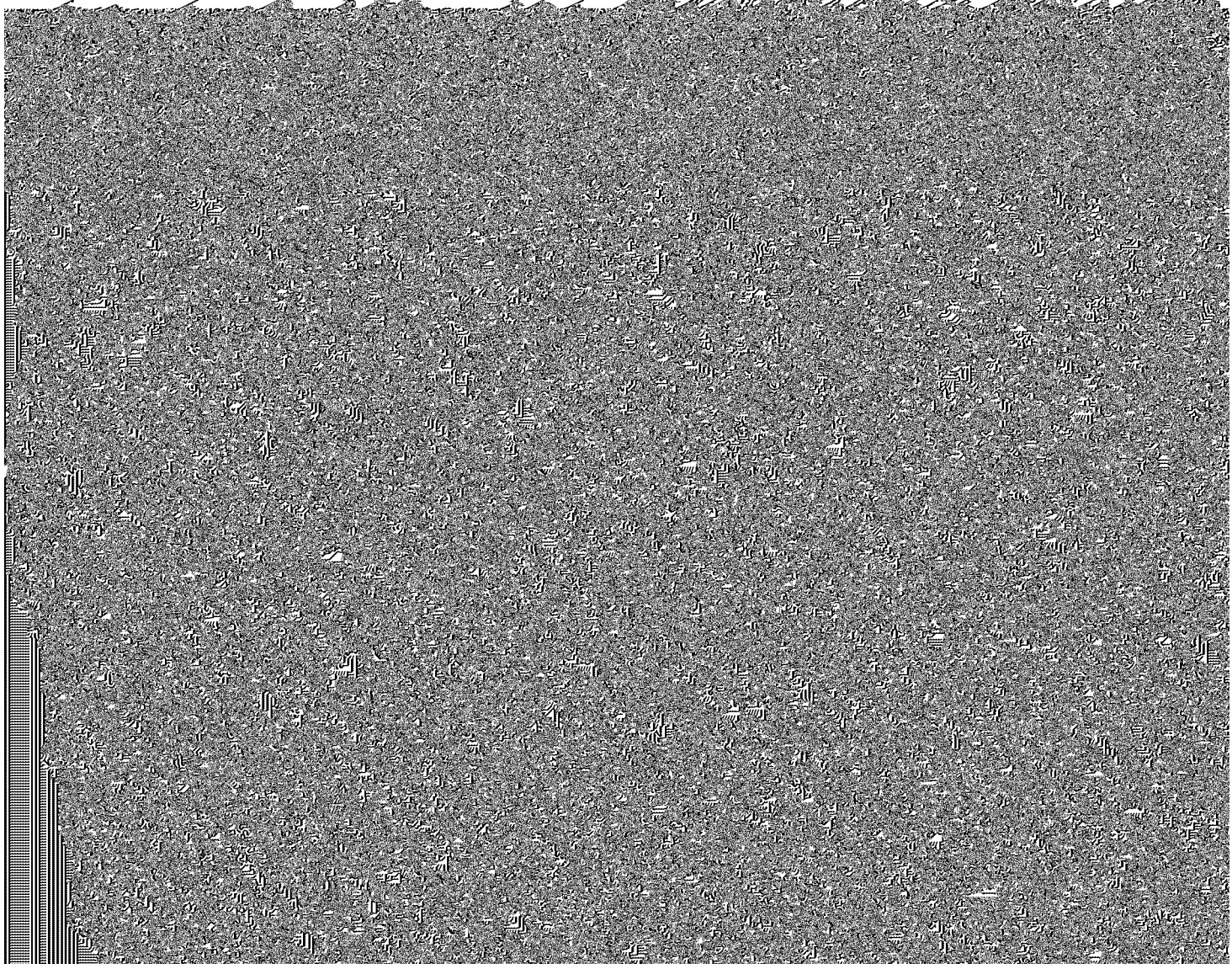
Included with this soil in mapping are spots of severely eroded soils, spots of red clay, wet spots, sand spots, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Caleb soil is better suited to small grain, hay, and pasture than to row crops. It is susceptible to erosion, and it tends to be droughty. The organic matter content is low to very low. Capability unit IVe–3; environmental planting group 1.

Chelsea series

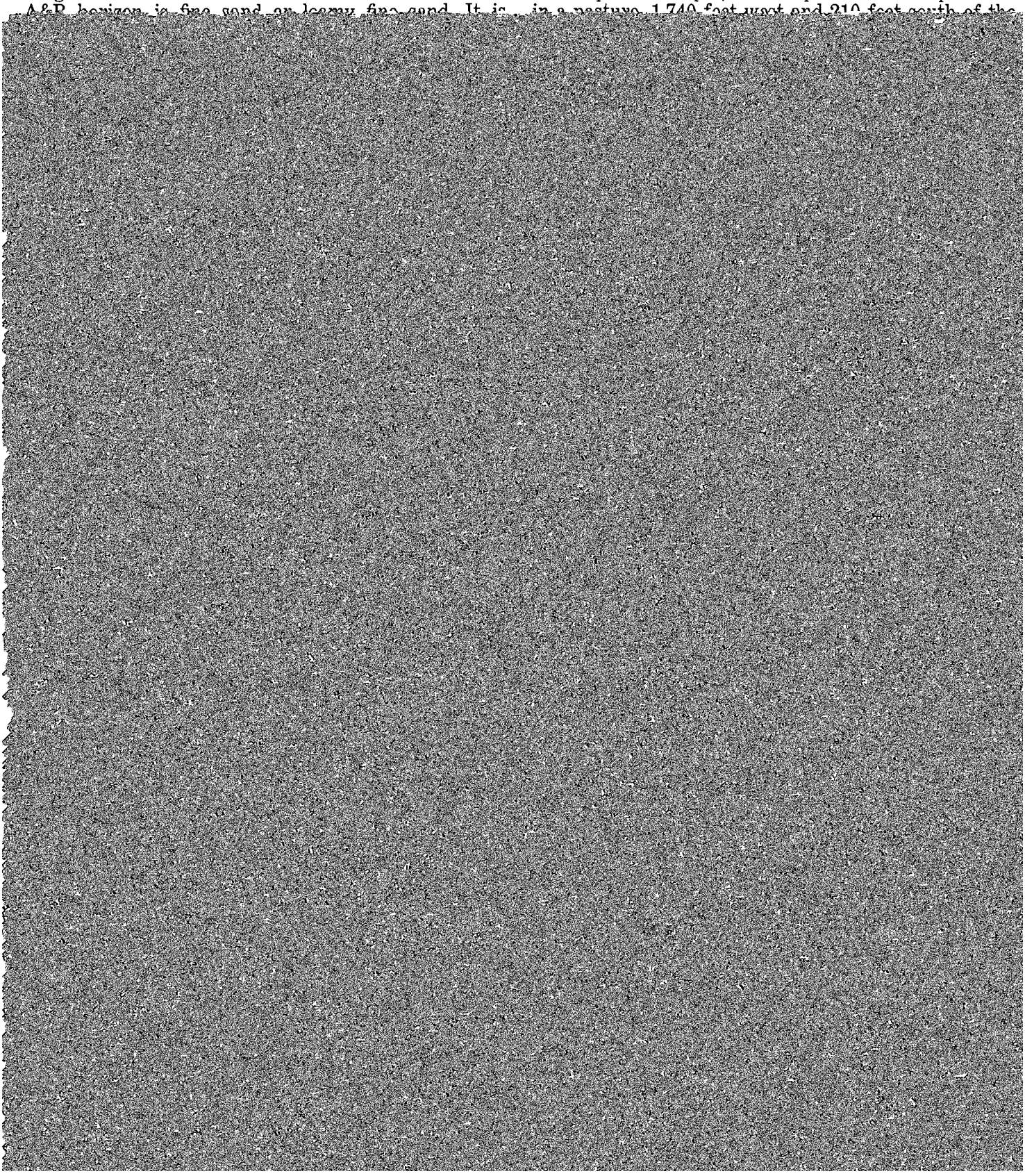
The Chelsea series consists of deep, moderately sloping to moderately steep, excessively drained soils. These soils are on upland side slopes and ridgetops adjacent to the major streams. They formed in windblown sand under a native vegetation of trees.

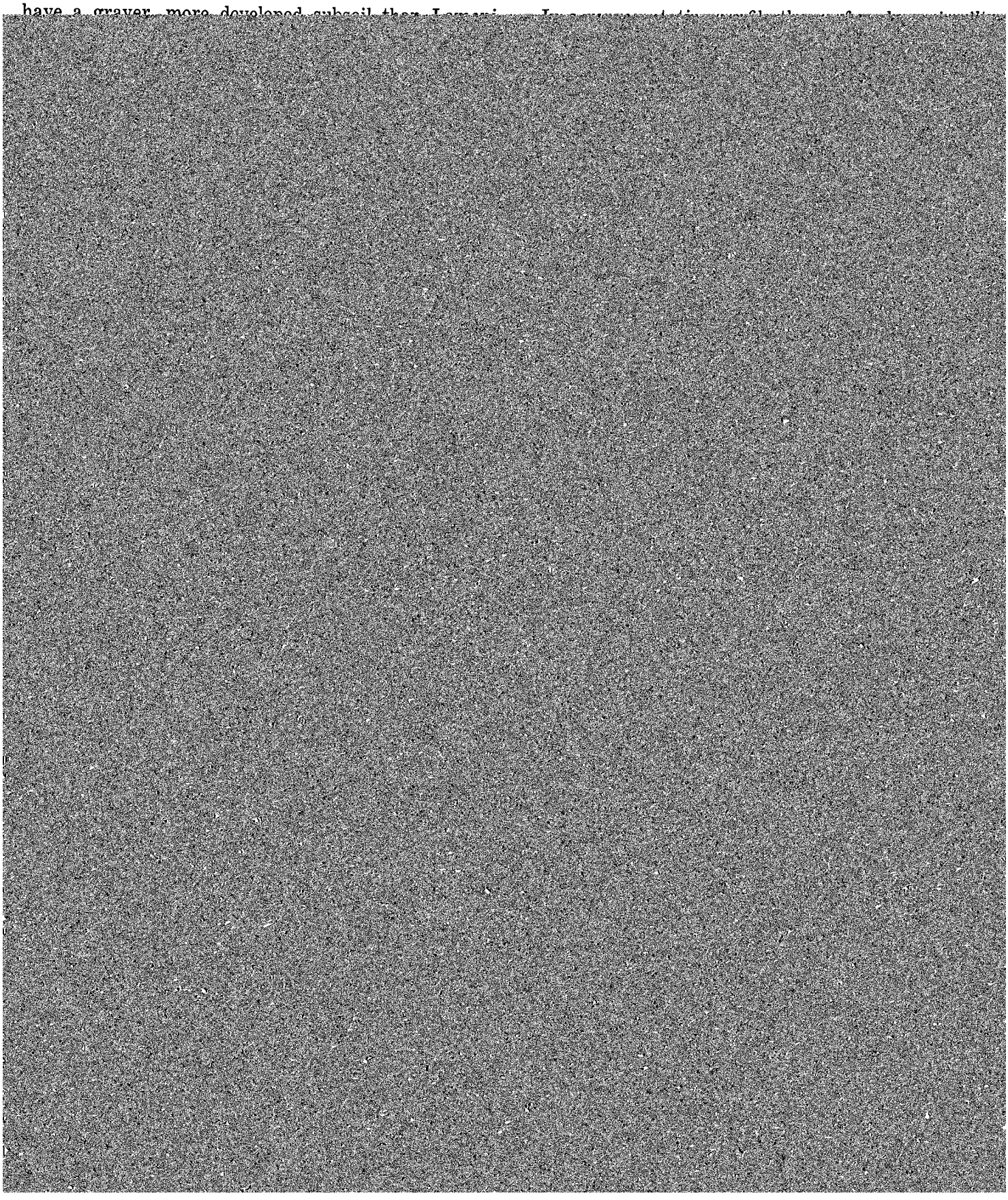
In a representative profile the surface layer is very dark gravish brown loamy fine sand about 5 inches



(10YR 4/2) to light yellowish brown (10YR 6/4), but ranges to darker colors in the horizontal bands. The A&B horizon is fine sand or loamy fine sand. It is

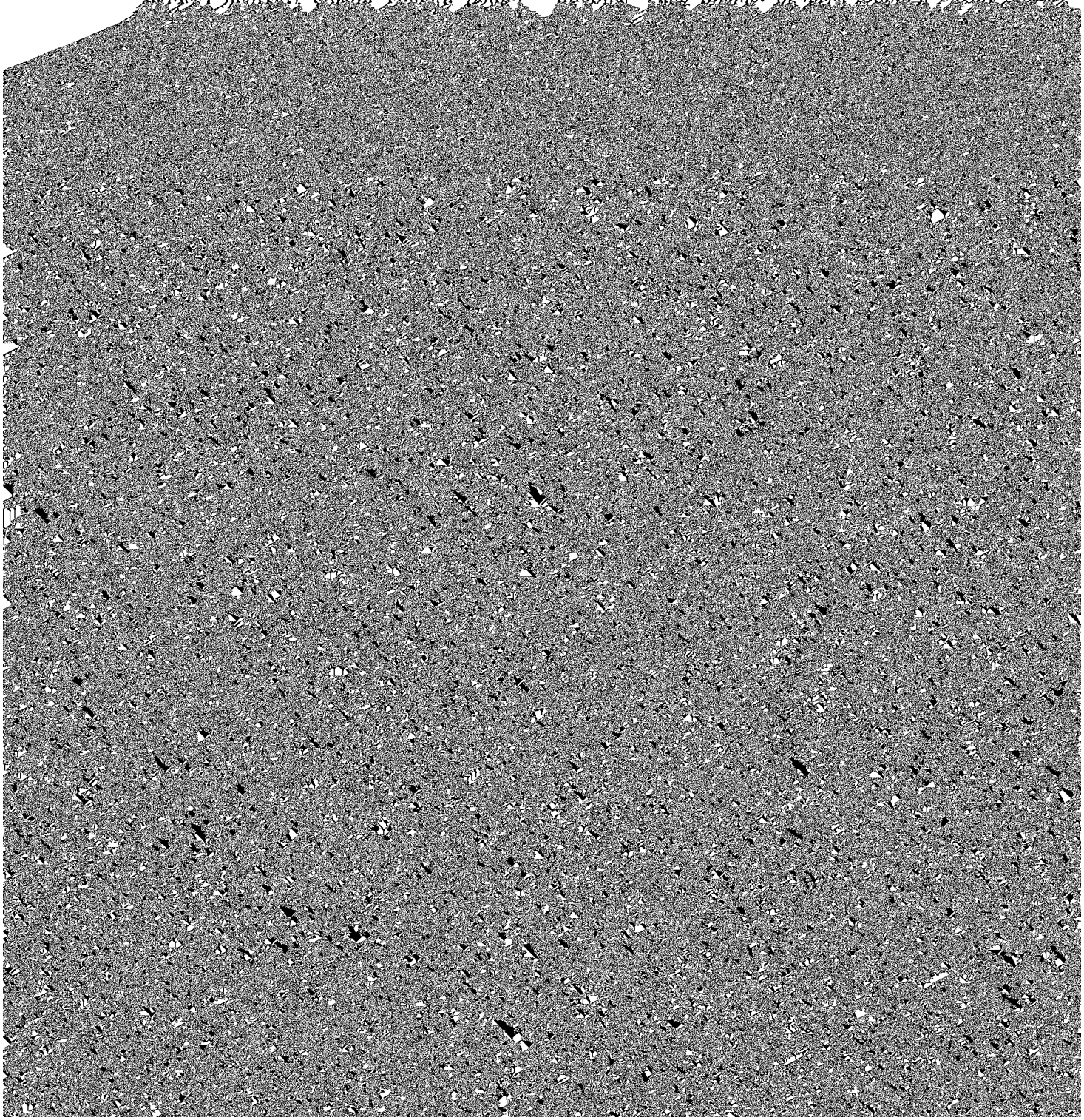
Representative profile of Clarinda silty clay loam, 5 to 9 percent slopes, in an upland bowl-shaped cove in a pasture, 1,740 feet west and 210 feet south of the





clay films; very fine dark oxides; neutral; gradual smooth boundary.

IIB1b—41 to 46 inches; dark gray (5Y 4/1) silty clay; many fine distinct dark brown (7.5YR 4/4) and yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak coarse subangular blocky; firm; very fine dark oxides; neutral; abrupt smooth bound



content is high. Capability unit IIIw–1; environmental planting group 2.

Clinton series

The Clinton series consists of deep, gently sloping to strongly sloping, moderately well drained soils. These soils are on convex ridgetops and side slopes on uplands. They formed in loess under a native vegeta-

Figure 13.—**An area of a Clinton soil in the foreground that has been cleared of native trees and sown to improved grasses for pasture. Trees in the background are on infertile Gosport soils.**

mon fine dark oxides; medium acid; gradual smooth boundary.

B23t 38 to 46 inches; yellowish brown (10YR

very dark grayish brown (10YR 3/2). It is 2 to 5 inches thick and is neutral to strongly acid.

The A2 horizon is dark grayish brown (10YR 4/2)

spots, which are indicated on the soil map by a special symbol. Also included are some areas that are somewhat poorly drained.

This Clinton soil is well suited to row crops. It is susceptible to erosion. The organic matter content is low. Capability unit IIe–2; environmental planting group 1.

80C2—Clinton silt loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on long, convex ridgetops and side slopes on uplands. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas plowing has mixed material from the subsoil into the surface layer.

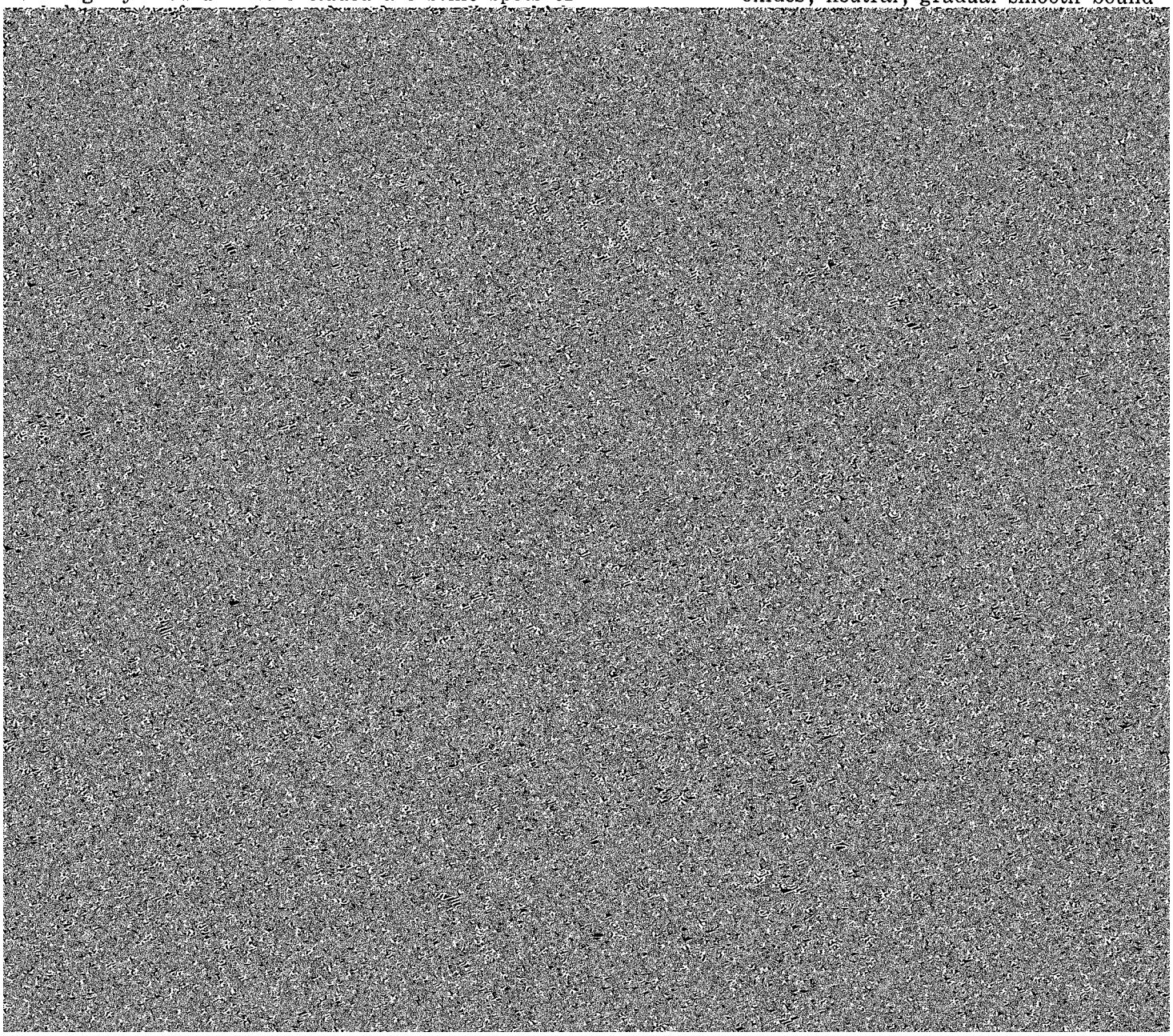
Included with this soil in mapping are areas that are slightly eroded. Also included are some spots of

weak fine granular structure; friable; neutral; clear smooth boundary.

A12—8 to 13 inches; black (N 2/0) silty clay loam; moderate fine angular blocky structure; friable; neutral; gradual smooth boundary.

A13—13 to 19 inches; black (10YR 2/1) silty clay loam; weak fine and medium prismatic structure parting to weak fine subangular blocky; friable; neutral; diffuse smooth boundary.

A14—19 to 25 inches; black (10YR 2/1) silty clay loam; few fine distinct yellowish brown (10YR 5/8) mottles; weak medium prismatic structure parting to weak fine subangular blocky; firm; few dark oxides; neutral; gradual smooth bound-



This Colo soil is well suited to row crops. It is susceptible to wetness. The organic matter content is high. Capability unit IIw–2; environmental planting group 2.

133B—Colo silty clay loam, 2 to 5 percent slopes. This gently sloping soil is on foot slopes adjacent to upland side slopes and in small valleys. Areas are long and narrow or irregular in shape. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are wet spots, which are indicated on the soil map by a special symbol. Also included are some soils that are similar to this Colo soil but are sandier.

This Colo soil is well suited to row crops. Most areas are managed with adjacent soils, and many areas are in pasture. The soil is susceptible to wetness and gully erosion. The organic matter content is high. Capability unit IIw–3; environmental planting group 2.

11B—Colo-Ely silty clay loams, 2 to 5 percent slopes. These gently sloping soils are in upland drainageways. The Colo soil is near the stream, and the Ely soil is on foot slopes. This complex is about 60 percent Colo silty clay loam and 40 percent Ely silty clay loam. Areas of this complex are long and narrow.

Included with these soils in mapping are areas of soils that have 8 to 18 inches of silty, stratified overwash.

These soils are well suited to row crops. Some areas are used for grassed waterways, and many areas are in pasture. The soils are susceptible to wetness and gully erosion. The organic matter content is high. Capability unit IIw–3; environmental planting group 2.

Downs series

The Downs series consists of deep, nearly level to strongly sloping, well drained soils. These soils are on upland ridgetops and side slopes and on benches adjacent to the major streams. They formed in loess under a native vegetation of mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown silt loam about 7 inches thick. The sub-

A2—7 to 12 inches; dark grayish brown (10YR 4/2) silt loam; very dark grayish brown (10YR 3/2) faces of peds, grayish brown (10YR 5/2) dry; weak medium platy structure parting to moderate very fine granular; friable; medium acid; clear smooth boundary.

B1—12 to 19 inches; brown (10YR 4/3) heavy silt loam; dark brown (10YR 3/3) and dark yellowish brown (10YR 3/4) faces of peds; weak medium subangular blocky structure parting to moderate fine subangular blocky; friable; thin discontinuous clay films; thin discontinuous silt coatings; medium acid; gradual smooth boundary.

B21t—19 to 29 inches; brown (10YR 4/3) light silty clay loam; weak medium subangular blocky structure parting to moderate fine subangular and angular blocky; friable; thin continuous clay films; thin discontinuous silt coatings; strongly acid; gradual smooth boundary.

B22t—29 to 40 inches; dark yellowish brown (10YR 4/4) light silty clay loam; weak medium prismatic structure parting to strong fine subangular and angular blocky; friable; thin discontinuous clay films; thin continuous silt coatings; very strongly acid; gradual smooth boundary.

B3—40 to 48 inches; yellowish brown (10YR 5/4) light silty clay loam; few fine faint light brownish gray (10YR 6/2) mottles, many fine distinct grayish brown (2.5Y 5/2) mottles, and common fine faint yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate fine and very fine subangular blocky; friable; thin discontinuous clay films; thin discontinuous silt coatings; few fine dark oxides; strongly acid; gradual smooth boundary.

to that of Fayette and Tama soils. They have less sand and fewer pebbles in the solum than Gara soils, which are downslope and formed in glacial till. They have a thicker surface layer than Fayette soils. They have an A2 horizon and Tama soils do not.

162—Downs silt loam, 0 to 2 percent slopes. This nearly level soil is on broad upland ridgetops. Areas are small in size and irregular in shape. This soil has a profile similar to the one described as representative of the series, but the subsoil contains more gray mottles.

Included with this soil in mapping are areas of somewhat poorly drained soils that are susceptible to wetness.

This Downs soil is well suited to intensive row crops. The organic matter content is high. Capability unit I–1; environmental planting group 1.

162B—Downs silt loam, 2 to 5 percent slopes. This gently sloping soil is on upland ridgetops. Areas are long and narrow or irregular in shape. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are areas of moderately eroded soils. In these areas, the surface layer is thinner and in some places plowing has mixed material from the subsoil into the surface layer. Also included are sand spots, which are indicated on the soil very low. Capability unit IIIe–1; environmental planting group 1.

T162B—Downs silt loam, benches, 2 to 5 percent slopes. This gently sloping soil is on long, convex benches along major streams. Areas are long and narrow or irregular in shape. Slopes are typically short.

Included with this soil in mapping are sand spots, which are indicated on the soil map by a special symbol. Also included are some areas of moderately sloping Downs soils, which are indicated on the soil map by a special symbol for short, steep slopes.

This Downs soil is well suited to row crops. It is susceptible to erosion. The organic matter content is moderate. Capability unit IIe–1; environmental planting group 1.

Ely series

The Ely series consists of deep, gently sloping, somewhat poorly drained soils. These soils are on narrow foot slopes and alluvial fans. They formed in alluvium from adjacent slopes under a native vegetation of prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish brown silty clay loam about 22 inches thick. The silty clay loam subsoil extends to a depth of 55 inches; it is mostly very dark

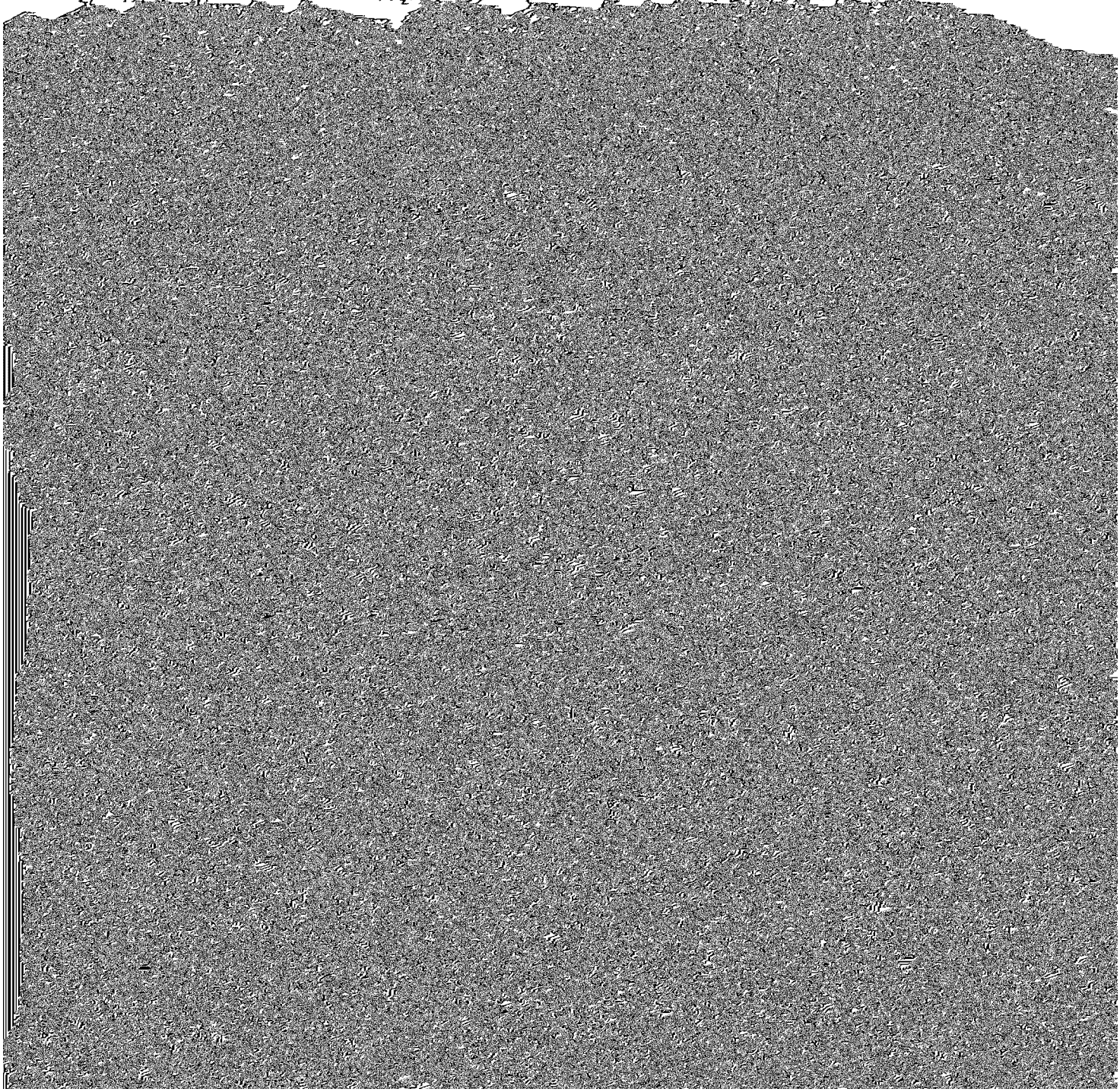
B21—32 to 39 inches; dark grayish brown (10YR 4/2) silty clay loam; very dark grayish brown (10YR 3/2) and dark gray (10YR 4/1) faces of peds; common fine faint dark brown (10YR 3/3) mottles and few fine distinct yellowish brown (10YR 5/4) mottles; weak medium prismatic structure parting to moderate fine and medium subangular blocky; friable; few fine dark oxides; medium acid; gradual smooth boundary.

[illegible]

It is generally managed with adjacent soils. It is susceptible to erosion and overflow from the adjoining uplands. The organic matter content is high. Capability unit IIe–3; environmental planting group 1.

Fayette series

The Fayette series consists of deep, gently sloping to steep, well drained soils. These soils are on convex upland ridgetops and side slopes. They formed in loess under a native vegetation of trees.



thin discontinuous clay films; thin discontinuous gray silt coatings; few fine dark oxides; medium acid; gradual smooth boundary.

C—45 to 60 inches; yellowish brown (10YR 5/4) medium silt loam; massive; friable; medium acid.

The solum ranges from 36 to 60 inches in thickness. The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). It is 1 inch to 4 inches thick and is neutral or slightly acid.

The B2t horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4) light or medium silty clay loam. It is 10 to 25 inches thick and is slightly acid to very strongly acid. The B3t horizon is dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/6) heavy silt loam or light silty clay loam. It is 9 to 18 inches thick and is medium acid or strongly acid.

Fayette soils are associated on the landscape with Chelsea and Gosport soils, and they formed in parent material similar to that of Downs soils. They contain less sand than Chelsea soils. They contain less clay than Gosport soils, which are downslope and formed in shale. They have a thinner surface layer than Downs soils.

163B—Fayette silt loam, 2 to 5 percent slopes. This gently sloping soil is on upland ridgetops. Areas are small and irregular in shape. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are sand spots, which are indicated on the soil map by a special symbol.

This Fayette soil is well suited to row crops. It is susceptible to erosion. The organic matter content is low. Capability unit IIe–2; environmental planting group 1.

163C2—Fayette silt loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on upland ridgetops and side slopes. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are spots of severely eroded soils, sand spots, and wet spots, all of which are indicated on the soil map by special symbols.

This Fayette soil is moderately well suited to row crops and pasture. Some areas are in woodland. The soil is susceptible to erosion. The organic matter content is low to very low. Capability unit IIIe–2; environmental planting group 1.

163D2—Fayette silt loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on convex upland side slopes. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed material from the subsoil into the surglacial till outcrop, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Fayette soil is moderately well suited to row crops. Some areas are in woodland. The soil is susceptible to erosion. Erosion is more difficult to control on this soil than on moderately sloping Fayette soils. The organic matter content is low to very low. Capability unit IIIe–2; environmental planting group 1.

163E2—Fayette silt loam, 14 to 18 percent slopes, moderately eroded. This moderately steep soil is on upland side slopes. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed subsoil material with the surface layer.

Included with this soil in mapping are spots of severely eroded soil, sand spots, spots of red clay, glacial till outcrop, and shale outcrop, all of which are indicated on the soil map by special symbols. Also included are soils that have a thicker surface layer.

This Fayette soil is poorly suited to row crops; it is better suited to small grain and hay than to most other uses. Many areas are in pasture and woodland. Farm equipment can be used. The soil is susceptible to erosion. The organic matter content is very low. Capability unit IVe–1; environmental planting group 1.

163F2—Fayette silt loam, 18 to 25 percent slopes, moderately eroded. This steep soil is on upland side slopes. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner.

Included with this soil in mapping are small sand spots, glacial till outcrop, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Fayette soil is generally unsuited to cultivated crops. Most areas are in woodland and pasture. The use of farm machinery requires caution because of the steepness of slopes, but in most places it can be used to improve pasture. The soil is susceptible to erosion. The organic matter content is very low. Capability unit VIe–1; environmental planting group 1.

Gara series

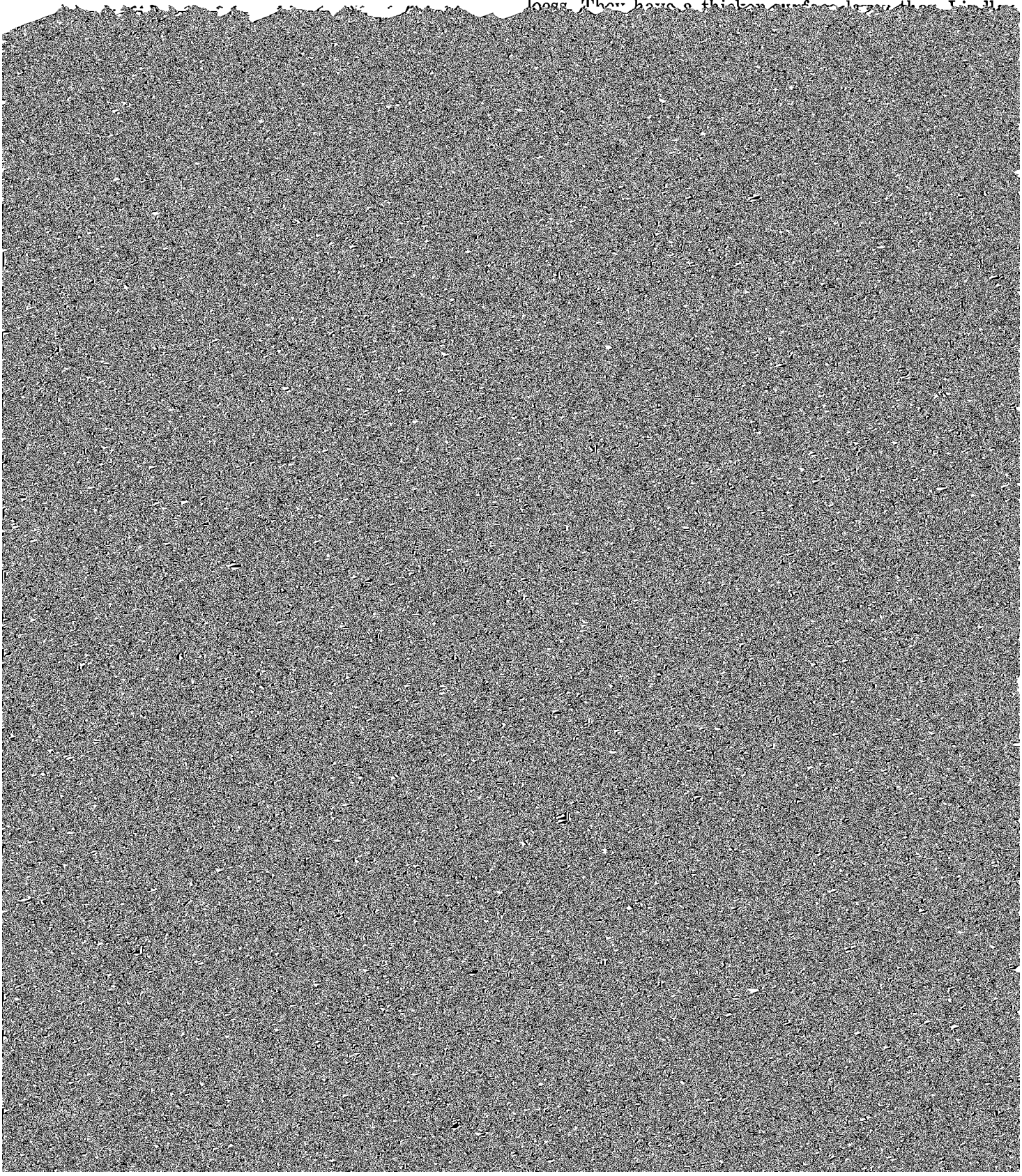
The Gara series consists of deep, strongly sloping to very steep, moderately well drained and well drained soils. These soils are on convex side slopes of uplands. They formed in glacial till under a native vegetation of prairie grasses and trees.

In a representative profile the surface layer is very dark gray loam about 8 inches thick. The subsurface layer is dark grayish brown loam about 6 inches thick. The clay loam subsoil extends to a depth of 40 inches; it is brown in the upper part and yellowish brown in the lower part. The substratum is yellowish brown clay loam.

Permeability is moderately slow, and available water capacity is high. The subsoil is low in available

slopes, in a pasture, 1,120 feet west and 150 feet north of the southeast corner of sec. 3, T. 74 N., R. 23 W.:

contain more sand in the subsoil than Grundy, Ladoga, and Pershing soils, which are upslope and formed in loess. They have a thicker surface layer than [illegible]



Areas are long and narrow or irregular in shape. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are spots of severely eroded soils. Also included is shale outcrop that causes vertical escarpments. These areas are indicated on the soil map by a special symbol for rock outcrop.

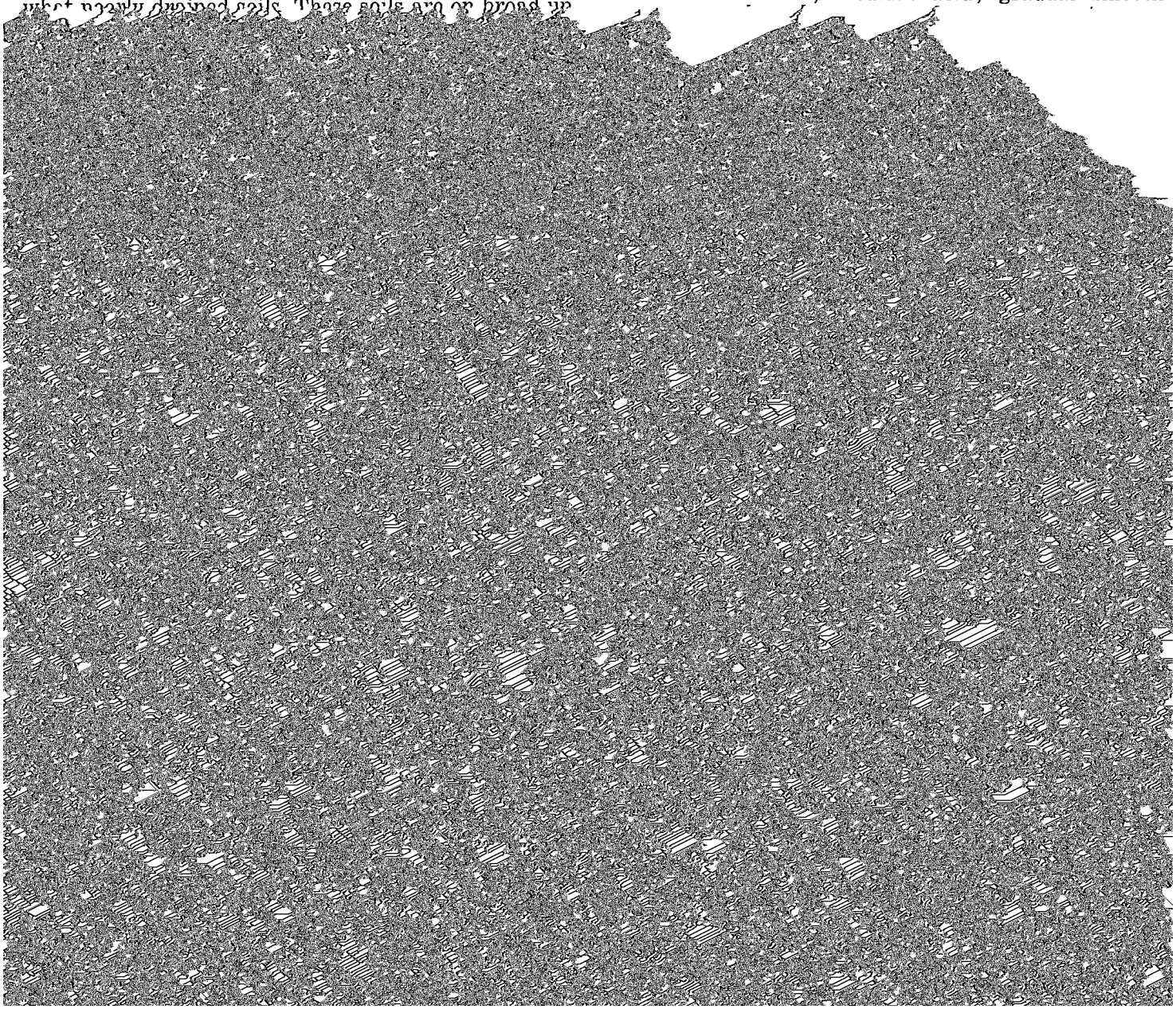
This Gara soil is not suited to row crops or hay; it is better suited to pasture and woodland than to most other uses. Most areas are too steep to safely use farm machinery. Many areas are in woodland. The soil is susceptible to erosion. The organic matter content is moderately low to low. Capability unit VIIe–2; environmental planting group 1.

Givin series

The Givin series consists of deep, nearly level, somewhat poorly drained soils. These soils are on broad up

B22t—22 to 29 inches; dark grayish brown (10YR 4/2) and grayish brown (2.5Y 5/2) heavy silty clay loam; common fine distinct strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to strong fine angular and subangular blocky; firm; thin continuous clay films; few fine and medium dark oxides; strongly acid; gradual smooth boundary.

B23t—29 to 39 inches; grayish brown (2.5Y 5/2) medium silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to strong fine angular blocky; firm; thin discontinuous clay films; common fine and medium dark oxides; medium acid; gradual smooth



tion. The organic matter content is moderate. Capability unit I–1; environmental planting group 1.

Gosport series

The Gosport series consists of strongly sloping to very steep, moderately well drained soils that have a clayey, shaley subsoil at a depth of about 1 foot. These soils are on convex side slopes on uplands. They formed in residuum weathered from gray and brown acid shale under a native vegetation of trees.

In a representative profile the surface layer is very

north of the southeast corner of sec. 15, T. 74 N., R. 22 W.:

A1—0 to 4 inches; very dark gray (10YR 3/1) heavy silt loam, gray (10YR 5/1) dry; weak thin platy structure parting to weak very fine and fine granular; friable; slightly acid; clear smooth boundary.

A2—4 to 8 inches; dark grayish brown (10YR 4/2) heavy silt loam, light brownish gray (10YR 6/2) dry; weak thin platy structure; friable; slightly acid; clear smooth

and medium angular blocky and subangular blocky structure; firm; thin discontinuous gray silt coatings; strongly acid; gradual smooth boundary.

C—23 to 60 inches; olive gray (5Y 5/2) clay; common medium distinct brownish yellow (10YR 6/6) mottles; weak medium platy structure; extremely firm; strongly acid.

The solum is typically 20 to 30 inches thick, but it ranges to 40 inches in thickness.

The A1 horizon is very dark gray (10YR 3/1) to dark grayish brown (10YR 4/2). It typically is silty clay loam, silt loam, loam, sandy loam, or clay loam, but in severely eroded areas it is silty clay or clay. The A1 horizon is 0 to 5 inches thick. The A2 horizon is dark grayish brown (10YR 4/2) to brown (10YR 5/3) silty clay loam, silt loam, loam, sandy loam, or clay loam. It is 3 to 8 inches thick and is slightly acid to strongly acid.

The B horizon is brown (10YR 5/3) and light olive brown (2.5Y 5/4) to light yellowish brown (10YR or 2.5Y 6/4) silty clay or clay. It is 12 to 28 inches thick and is strongly acid to extremely acid.

The C horizon varies widely in color. Hue ranges from 7.5YR to 5Y, value ranges from 2 to 8, and chroma ranges from 4 to 6. The C horizon is clay that has thin strata of siltstone, sandstone, and lignite. It ranges from strongly acid to extremely acid.

Gosport soils are associated on the landscape with

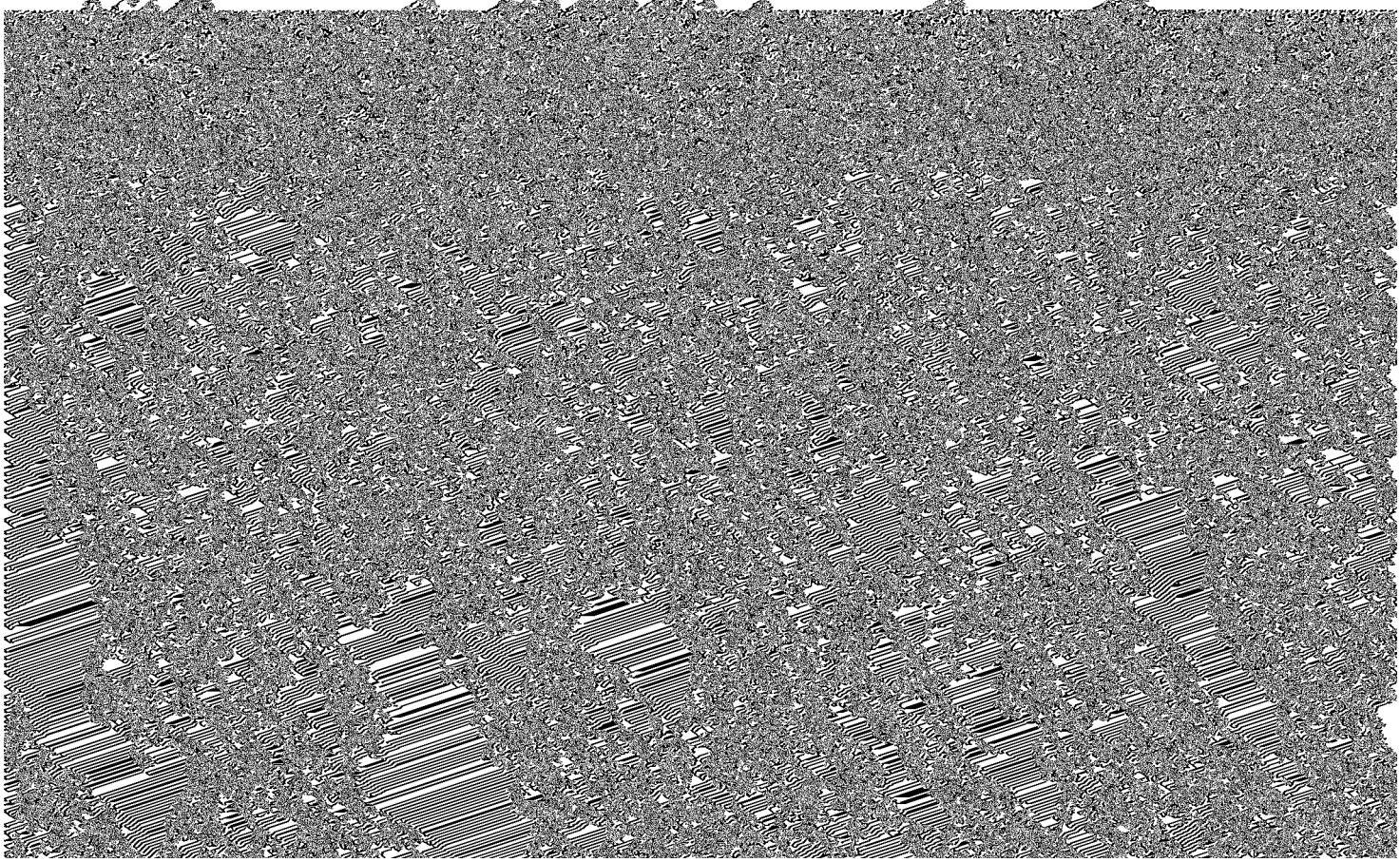
be used for pasture improvement or timber operations. Most areas are in woodland. The soil is susceptible to erosion. The organic matter content is low. Capability unit VIIe–1; environmental planting group 1.

313F—Gosport silt loam, 18 to 35 percent slopes. This steep to very steep soil is on convex side slopes on uplands. Areas are long and narrow or irregular in shape. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of glacial till outcrop and spots of severely eroded soils, both of which are indicated on the soil map by special symbols.

This Gosport soil is not suited to row crops or hay; it is better suited to woodland, wildlife habitat, and pasture than to most other uses. Mechanized equipment can be used in a few places, but it is hazardous because of slope. Most areas are in woodland. The soil is susceptible to erosion. The organic matter content is low. Capability unit VIIe–2; environmental planting group 1.

313E3—Gosport soils, 14 to 18 percent slopes, severely eroded. These moderately steep soils are on convex side slopes on uplands. Areas are long and narrow or irregular in shape. These soils have profiles similar to the one described as representative of the Gosport series, but erosion has removed the surface layer and most or all of the subsurface layer. In cultivated areas, material from the subsoil has been mixed into the remaining original subsurface layer. The sur-



Permeability is slow, and available water capacity is high. The subsoil is very low to low in available phosphorus and is low to medium in available potassium.

Grundy soils are used mainly for row crops. The major hazard is erosion, and the major limitation is wetness.

Representative profile of Grundy silty clay loam, 2 to 5 percent slopes, on a side slope in a pasture, 400 feet east and 360 feet south of the northwest corner of sec. 23, T. 75 N., R. 22 W.:

Ap—0 to 9 inches; very dark brown (10YR 2/2) light silty clay loam; black (10YR 2/1) faces of peds; moderate medium granular structure parting to moderate fine granular; friable; slightly acid; abrupt smooth boundary.

A12—9 to 12 inches; very dark grayish brown [illegible]

parting to weak medium subangular blocky; firm; thin discontinuous clay films; organic coatings in root channels; common very fine and fine and few medium dark oxides; slightly acid; gradual smooth boundary.

C—46 to 60 inches; grayish brown (2.5Y 5/2) light silty clay loam; many medium prominent strong brown (7.5YR 5/8) mottles and few fine faint light yellowish brown (10YR 6/4) mottles; massive; firm; common fine dark oxides; slightly acid.

The solum ranges from 40 to 60 inches in thickness. The A horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2) heavy silt loam or light

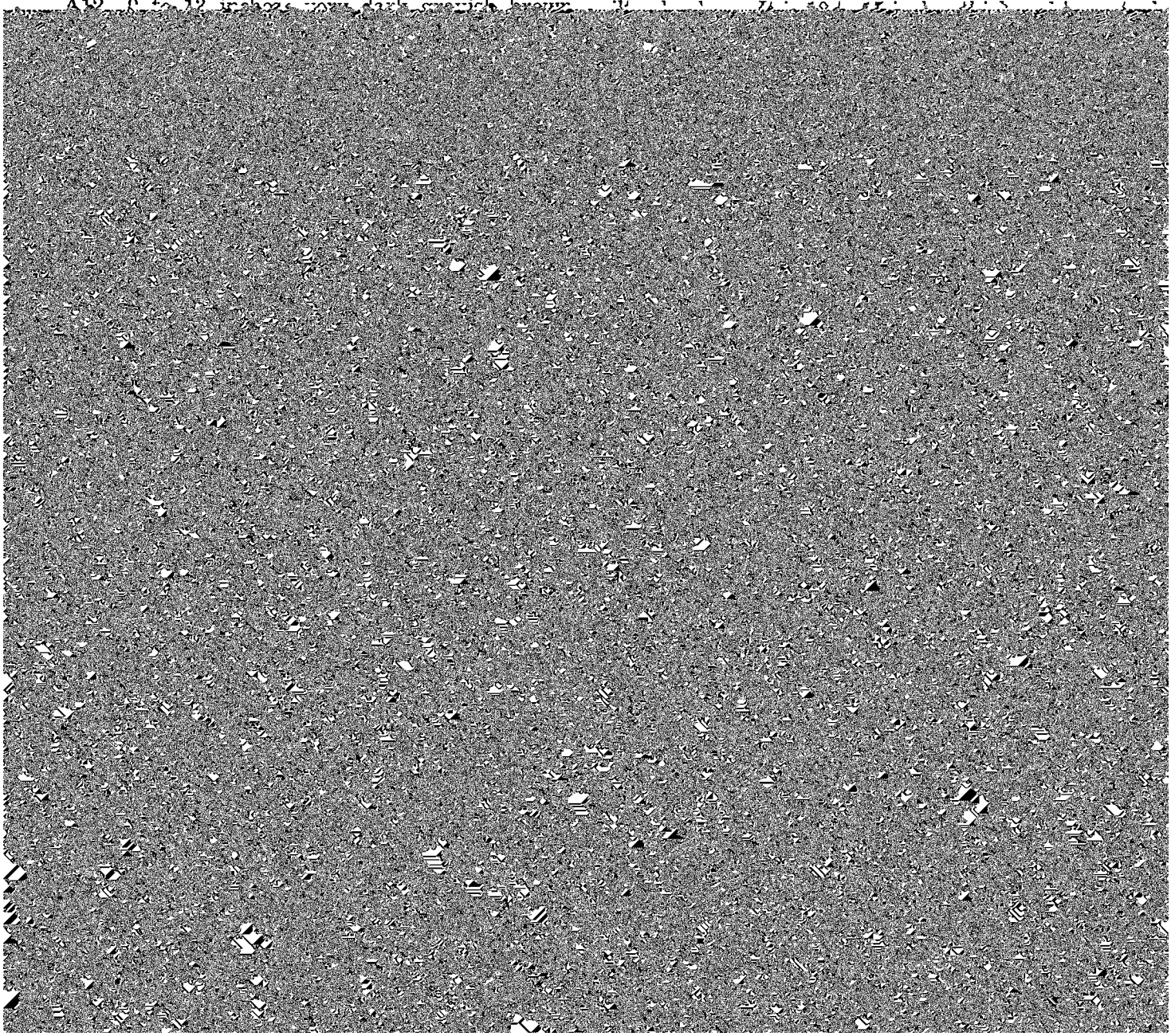
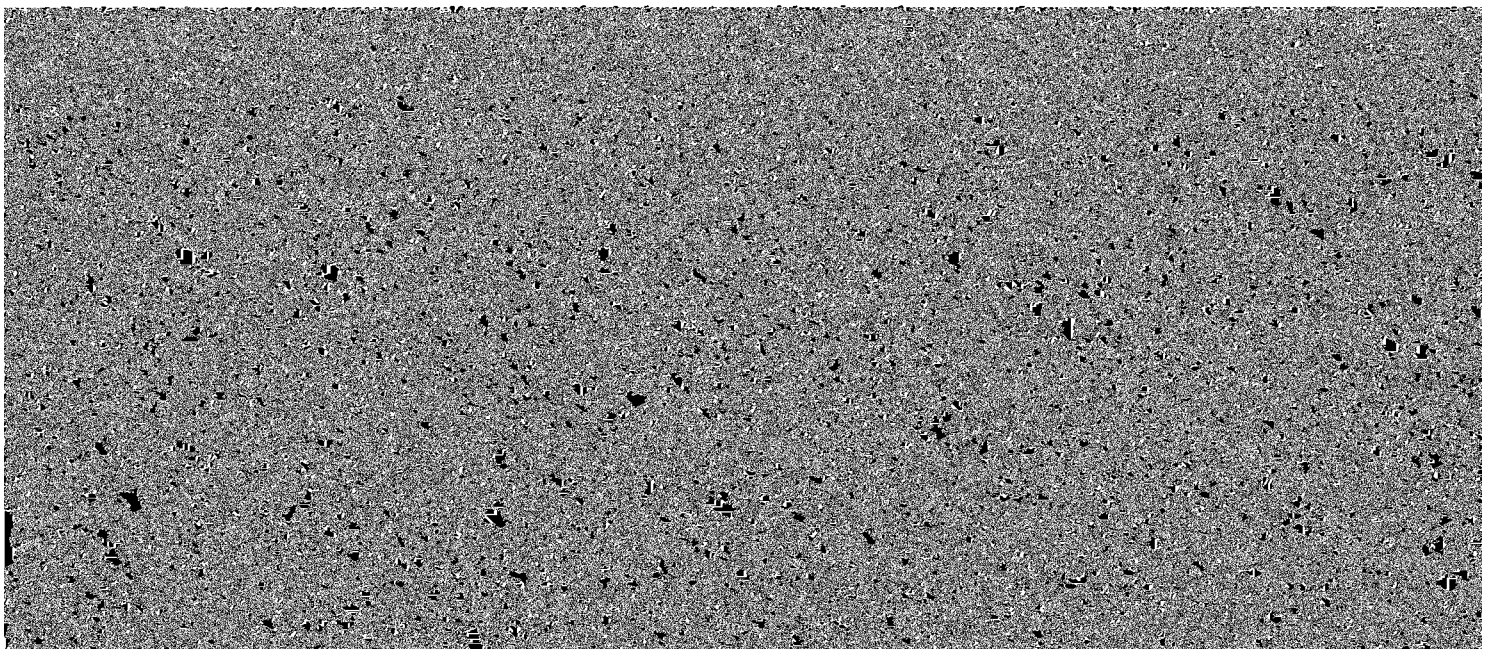
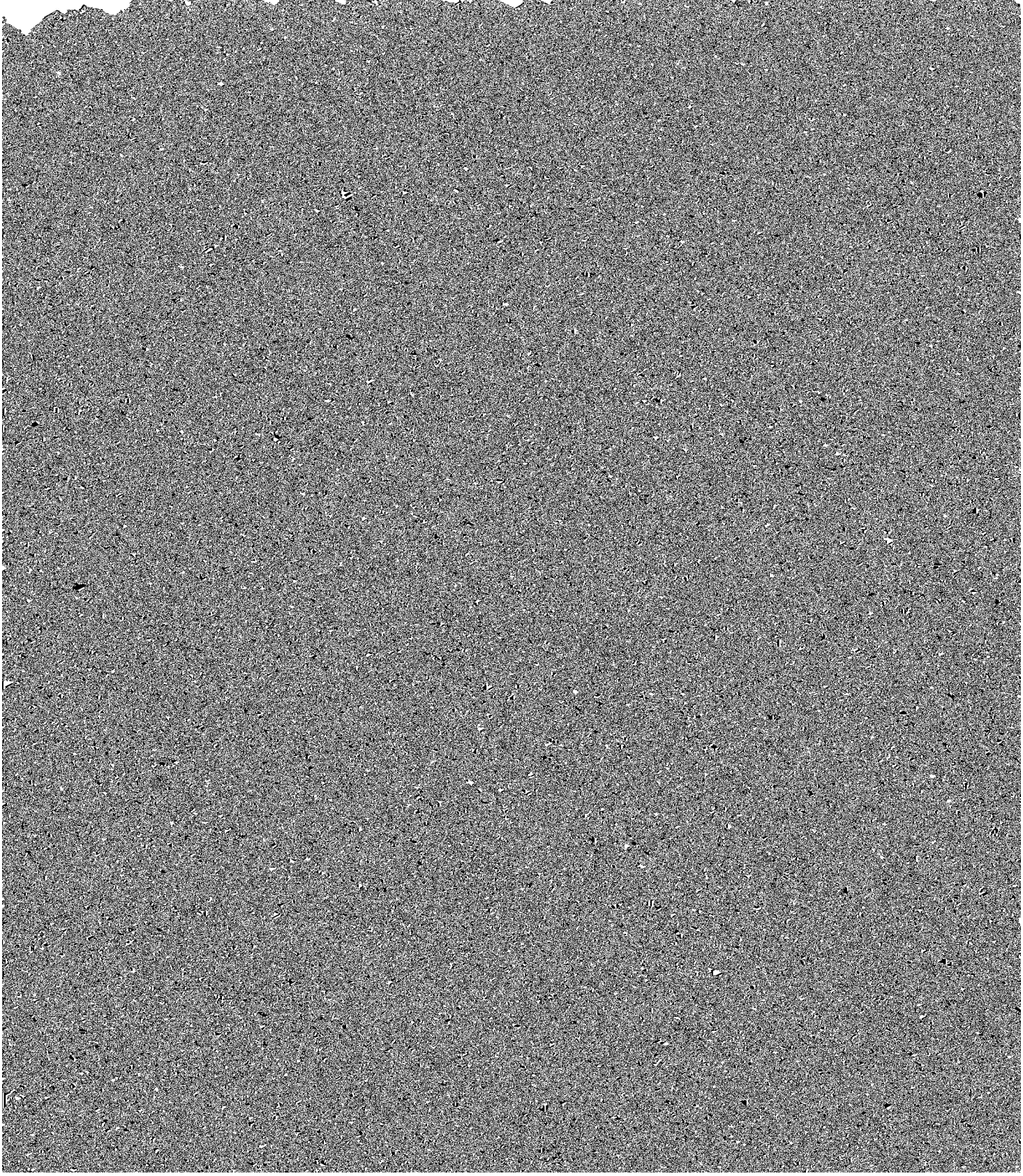


Figure 15.—An area of Gullied land-Ely-Colo complex, 2 to 5 percent slopes. The gully occupies a large part of the mapped area. Landforming for cultivationis not economically feasible.



A22—16 to 21 inches; dark gray (10YR 4/1) silt loam; few black (10YR 2/1) faces

Included with this soil in mapping are small areas of soils that have a thinner surface layer and a grayer



mon fine distinct yellowish brown (10YR 5/8) mottles; massive; friable; few fine dark oxides; slightly acid.

The solum ranges from 40 to 60 inches in thickness.

The A horizon is black (10YR 2/1) to very dark brown (10YR 2/2) in the upper part to very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3) in the lower part. It is heavy silt loam or light silty clay loam. The A horizon is 20 to 36 inches thick and is medium acid to neutral.

The B horizon is dark brown (10YR 3/3) to yellowish brown (10YR 5/4). It is 20 to 34 inches thick and is medium acid or slightly acid.

The C horizon is heavy silt loam or light silty clay loam. It is medium acid or slightly acid.

Judson soils formed in parent material similar to that of Ely soils. They have better natural drainage and a more yellow subsoil than Ely soils.

8B—Judson silty clay loam, 2 to 6 percent slopes. This gently sloping soil is on foot slopes. Areas are small in size and irregular in shape.

Included with this soil in mapping are small areas of Ely soils.

This Judson soil is well suited to intensive row crops. It is susceptible to erosion. In some places, runoff from adjacent soils is a concern. The organic matter content is high. Capability unit IIe-3; environmental planting group 1.

Kennebec series

The Kennebec series consists of deep, nearly level [illegible]

fine subangular blocky structure; friable; slightly acid; diffuse smooth boundary.

C—41 to 60 inches; very dark grayish brown (10YR 3/2) silt loam; massive; friable; slightly acid.

The solum is typically more than 36 inches thick, and it ranges from 36 to 60 inches in thickness.

The A horizon is black (10YR 2/1) or very dark gray (10YR 3/1) and is 30 to 45 inches thick.

The AC horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is 6 to 15 inches thick and is medium acid or slightly acid.

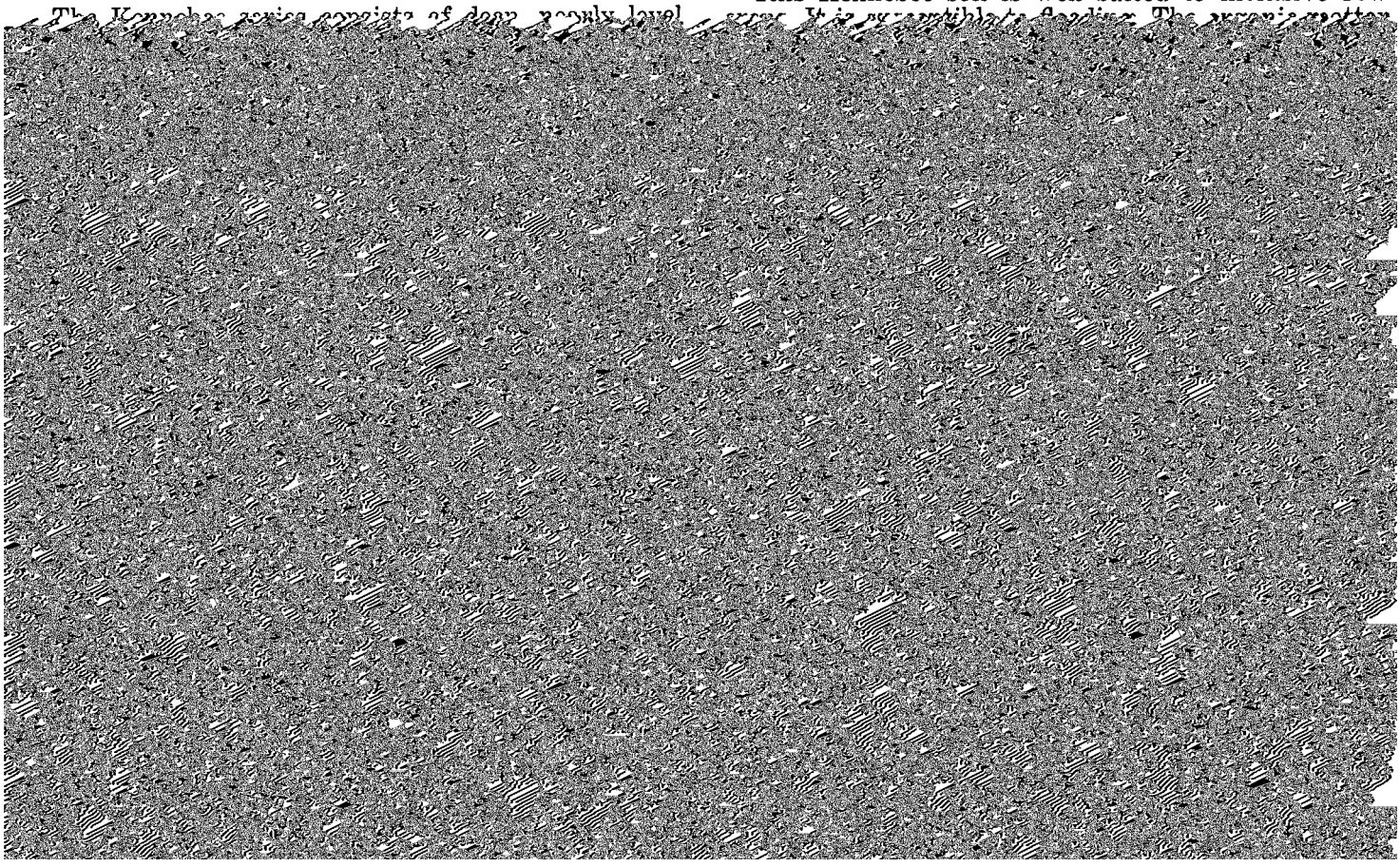
The C horizon is very dark grayish brown (10YR 3/2) or dark grayish brown (10YR 4/2). It is silt loam to medium silty clay loam. The C horizon is slightly acid or neutral.

Kennebec soils are associated on the landscape with Colo, Nodaway, and Zook soils. They also formed in parent material similar to that of those soils. They contain less clay than Colo and Zook soils. They lack stratification and have a darker surface layer than Nodaway soils.

212—Kennebec silt loam, 0 to 2 percent slopes. This nearly level soil is on first bottoms near the stream channel. Areas are irregular in shape and range from 5 to 100 acres in size.

Included with this soil in mapping are sand spots and wet spots, which are indicated on the soil map by special symbols.

This Kennebec soil is well suited to intensive row [illegible]



structure; very friable; thin continuous gray silt coatings; neutral; clear smooth boundary.

A12—2 to 4 inches; very dark gray (10YR 3/1) loam, grayish brown (10YR 5/2) dry; weak thin platy structure; very friable; thin continuous and thick discontinuous gray silt coatings; very strongly acid; clear smooth boundary.

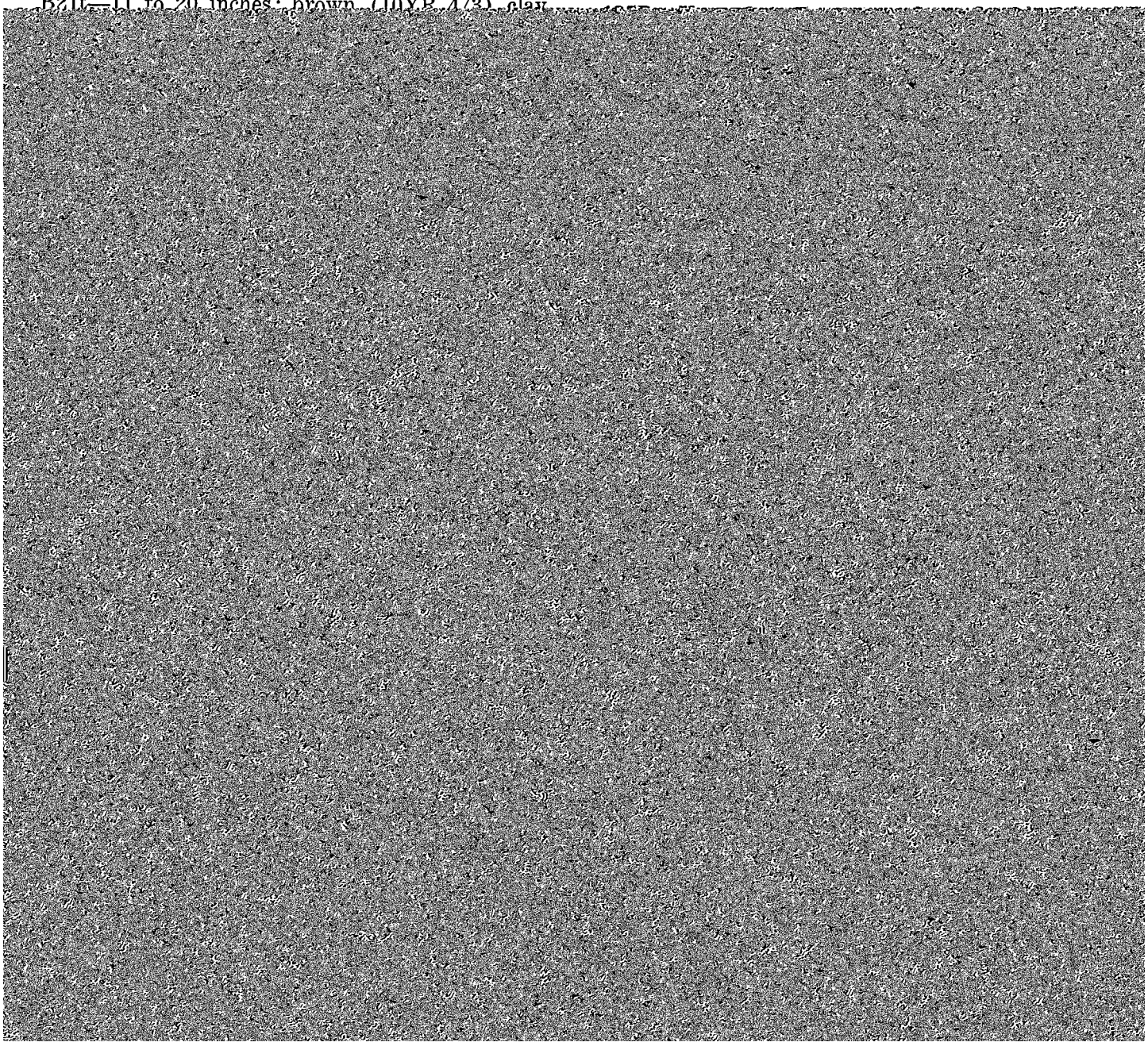
A2—4 to 11 inches; dark grayish brown (10YR 4/2) loam; very dark grayish brown (10YR 3/2) faces of peds, grayish brown (10YR 5/2) dry; weak thin platy structure; very friable; thick continuous gray silt coatings; very strongly acid; gradual smooth boundary.

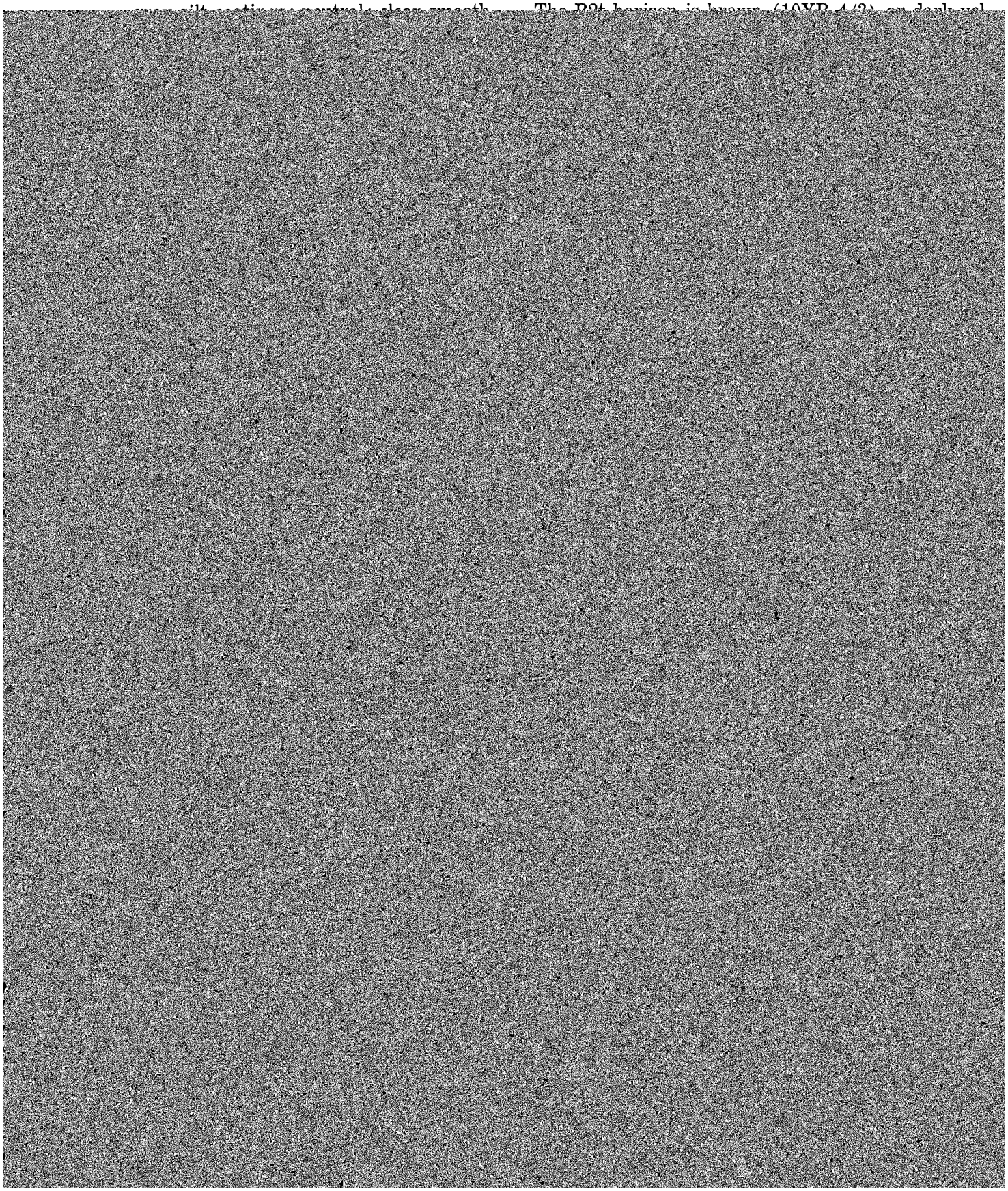
B21t—11 to 20 inches; brown (10YR 4/3) clay

The A1 horizon is black (10YR 2/1), very dark gray (10YR 3/1), very dark grayish brown (10YR 3/2), or very dark brown (10YR 2/2) loam or silt loam. It is 1 to 5 inches thick and is neutral to very strongly acid.

The B2t horizon commonly has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. If the matrix has hue of 7.5YR, it has mottles that have hue of 5YR or 2.5YR. The B2t horizon is heavy clay loam or clay.

Keswick soils are associated on the landscape with Clinton and Weller soils. They formed in parent material similar to that of Lindley soils. They have redder hue and more sand than Clinton and Weller soils, which are upslope and formed in loess. They have more clay and a redder hue than Lindley soils, which are downslope.





severely eroded soils, seepy wet spots, sand spots, spots of red clay, spots of gray clay, glacial till outcrop, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Ladoga soil is moderately well suited to row crops. Some areas are in pasture. The soil is susceptible to erosion. Most of the original surface layer has been removed by erosion and only a thin layer remains over the heavy silty clay loam subsoil. As a result, a good seedbed is difficult to prepare and plant growth is retarded. The organic matter content is moderate to low. Capability unit IIIe–1; environmental planting group 1.

T76B—Ladoga silt loam, benches, 2 to 5 percent slopes. This gently sloping soil is on benches adjacent to the major streams. Areas are small in size and irregular in shape. Slopes are typically short.

Included with this soil in mapping are wet spots, which are indicated on the soil map by a special symbol. Also included are areas of nearly level Ladoga soils and gently sloping Grundy and Clinton soils.

This Ladoga soil is well suited to row crops. It is susceptible to erosion. In most areas, the loess is underlain by stratified alluvium instead of glacial till. Commonly, the alluvium is sand and is rapidly permeable, which creates a hazard for farm ponds and other uses that require water retention. The organic matter content is moderate. Capability unit IIe–1; environmental planting group 1.

T76C2—Ladoga silt loam, benches, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on benches adjacent to major streams. Areas are long and narrow or irregular in shape. Slopes are typically short. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are spots of red clay and seepy wet spots, both of which are indicated on the soil map by special symbols. Also included are areas of Arispe and Clinton soils on benches.

This Ladoga soil is moderately well suited to row crops. Some areas are in pasture. The soil is susceptible to erosion. In most areas, the loess is underlain by stratified alluvium instead of glacial till. Commonly, the alluvium is rapidly permeable, which creates a hazard for farm ponds and other uses that require water retention. The organic matter content is moderate to low. Capability unit IIIe–1; environmental planting group 1.

427C2—Ladoga-Chelsea complex, 5 to 9 percent slopes, moderately eroded. These moderately sloping soils are on the ends of long, convex ridges and the upper part of side slopes on uplands southeast of and within 1 to 2 miles of the major streams. This complex is about 60 percent Ladoga soils and 40 percent Chelsea soils. Areas are irregular in shape and range from a few acres to 30 acres in size. These soils have profiles similar to the ones described as representative of their respective series, but the surface layer is thinner. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with these soils in mapping are spots of severely eroded soils and spots of red clay, both of which are indicated on the soil map by special symbols. Also included are areas that are moderately steep.

These soils are moderately well suited to row crops, but many areas are in pasture, hay, or woodland. The soils are susceptible to erosion, and the Chelsea soils are susceptible to drought. The organic matter content is low to moderate. Capability unit IIIe–1; environmental planting group 1.

427D2—Ladoga-Chelsea complex, 9 to 14 percent slopes, moderately eroded. These strongly sloping soils are at the ends of long, convex ridges and the upper part of side slopes on uplands southeast of and within 1 to 2 miles of the major streams. This complex is about 60 percent Ladoga soils and 40 percent Chelsea soils. Areas are irregular in shape and range from a few acres to 30 acres in size. These soils have profiles similar to the ones described as representative of their respective series, but the surface layer is thinner. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with these soils in mapping are spots of severely eroded soils and spots of red clay, both of which are indicated on the soil map by special symbols. Also included are areas that are moderately steep.

These soils are poorly suited to row crops; they are better suited to small grain, pasture, hay, or woodland than to most other uses. They are susceptible to erosion, and the Chelsea soils are susceptible to drought. The organic matter content is low to moderate. Capability unit IVe–1; environmental planting group 1.

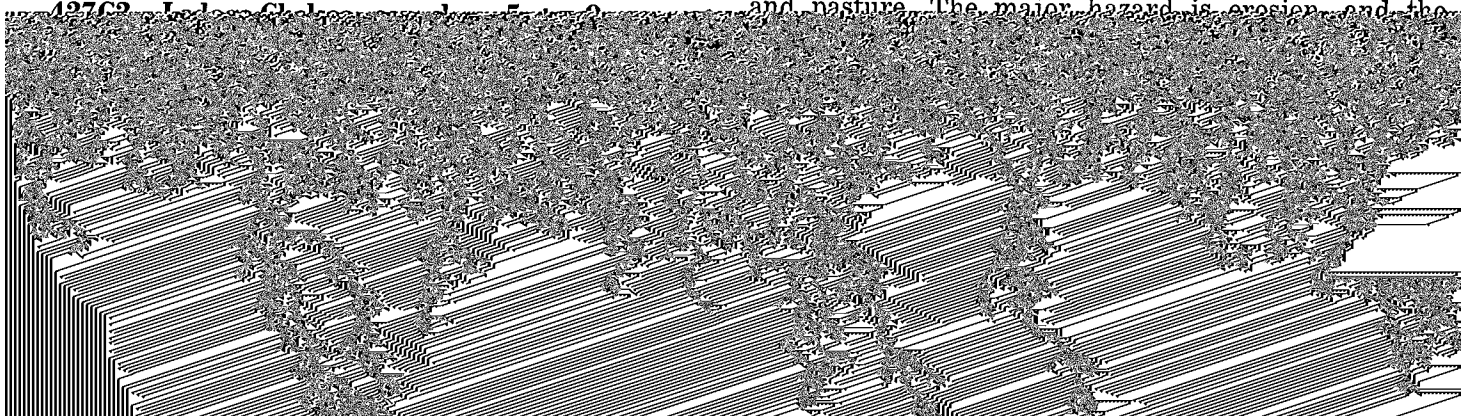
Lamoni series

The Lamoni series consists of deep, strongly sloping, somewhat poorly drained soils. These soils are in coves at the upper reaches of drainageways and in bands on the shoulders of slopes. They formed in gray, highly weathered glacial till under a native vegetation of prairie grasses. The upper 1 to 2 feet of the profile formed in loess or other less clayey material.

In a representative profile the surface layer is black silty clay loam about 11 inches thick. The subsoil extends to a depth of 50 inches; it is very dark gray, dark gray, and dark grayish brown clay loam in the upper part and yellowish brown and olive gray clay loam in the lower part. The substratum is yellowish brown and strong brown clay loam.

Permeability is slow to very slow, and available water capacity is high. The subsoil is low in available phosphorus and low to medium in available potassium.

Lamoni soils are used mainly for row crops, hay, and pasture. The major hazard is erosion, and the



subangular blocky structure; friable; medium acid; gradual smooth boundary.

IIB21t—11 to 18 inches; very dark gray (10YR 3/1), dark gray (10YR 4/1), and dark grayish brown (10YR 4/2) medium clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; moderate very fine and fine subangular blocky structure; friable; thin continuous clay films; medium acid; gradual smooth boundary.

IIB22t—18 to 26 inches; dark grayish brown (10YR 4/2) heavy clay loam; dark gray (10YR 4/1) and dark grayish brown (10YR 4/2) faces of peds; many fine distinct yellowish brown (10YR 5/4 and 5/6) mottles; moderate fine subangular blocky structure; firm; thin continuous clay films; few fine dark oxides; slightly acid; gradual smooth boundary.

IIB23t—26 to 38 inches; yellowish brown (10YR 5/6) heavy clay loam; few fine faint dark grayish brown (10YR 4/2) mottles and common fine distinct gray (10YR 5/1) and grayish brown (10YR 5/2) mottles; weak coarse prismatic structure parting to moderate fine subangular blocky; firm; thin discontinuous clay films; few fine dark oxides; neutral; gradual smooth boundary.

IIB3t—38 to 50 inches; yellowish brown (10YR 5/6) and olive gray (5Y 5/2) medium clay loam; weak coarse prismatic structure; firm; few fine dark oxides; neutral; gradual smooth boundary.

IIC—50 to 60 inches; yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) medium clay loam; common fine distinct grayish brown (2.5Y 5/2) mottles; massive; firm; few fine dark oxides; neutral.

The solum ranges from 48 to 64 inches in thickness. The A horizon is black (10YR 2/1) to very dark

in coves at the upper reaches of drainageways and in bands on the shoulders of slopes. Areas are long or irregular in shape. They range from a few acres to 60 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed material from the subsoil into the surface layer.

Included with this soil in mapping are spots of severely eroded soils, sand spots, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Lamoni soil is poorly suited to row crops; it is better suited to small grain, hay, or pasture than to most other uses. It is susceptible to erosion and wetness. The organic matter content is moderate. Capability unit IVe–2; environmental planting group 1.

822D3—Lamoni soils, 9 to 14 percent slopes, severely eroded. These strongly sloping soils are in coves at the upper reaches of drainageways and in bands at the shoulders of slopes. Areas are long or irregular in shape. They range from a few acres to 40 acres in size. These soils have profiles similar to the one described as representative of the series, but all or most of the original surface layer has been removed by erosion. The surface layer is silty clay loam, silty clay, or clay loam.

Included with these soils in mapping are spots of gray clay, which are indicated on the soil map by a special symbol.

These Lamoni soils are generally unsuited to cultivated crops; they are better suited to pasture or hay than to most other uses. They are susceptible to erosion and wetness. The surface layer is more clayey and contains less organic matter than less eroded Lamoni soils. Thus, a good seedbed is difficult to prepare and plant growth is retarded. Capability unit VIe–1; environmental planting group 1.

Lindley series

The Lindley series consists of deep, strongly sloping to very steep, well drained to moderately well drained soils. These soils are on upland side slopes. They formed in glacial till under a native vegetation

structure; very friable; neutral; clear smooth boundary.

A21—2 to 5 inches; dark grayish brown (10YR 4/2) loam; very dark grayish brown (10YR 3/2) faces of peds, grayish brown (10YR 5/2) and brown (10YR 5/3) dry; weak thin platy structure; very friable; thin continuous gray silt coatings; slightly acid; clear smooth boundary.

A22—5 to 8 inches; brown (10YR 5/3) light clay loam; dark grayish brown (10YR 4/2) faces of peds, grayish brown (10YR 5/2), and brown (10YR 5/3) dry; weak thin platy structure parting to weak fine granular; very friable; thin continuous gray silt coatings; slightly acid; clear smooth boundary.

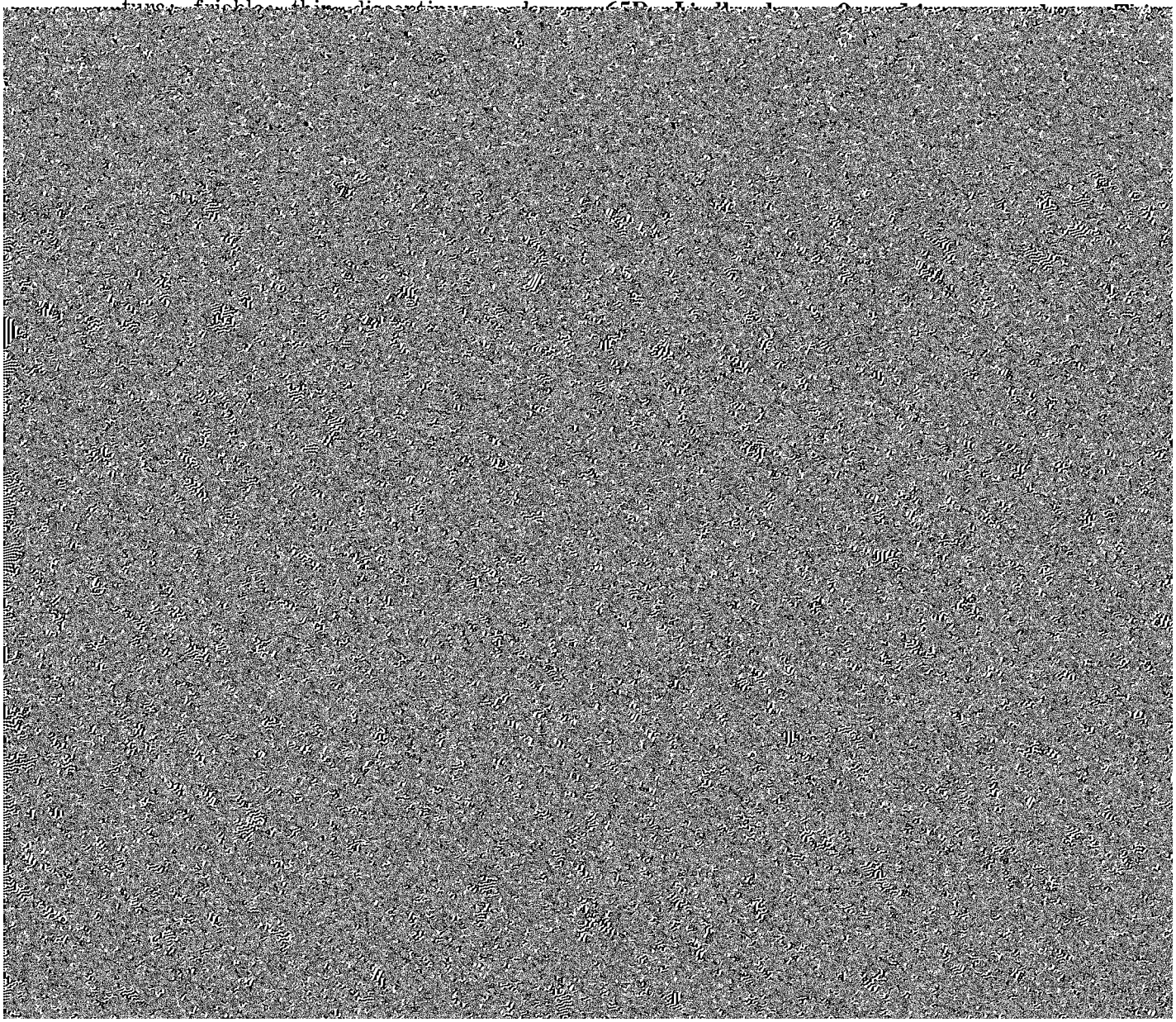
B21t—8 to 11 inches; brown (10YR 4/3) clay loam; weak fine subangular blocky structure; friable; thin discontinuous

clay loam; common fine distinct gray (10YR 6/1) mottles; massive; firm; common fine dark oxides; strong effervescence; mildly alkaline.

The solum ranges from 30 to 60 inches in thickness. The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and is silt loam to light clay loam. It is 1 to 4 inches thick and is neutral to strongly acid.

The B2t horizon is brown (10YR 4/3) to strong brown (7.5YR 5/6) light to heavy clay loam. It is 12 to 32 inches thick and is strongly acid to extremely acid in the most acid part. The B3 horizon is yellowish brown (10YR 5/4 or 5/6). It is 8 to 22 inches thick and is neutral to medium acid.

Lindley soils formed in parent material similar to that of Gara soils. They have a thinner surface layer than Gara soils.



very steep soil is on upland side slopes. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer and the subsoil are thinner.

Included with this soil in mapping are spots of severely eroded soils, spots of red clay, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Lindley soil is not suited to row crops or hay. The use of farm machinery is hazardous or impractical. Most areas are in pasture and woodland. The soil is susceptible to erosion. The organic matter content is very low. Capability unit VIIe–2; environmental planting group 1.

65E3—Lindley soils, 14 to 18 percent slopes, severely eroded. These moderately steep soils are on upland side slopes. Areas are small in size and irregular in shape. These soils have profiles similar to the one described as representative of the series, but the surface layer is loam or clay loam because erosion has removed most of the original surface layer and has exposed the subsoil at the surface.

Included with these soils in mapping are shale outcrop and spots of red clay, both of which are indicated on the soil map by special symbols.

These Lindley soils are not suited to row crops. Most areas are in pasture and woodland. The soils are susceptible to erosion. The surface layer is more clayey and lower in content of organic matter than the surface layer of less eroded Lindley soils. As a result, the survival rate of seedlings, trees, and other plants is often reduced. The organic matter content is very low. Capability unit VIIe–1; environmental planting

A12—7 to 12 inches; very dark brown (10YR 2/2) medium silty clay loam; black (10YR 2/1) faces of peds, dark gray (10YR 4/1) dry; moderate very fine granular structure; friable; strongly acid; clear smooth boundary.

A13—12 to 18 inches; very dark brown (10YR 2/2) medium silty clay loam, dark grayish brown (10YR 4/2) dry; weak very fine and fine subangular blocky structure parting to moderate fine granular; friable; strongly acid; gradual smooth boundary.

B1—18 to 25 inches; very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) medium silty clay loam; few fine faint dark yellowish brown (10YR 4/4) mottles; moderate very fine subangular blocky structure; friable; few very fine dark oxides; strongly acid; gradual smooth boundary.

B21t—25 to 34 inches; dark grayish brown (10YR 4/2) heavy silty clay loam; few fine distinct yellowish brown (10YR 5/6) and brown (7.5YR 5/4) mottles; weak fine prismatic structure parting to moderate fine subangular blocky; firm; thin continuous clay films; common fine dark oxides; strongly acid; gradual smooth boundary.

B22t—34 to 42 inches; grayish brown (2.5Y 5/2) medium silty clay loam; few fine prominent strong brown (7.5YR 5/6) mottles and common fine distinct yellowish

They have a thicker, darker colored surface layer than Sharpsburg soils. They do not have a subsurface layer and have less clay in the subsoil than Sperry soils. They have a thinner surface layer, have fewer mottles, and have a browner subsoil than Winterset soils.

368—Macksburg silty clay loam, 0 to 2 percent slopes. This nearly level soil is on broad upland divides. Areas are long and broad or irregular in shape. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of Winterset and Sperry soils, which are indicated on the soil map by a wet spot symbol.

This Macksburg soil is well suited to intensive row crops. The organic matter content is high. Capability unit I–1; environmental planting group 1.

368B—Macksburg silty clay loam, 2 to 5 percent slopes. This gently sloping soil is mainly on the upper part of side slopes adjacent to upland divides. In the southwest part of the county it is on long, narrow upland ridges. Areas are small in size and irregular

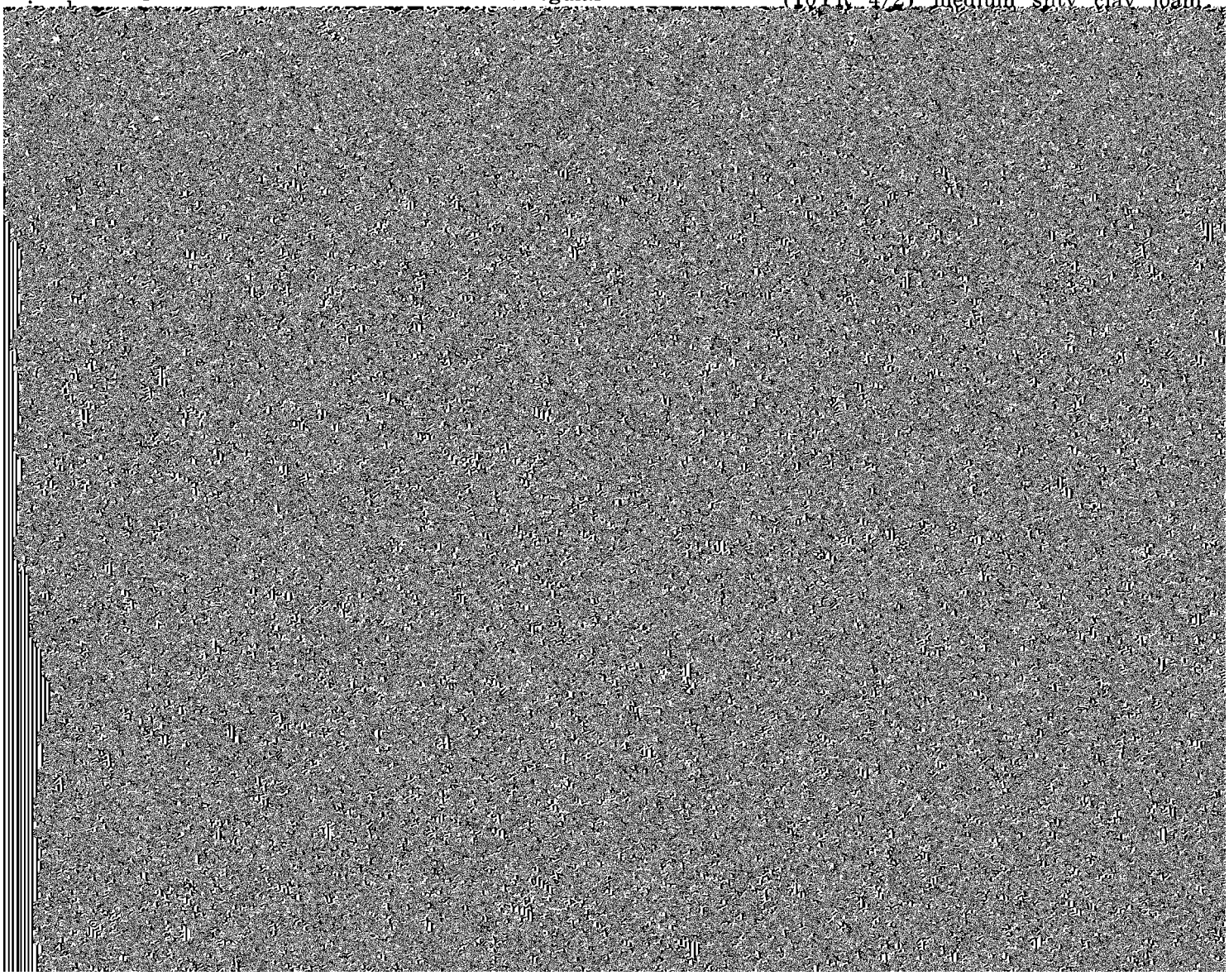
west and 180 feet south of the northeast corner of sec. 1, T. 76 N., R. 23 W.:

Ap—0 to 8 inches; very dark brown (10YR 2/2) light silty clay loam; black (10YR 2/1) faces of peds; weak medium subangular blocky structure parting to moderate fine granular; friable; strongly acid; abrupt smooth boundary.

A12—8 to 17 inches; very dark brown (10YR 2/2) light silty clay loam; black (10YR 2/1) faces of peds; moderate fine and very fine subangular blocky and moderate fine granular structure; friable; strongly acid; gradual smooth boundary.

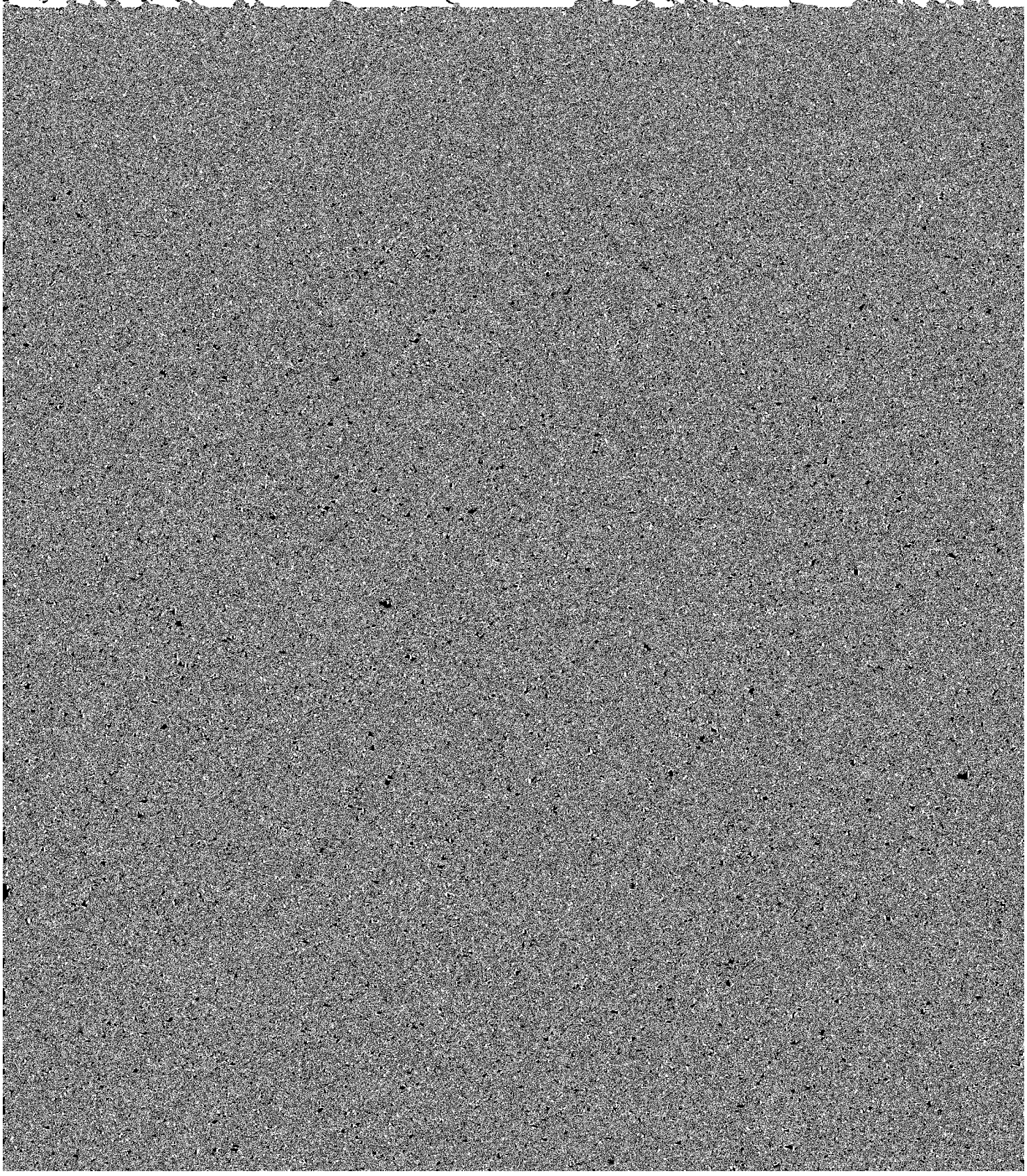
B1—17 to 25 inches; very dark grayish brown (10YR 3/2) medium silty clay loam; moderate fine and very fine subangular blocky structure; friable; strongly acid; gradual smooth boundary.

B21t—25 to 31 inches; dark grayish brown (10YR 4/2) medium silty clay loam;



of this soil is the one described as representative of the series.

ous clay films; strongly acid; gradual smooth boundary.

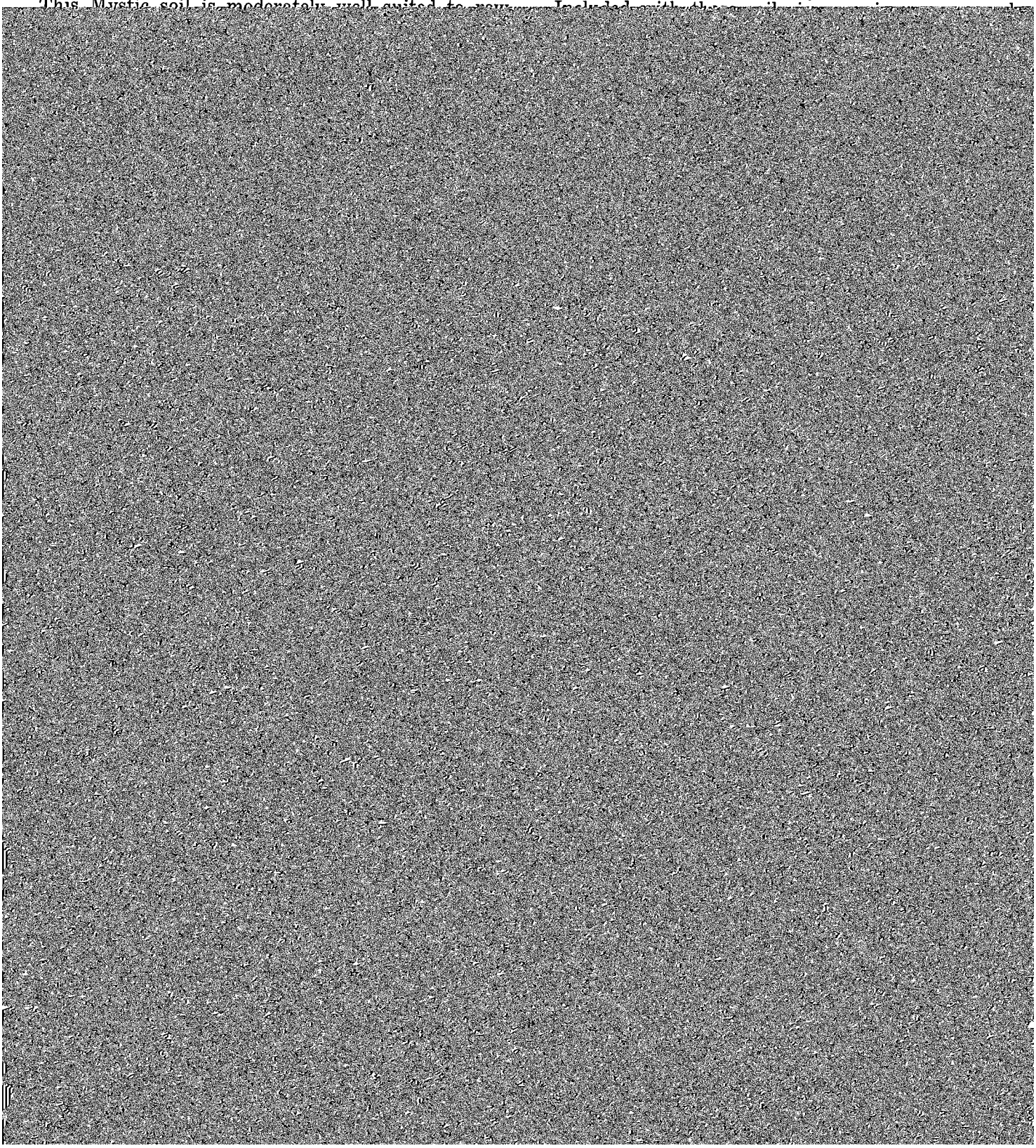


are slightly eroded and small areas of Caleb soils. Also included are spots of severely eroded soils and shale outcrop, both of which are indicated on the soil map by special symbols.

This Mystic soil is moderately well suited to row

respective series, but in most places the Mystic soil does not have a dark grayish brown subsurface layer. In many areas, plowing has mixed the material from the subsoil with the surface layer.

Included with the



dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4 and 5/6) mottles; weak medium prismatic structure parting to moderate fine and medium subangular blocky; firm; neutral; gradual smooth boundary.

B3t—43 to 50 inches; grayish brown (2.5Y 5/2) silty clay loam; common medium distinct brown (7.5YR 4/4) mottles and few fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak fine and medium subangular blocky; firm; neutral.

The solum is typically more than 40 inches thick, and it ranges from 36 to 60 inches in thickness.

The A horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2) light silty clay loam or silt loam. It is 18 to 30 inches thick and is medium acid to neutral.

The B2t horizon is dark grayish brown (10YR to 2.5Y 4/2) and grayish brown (10YR to 2.5Y 5/2) to brown (10YR 5/3 and 4/3). It is 10 to 21 inches thick and is medium acid to neutral.

Nira series

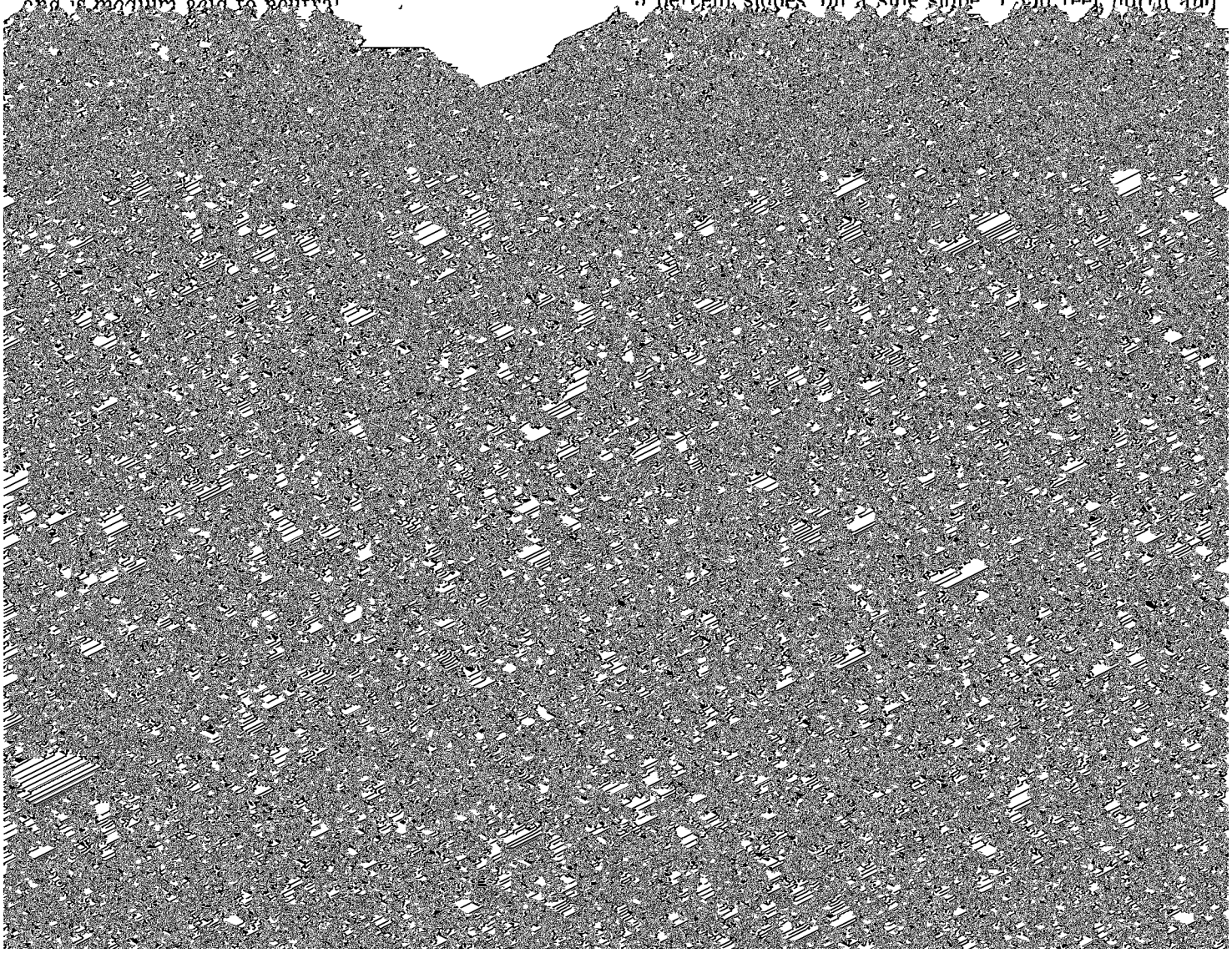
The Nira series consists of deep, gently sloping and moderately sloping, moderately well drained soils. These soils are on short, convex upper parts of side slopes and on slopes bordering coves of drainageways on uplands and benches adjacent to the major streams. They formed in loess under a native vegetation of tall prairie grasses.

In a representative profile the surface layer is very dark gray silty clay loam about 14 inches thick. The silty clay loam subsoil extends to a depth of 44 inches; it is brown in the upper part, olive gray in the middle part, and light olive gray in the lower part. The silty clay loam substratum is similar in color to the lower part of the subsoil.

Permeability is moderately slow, and available water capacity is high. The subsoil is very low in available phosphorus and potassium.

Nira soils are used mainly for row crops. The major hazard is erosion.

Representative profile of Nira silty clay loam, 2 to 5 percent slopes, on a side slope 1,350 feet north and

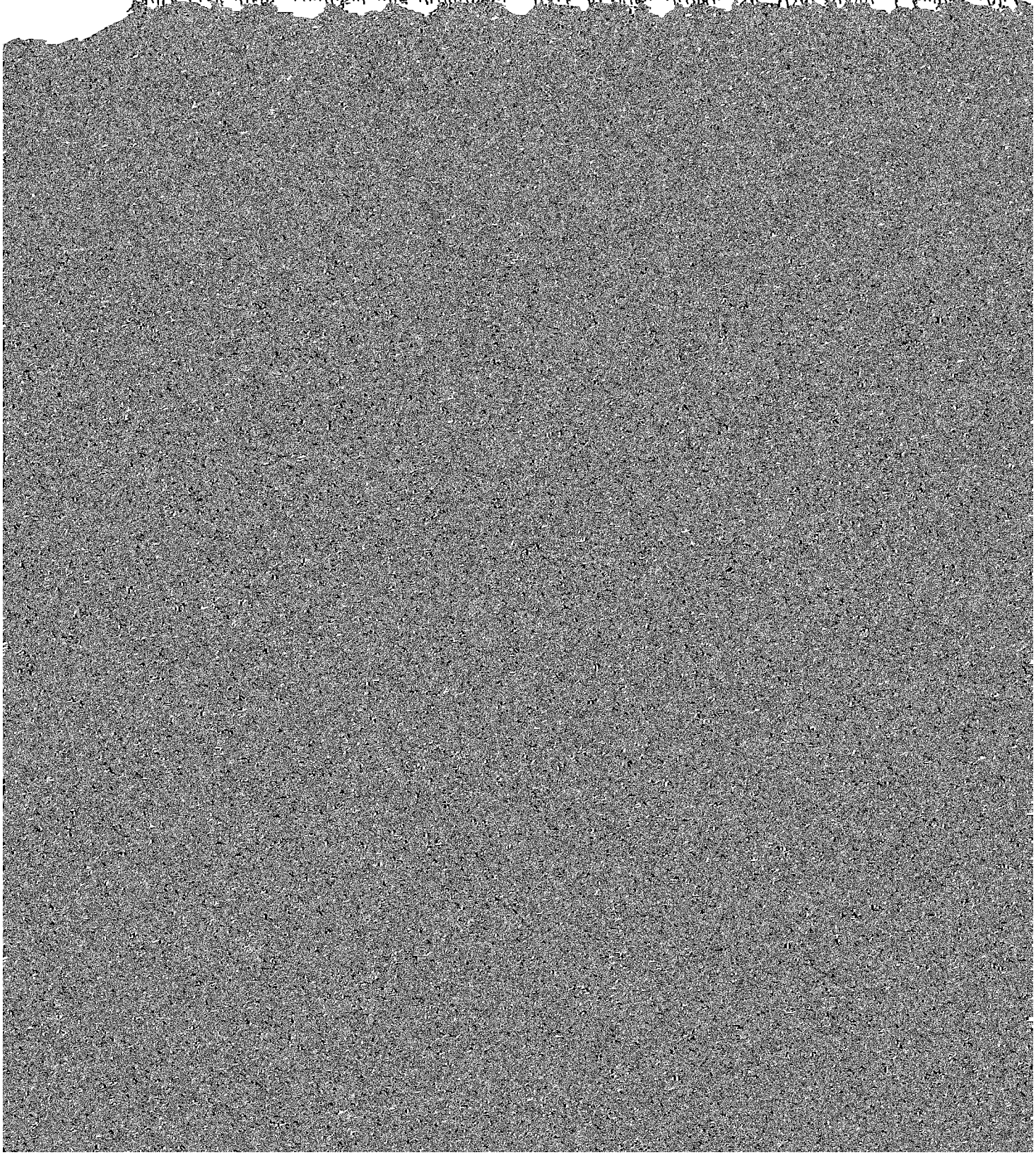


able; dark organic stains; common very fine dark oxides; neutral; gradual smooth boundary.

Cg—44 to 60 inches; light olive gray (5Y 6/2) silty clay loam; common fine prominent

bottoms near the original stream channels. They formed in silty alluvium under a native vegetation of trees.

In a representative profile the surface layer is very dark grayish brown silt loam about 5 inches thick



are not channeled. They are suited to cultivation but have not been cleared of trees.

This Nodaway soil is generally unsuited to row crops; it is better suited to trees or pasture than to most other uses. The soil can be used for row crops if trees are cleared, old channels are filled, and drainage and protection from flooding are adequate. The soil is susceptible to flooding. The organic matter content is low to moderate. Capability unit Vw–1; environmental planting group 1.

Olmitz series

The Olmitz series consists of deep, gently sloping and moderately sloping, well drained to moderately well drained soils. These soils are on alluvial fans and foot slopes. They formed in alluvium from adjacent slopes under a native vegetation of prairie grasses.

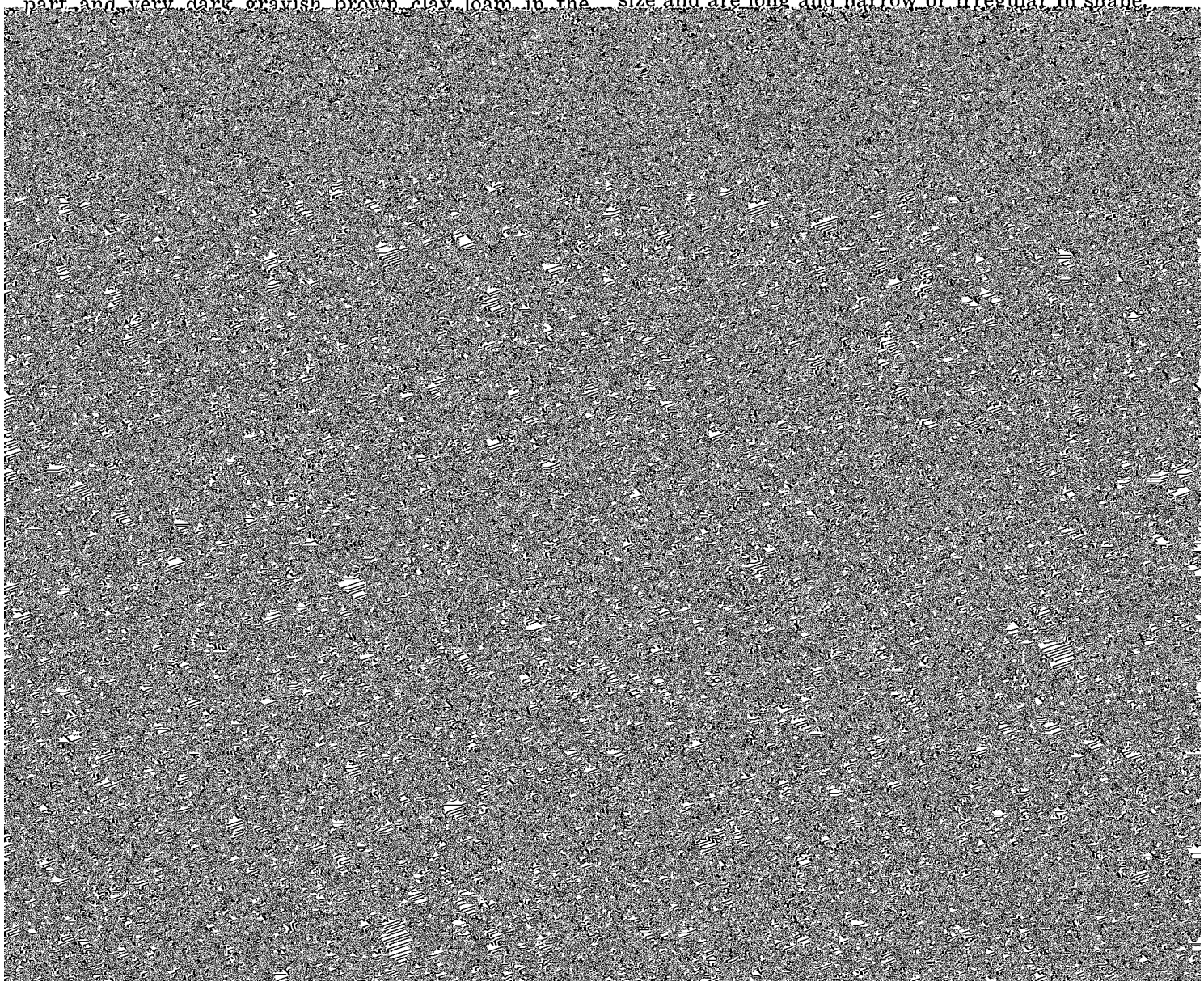
In a representative profile the surface layer is about 29 inches thick; it is very dark brown loam in the upper part and very dark grayish brown clay loam in the lower part. The solum is typically more than 40 inches thick.

The A11 horizon is black (10YR 2/1) or very dark brown (10YR 2/2) loam or light clay loam. It is 5 to 15 inches thick and is slightly acid to strongly acid.

The B1 horizon is very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3) light or medium clay loam. It is 6 to 12 inches thick and is slightly acid or medium acid. The B2 horizon is dark brown (10YR 3/3) or brown (10YR 4/3) light or medium clay loam. It is slightly acid or medium acid.

Olmitz soils are associated on the landscape with Gara and Lindley soils, and they formed in parent material similar to that of Arbor soils. They are deeper to firm glacial till than Arbor soils, which have firm glacial till at a depth of less than 40 inches. They have a thicker surface layer than Gara and Lindley soils, which formed upslope in glacial till.

273B—Olmitz loam, 2 to 5 percent slopes. This gently sloping soil is on foot slopes. Areas are small in size and are long and narrow or irregular in shape.



Pershing soils are used mainly for row crops, hay, and pasture. Some areas are in woodland. The major hazard is erosion.

Representative profile of Pershing silt loam, 2 to 5 percent slopes, on a broad ridge in an improved pasture, 1,965 feet west and 360 feet south of the northeast corner of sec. 22, T. 74 N., R. 22 W.:

Ap—0 to 7 inches; very dark gray (10YR 3/1) silt loam, some mixing of dark grayish brown (10YR 4/2), grayish brown (10YR 5/2) dry; weak very thin platy structure; friable; thick discontinuous gray silt coatings; neutral; abrupt smooth boundary.

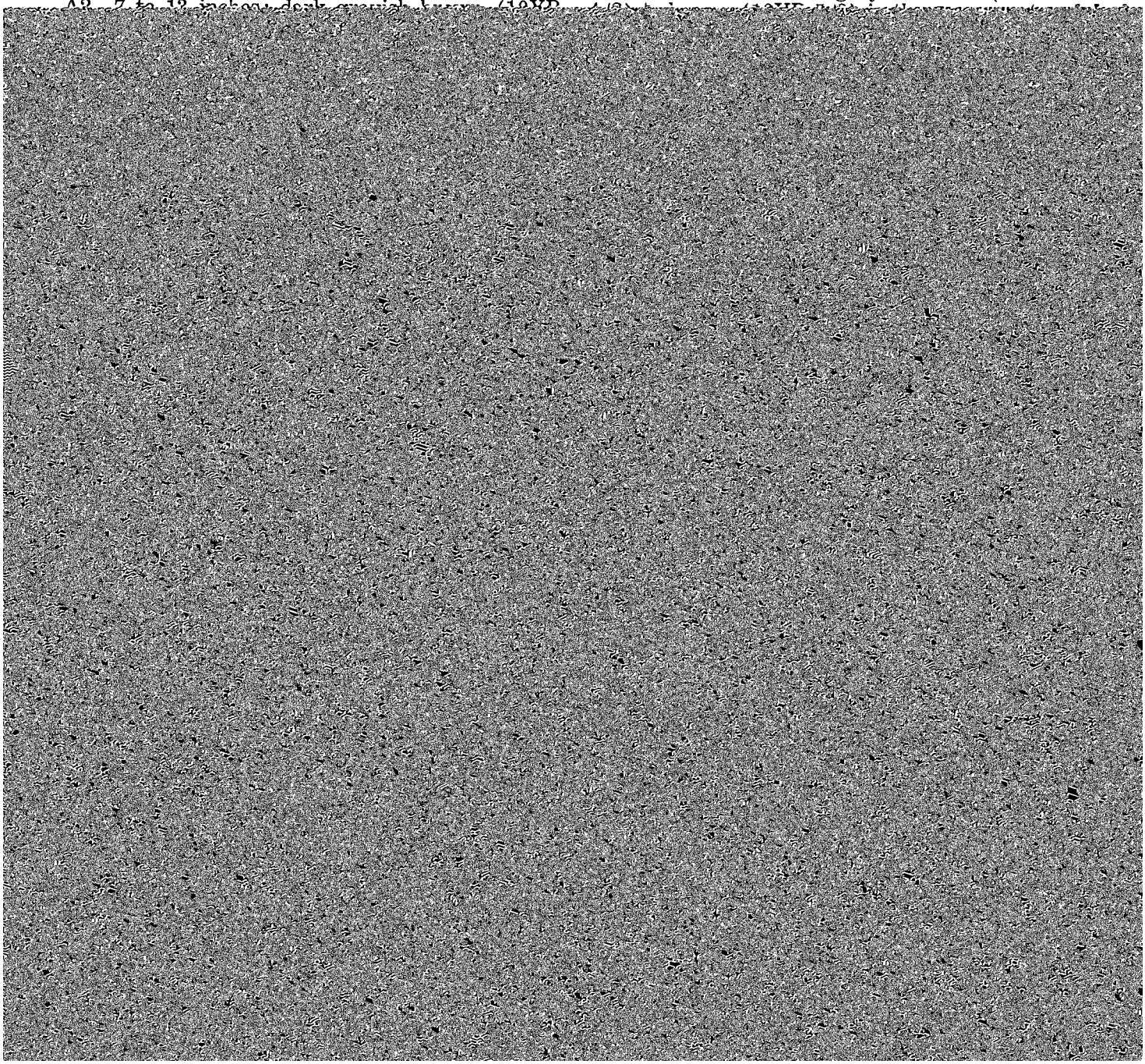
A2—7 to 13 inches; dark [illegible] (10YR

clay loam; black (10YR 2/1) stains on vertical faces of prisms; many fine distinct yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure; firm; thin continuous and thick discontinuous clay films on vertical faces of prisms; thin discontinuous gray silt coatings; common fine dark oxides; slightly acid.

The solum ranges from 50 to 80 inches in thickness.

The Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). It is 6 to 10 inches thick and is neutral to medium acid.

The B horizon is dark grayish brown (10YR to 2.5Y



They range from a few acres to 10 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. In many areas, plowing has mixed the surface and subsurface layers and, in places, material from the subsoil into the plow layer.

Included with this soil in mapping are spots of severely eroded soils, spots of red clay, glacial till outcrop, and shale outcrop, all of which are indicated on the soil map by special symbols.

This Pershing soil is poorly suited to row crops; it is better suited to small grain, pasture, hay, or woodland than to most other uses. It is susceptible to erosion. The organic matter content is moderate to low. Capability unit IVe–1; environmental planting group 1.

Sharpsburg series

The Sharpsburg series consists of deep, nearly level to strongly sloping, moderately well drained soils. These soils are on convex ridgetops, on the upper part of side slopes adjacent to upland ridges, and on loess covered stream benches. They formed in loess under a native vegetation of tall prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish brown silty clay loam about 16 inches thick. The silty clay loam subsoil extends to a depth of 50 inches; it is brown in the upper part and dark yellowish brown and yellowish brown in the lower part.

Permeability is moderately slow, and available water capacity is high. The subsoil is low in available phosphorus and medium in available potassium.

Sharpsburg soils are used mainly for row crops, hay, and pasture. The major hazard is erosion.

Representative profile of Sharpsburg silty clay loam, 5 to 9 percent slopes, in a cultivated field, 1,675 feet north and 140 feet east of the southwest corner of sec. 23, T. 76 N., R. 24 W.:

moderate fine subangular blocky; firm; thin discontinuous clay films; few fine dark oxides; medium acid; gradual smooth boundary.

B23t—32 to 41 inches; dark yellowish brown (10YR 4/4) light silty clay loam; common fine distinct grayish brown (2.5Y 5/2) mottles and few fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate fine and medium subangular blocky; firm; thin discontinuous clay films; common fine dark oxides; medium acid; gradual smooth boundary.

B3t—41 to 50 inches; yellowish brown (10YR 5/4) light silty clay loam; common fine and medium distinct grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) mottles; weak medium prismatic structure; friable; thin discontinuous clay films on vertical faces of peds; few fine dark oxides; medium acid.

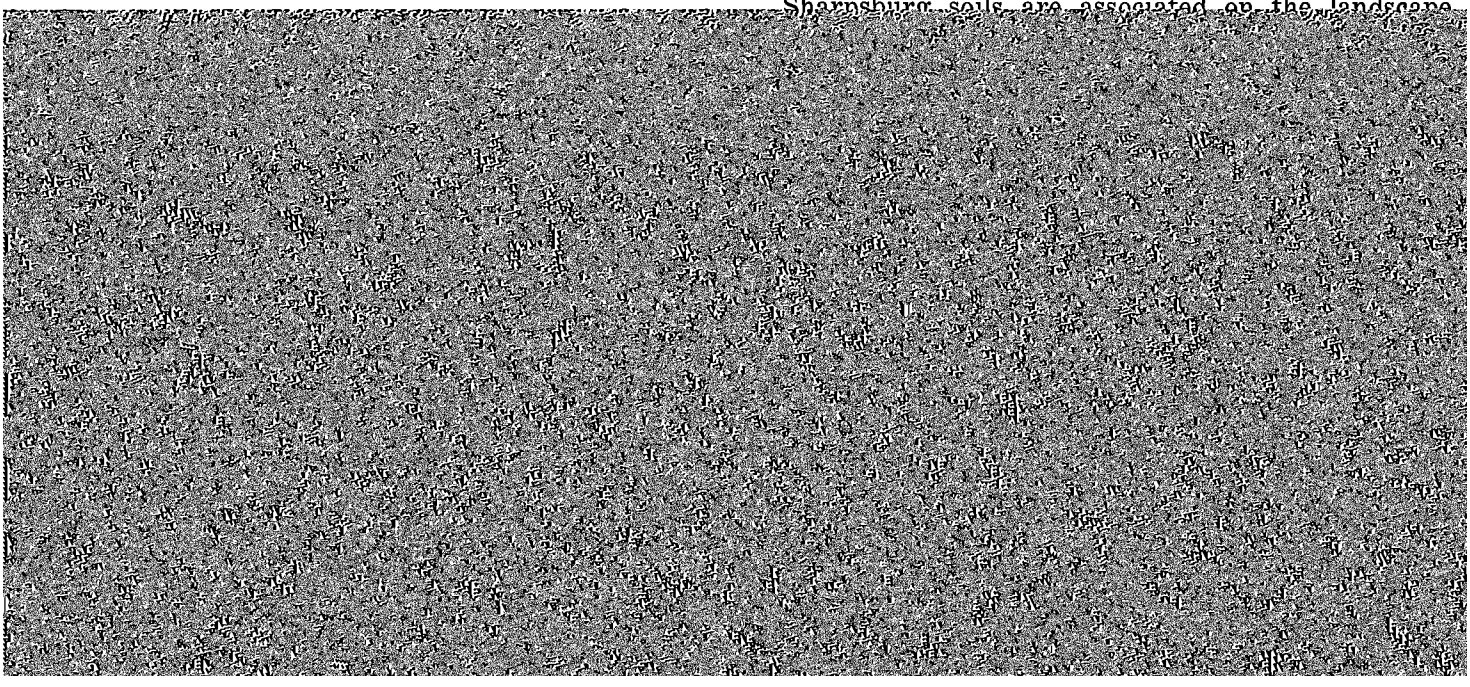
The solum is typically about 48 inches thick, and it ranges from 42 to 72 inches in thickness.

The A horizon is black (10YR 2/1) to dark brown (10YR 3/3) light or medium silty clay loam. It is 10 to 20 inches thick and is slightly acid to strongly acid.

The B2t horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4). The finest textured part of this horizon is heavy silty clay loam or light silty clay. The B2t horizon is 22 to 37 inches thick and is slightly acid to strongly acid. The B3t horizon is dark yellowish brown (10YR 4/4) or yellowish brown (10YR 5/4) light or medium silty clay loam. It is 8 to 15 inches thick and is slightly acid or medium acid.

The C horizon is not described in the representative profile, but it ranges from yellowish brown (10YR 5/4) to grayish brown (2.5Y 5/2). It is neutral or slightly acid.

Sharpsburg soils are associated on the landscape



Included with this soil in mapping are some areas of moderately eroded soils that have a thinner, lighter colored surface layer. Also included are sand spots and wet spots, both of which are indicated on the soil map by special symbols.

This Sharpsburg soil is well suited to intensive row crops. It is susceptible to erosion. The organic matter content is high. Capability unit IIe–1; environmental planting group 1.

370C—Sharpsburg silty clay loam, 5 to 9 percent slopes. This moderately sloping soil is on convex, upland ridgetops and side slopes. Areas are long and narrow or irregular in shape. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of shale outcrop, spots of red clay, spots of gray clay, seepy wet spots, and sand spots, all of which are indicated on the soil map by special symbols.

This Sharpsburg soil is well suited to row crops. It is susceptible to erosion. The organic matter content is high. Capability unit IIIe–1; environmental planting group 1.

370C2—Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on convex ridgetops and side slopes on uplands. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and lighter colored.

Included with this soil in mapping are spots of severely eroded soils, wet spots, sand spots, spots of gray clay, spots of red clay, glacial till outcrop, and shale outcrop, all of which are indicated on the soil map by special symbols.

of Macksburg soils, which are indicated on the soil map by a wet spot symbol.

This Sharpsburg soil is well suited to intensive row crops. In most areas, the loess is underlain by stratified alluvium rather than glacial till. In places the alluvium is sandy and is rapidly permeable. This porous substratum is a hazard for such uses as landfills. Capability unit I–1; environmental planting group 1.

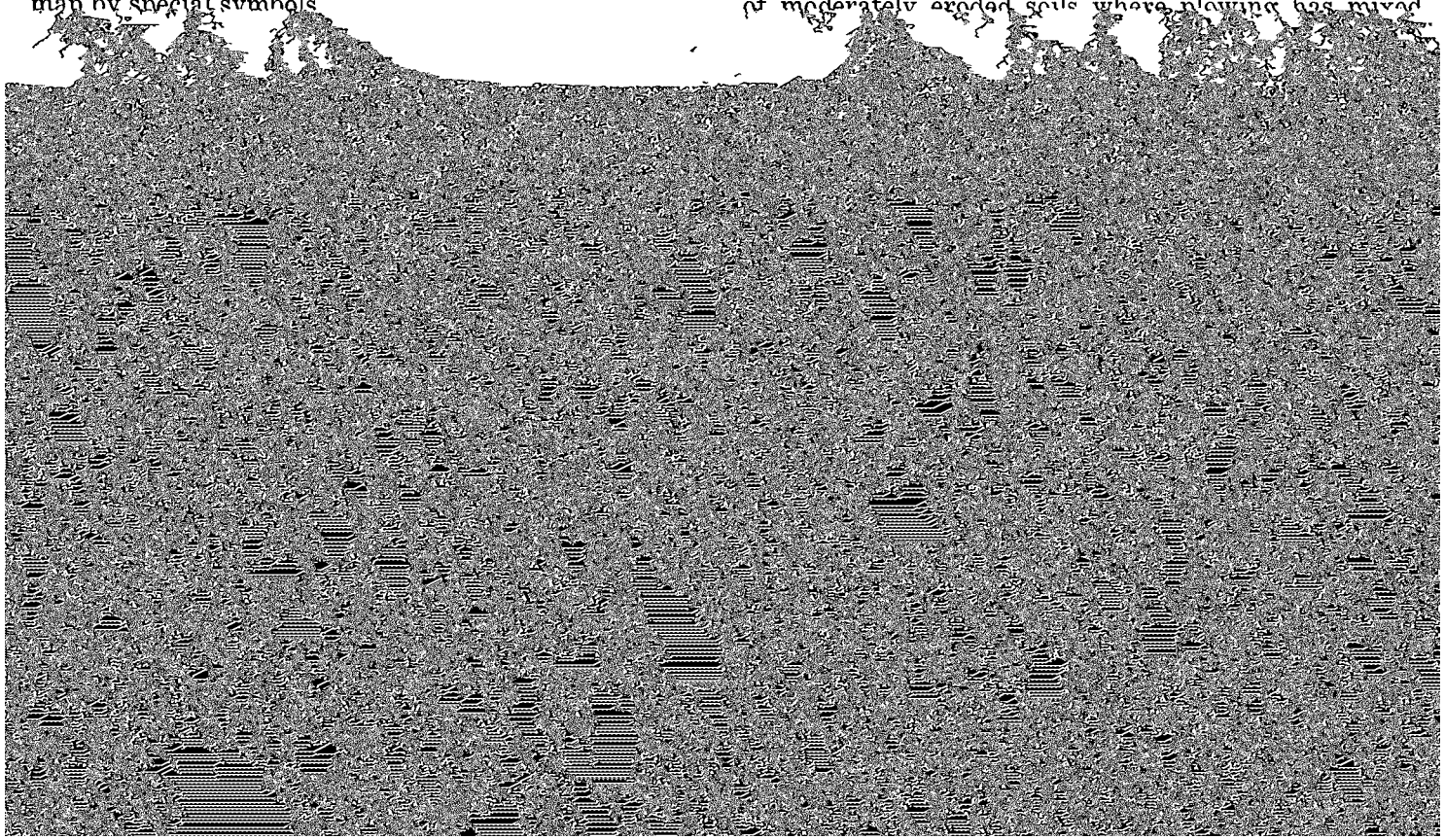
T370B—Sharpsburg silt clay loam, benches, 2 to 5 percent slopes. This gently sloping soil is on convex benches along major streams. Areas are long and narrow or irregular in shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is thicker.

Included with this soil in mapping are sand spots, which are indicated on the soil map by a special symbol.

This Sharpsburg soil is well suited to intensive row crops. It is susceptible to erosion. In most areas, the loess is underlain by stratified alluvium rather than glacial till. In places, the alluvium is sandy and is rapidly permeable. This porous substratum is a hazard for such uses as farm ponds. The organic matter content is high. Capability unit IIe–1; environmental planting group 1.

T370C—Sharpsburg silty clay loam, benches, 5 to 9 percent slopes. This moderately sloping soil is on convex benches adjacent to major streams. Areas are long and narrow or irregular in shape. Slopes are typically short. This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner.

Included with this soil in mapping are some areas of moderately eroded soils where plowing has mixed



percent slopes, moderately eroded, in a bluegrass pasture, 1,990 feet east and 120 feet south of the northwest corner of sec. 25, T. 76 N., R. 25 W.:

A1—0 to 7 inches; very dark brown (10YR 2/2) light clay loam; moderate medium granular structure parting to weak fine granular; friable; neutral; clear smooth boundary.

B1—7 to 11 inches; dark brown (10YR 3/3) clay loam; very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) faces of peds; moderate very fine subangular blocky structure; friable; neutral; clear smooth boundary.

B21t—11 to 16 inches; dark yellowish brown (10YR 4/4) heavy clay loam; dark brown (10YR 3/3) faces of peds; moderate very fine subangular blocky structure; friable; thin continuous clay films; slightly acid; clear smooth boundary.

It is medium to heavy clay loam. It is 10 to 24 inches thick and is slightly acid to strongly acid.

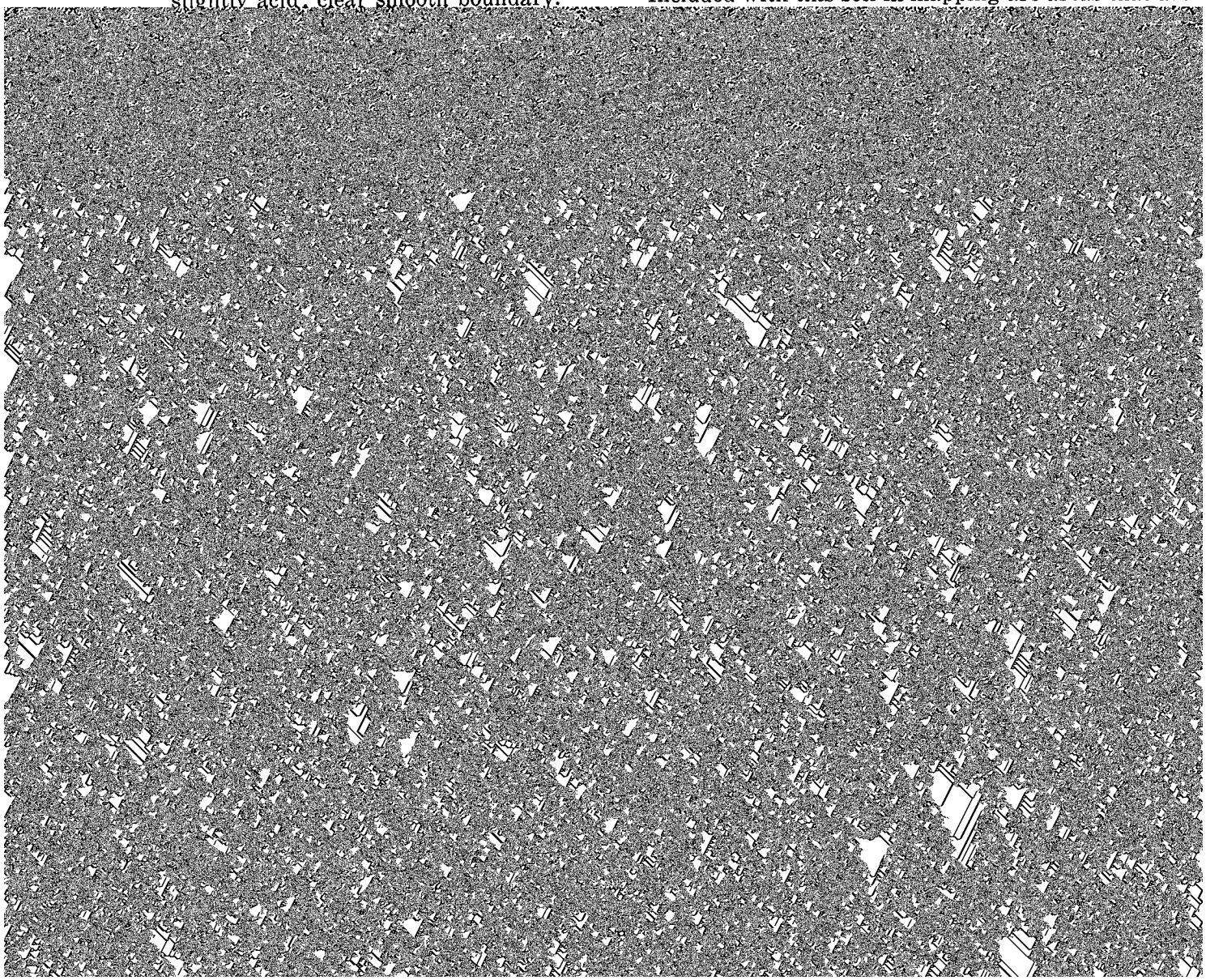
The C horizon is brown (10YR 4/3) to yellowish brown (10YR 5/6) mixed with grayish brown (2.5Y 5/2) to light olive gray (5Y 6/2).

The B2t horizon is finer textured than defined in the range of the Shelby series, but this difference does not alter the usefulness or behavior of the soil.

Shelby soils formed in parent material similar to that of Gara soils. They have a thicker surface layer than Gara soils.

24D2—Shelby clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on convex side slopes on uplands. Areas are long or irregular in shape. They range from a few acres to 20 acres in size. This soil has a profile similar to the one described as representative of the series, but in many places material from the subsoil is mixed into the plow layer.

Included with this soil in mapping are areas that are



poorly drained to very poorly drained soils. These soils are in depressional areas on broad upland flats. They formed in loess under a native vegetation of tall prairie grasses tolerant to wetness.

In a representative profile the surface layer is black silt loam about 10 inches thick. The subsurface layer is very dark gray and dark gray silt loam about 11 inches thick. The subsoil extends to a depth of 56 inches; it is dark gray silty clay loam and silty clay in the upper part and dark gray and gray silty clay in the lower part. The substratum is olive gray silty clay loam.

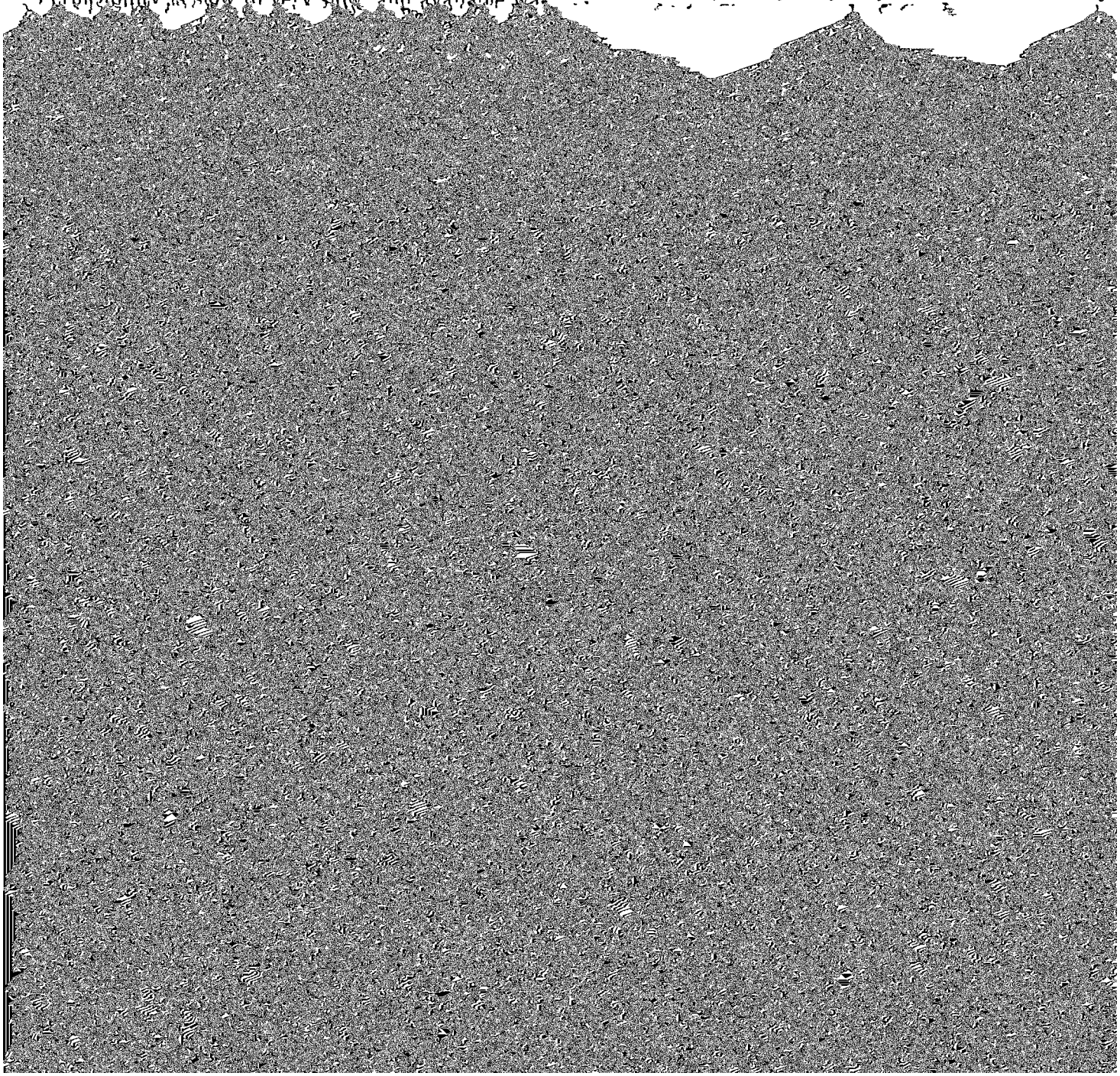
Permeability is slow to very slow, and available wa-

silty clay loam; common medium prominent strong brown (7.5YR 5/6) mottles; massive; firm; few dark oxides; neutral.

The solum ranges from 40 to 68 inches in thickness.

The Ap horizon is black (10YR 2/1) or very dark gray (10YR 3/1). It is 6 to 10 inches thick and is neutral to strongly acid. The A2 horizon is very dark gray (10YR 3/1) to dark grayish brown (10YR 4/2). It is 6 to 11 inches thick and is medium acid or strongly acid.

The B2t horizon is dark gray (10YR 4/1) to dark gray (5Y 4/1) heavy silty clay loam to medium silty



In a representative profile the surface layer is very dark brown light silty clay loam about 13 inches thick. The silty clay loam subsoil extends to a depth of 50 inches; it is mainly dark yellowish brown but is dark brown in the upper 6 inches.

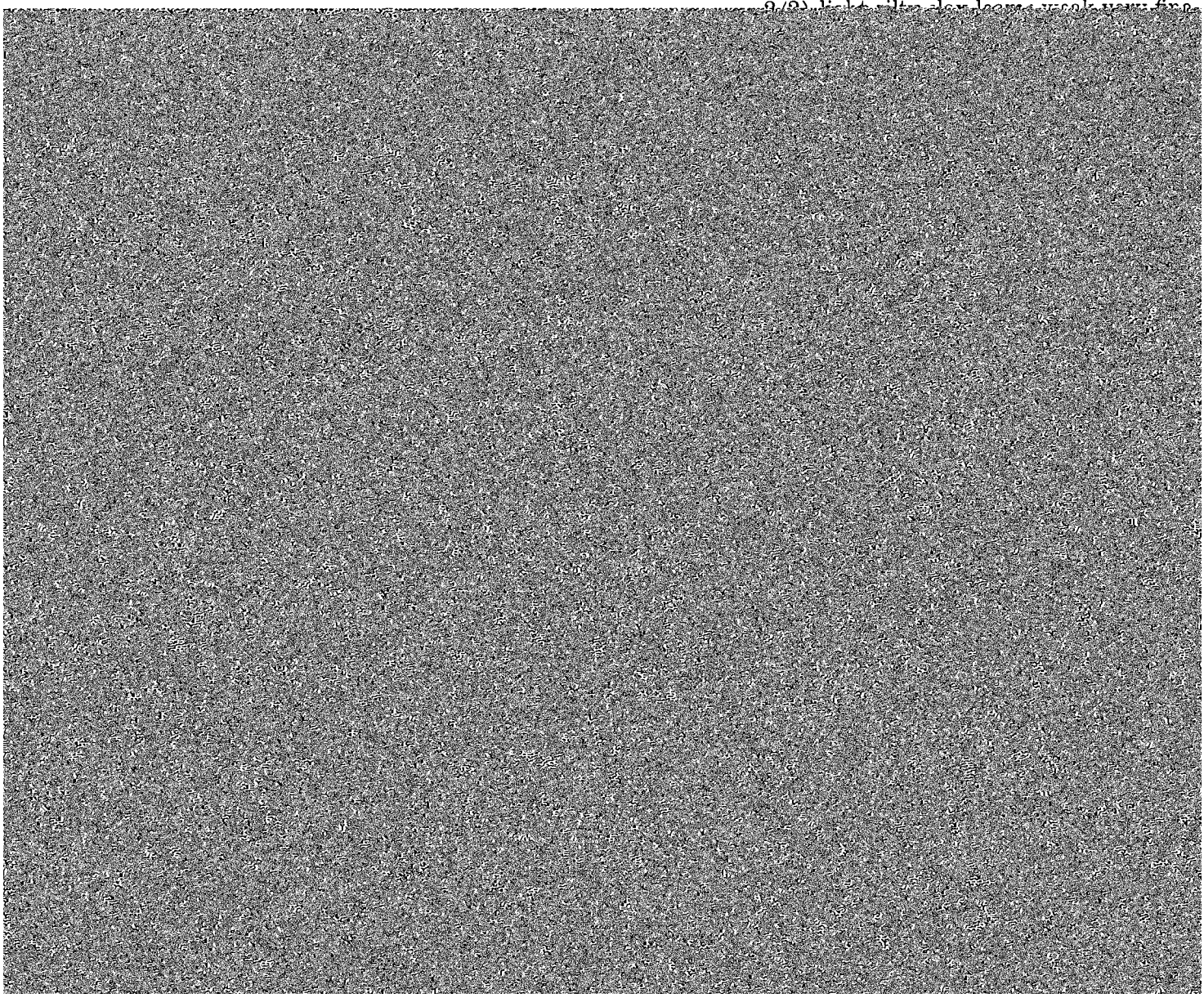
Permeability is moderate, and available water capacity is high. The subsoil is medium in available phosphorus and very low in available potassium.

Tama soils are used mainly for row crops, hay, and pasture. The major hazard is erosion.

Representative profile of Tama silty clay loam, 2 to 5 percent slopes, on an upland ridgetop, 400 feet south and 80 feet east of the northwest corner of sec. 28, T. 77 N., R. 22 W.:

Ap—0 to 8 inches; very dark brown (10YR 2/2) light silty clay loam; weak very fine granular structure; friable; strongly acid; abrupt smooth boundary.

A12—8 to 13 inches; very dark brown (10YR



The C horizon is not described in the representative profile, but it is from dark brown (10YR 4/3) to yellowish brown (10YR 5/6).

Tama soils formed in parent material similar to that of Downs and Muscatine soils. They have a thicker surface layer than Downs soils. They have a browner subsoil and a thinner surface layer than Muscatine soils.

120—Tama silty clay loam, 0 to 2 percent slopes. This nearly level soil is

Included in mapping are some areas of moderately sloping Tama soils, which are indicated on the soil map by a special symbol for short, steep slopes.

This Tama soil is well suited to intensive row crops. It is susceptible to erosion. In most areas, the loess is underlain by stratified alluvium rather than glacial till. In places, the alluvium is sandy and rapidly permeable, and it is a hazard for such uses as farm ponds or landfills. Capability unit IIe–1; environmental planting

platy structure parting to weak very fine subangular blocky; friable; medium acid; clear smooth boundary.

B21t—26 to 31 inches; very dark gray (10YR 3/1) medium silty clay loam; few fine distinct dark brown (7.5YR 3/2 and 4/4) mottles; moderate fine and medium prismatic structure parting to moderate medium and fine subangular blocky; friable; thin continuous clay films; slightly acid; gradual smooth boundary.

B22t—31 to 40 inches; dark grayish brown (10YR 4/2) medium silty clay loam; very dark gray (10YR 3/1) faces of peds; common fine distinct dark brown (7.5YR 4/4) and strong brown (7.5YR 5/6) mottles; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; firm; thin continuous clay films; slightly acid; gradual smooth boundary.

B23t—40 to 48 inches; dark gray (5Y 4/1) medium silty clay loam; many fine prominent yellowish brown (10YR 5/6) mottles and few fine faint dark gray (10YR 4/1) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; thin continuous clay films; few fine dark oxides; neutral; gradual smooth boundary.

B3g—48 to 60 inches; grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) light silty clay loam; few fine faint dark gray (10YR 4/1) and grayish brown (10YR

Included with this soil in mapping are small areas of Humeston soils.

This Vesser soil is moderately well suited to row crops. It is susceptible to wetness and to flooding. The organic matter content is high. Capability unit IIw–2; environmental planting group 2.

51B—Vesser silt loam, 2 to 5 percent slopes. This gently sloping soil is on foot slopes. Areas are small in size and irregular in shape. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of soils that have a thinner surface layer.

This Vesser soil is moderately well suited to row crops. It is susceptible to wetness, and many areas receive runoff from soils upslope. The organic matter content is high. Capability unit IIw–3; environmental planting group 2.

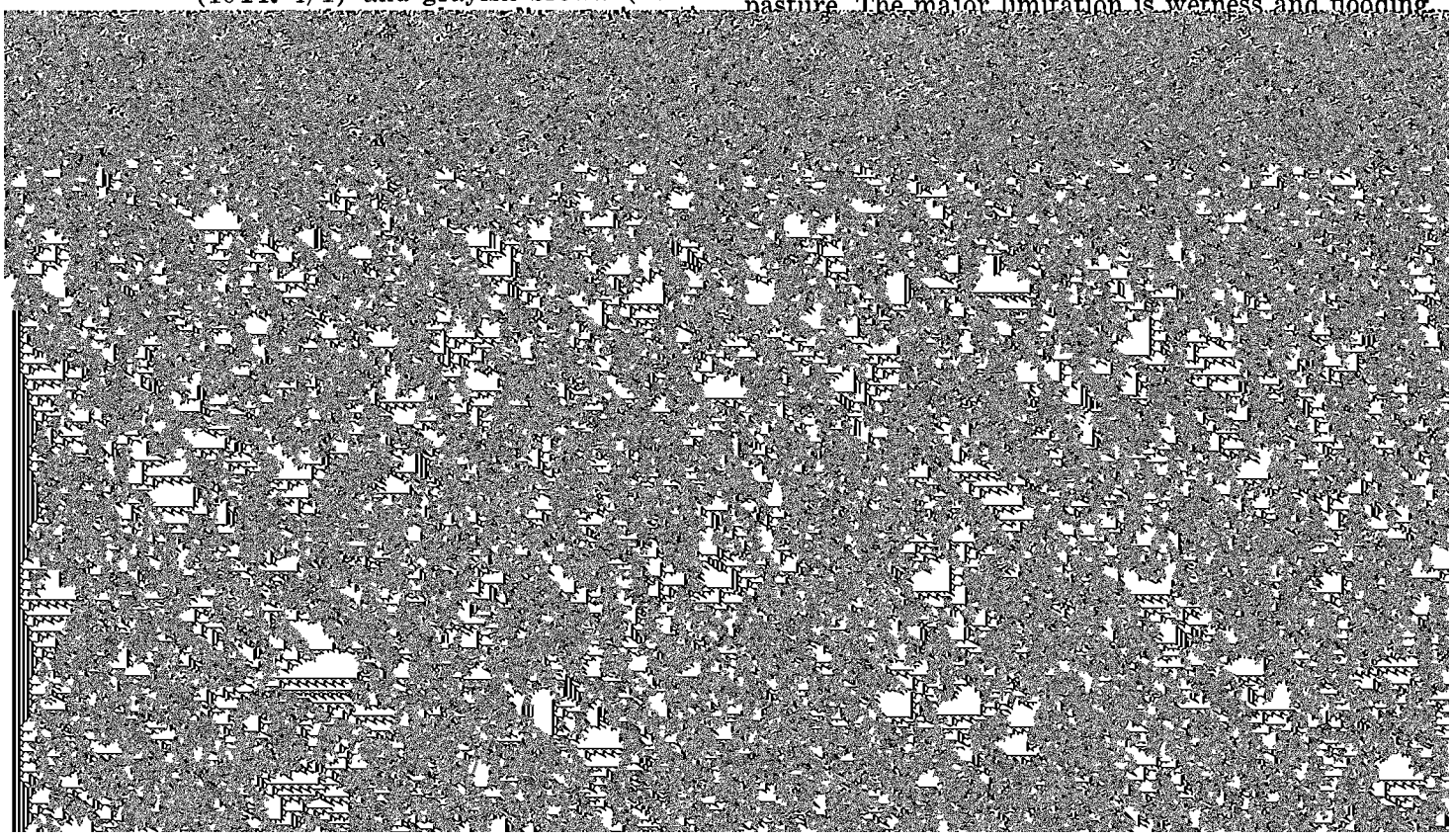
Wabash series

The Wabash series consists of deep, nearly level, very poorly drained soils. These soils are on broad bottom lands. They formed in fine textured alluvium under a native vegetation of mixed prairie grasses and trees tolerant to excessive wetness.

In a representative profile the surface layer is about 36 inches thick; it is black silty clay loam in the upper part and black silty clay in the lower part. The subsoil extends to a depth of 52 inches and is dark gray silty clay. The substratum is dark gray silty clay.

Permeability is very slow, and available water capacity is moderate. The subsoil is high in available phosphorus and medium in available potassium.

Wabash soils are used mainly for row crops and pasture. The major limitation is wetness and flooding.

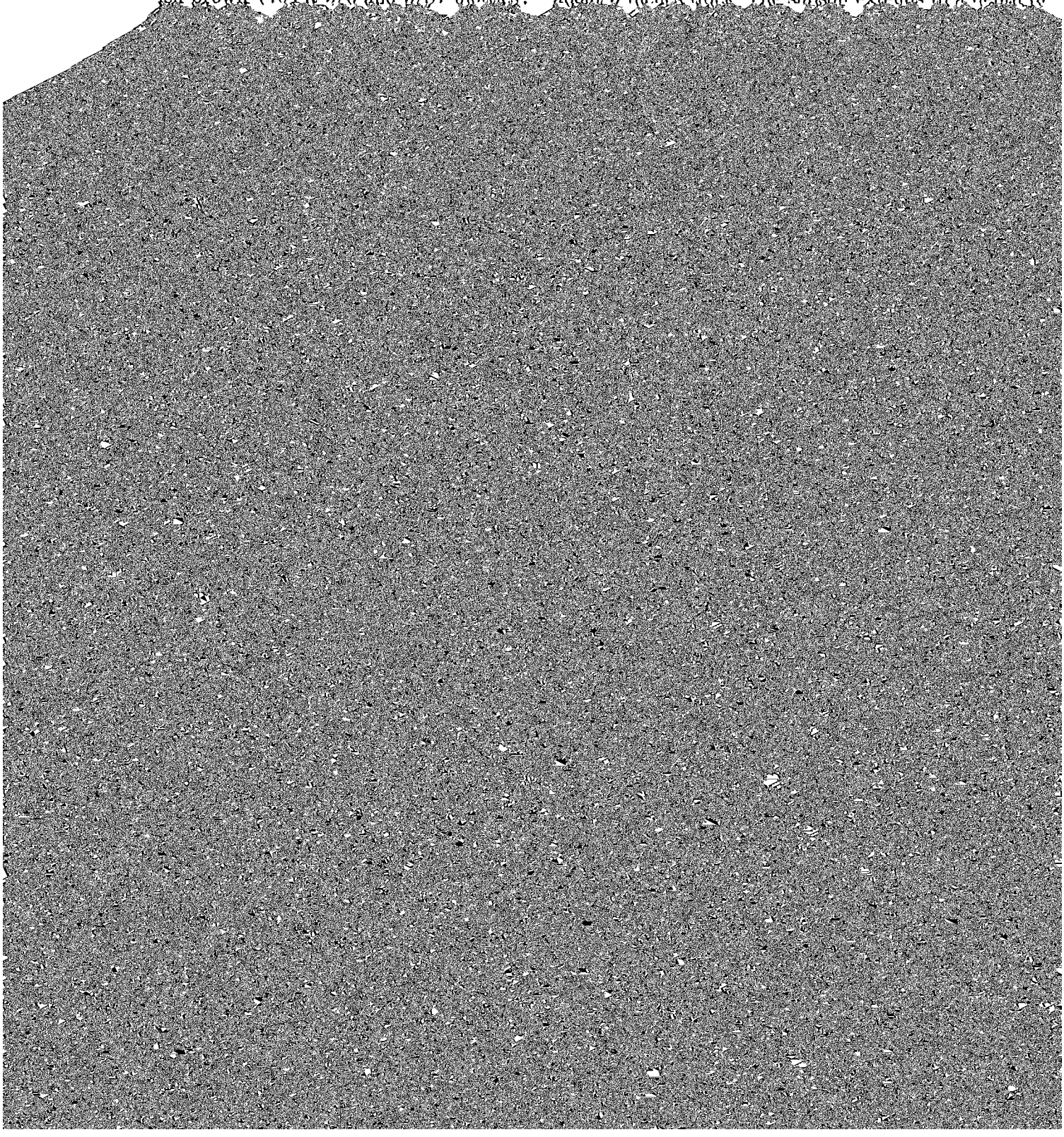


medium subangular blocky structure; firm; few fine dark oxides; neutral; gradual smooth boundary.

Cg—52 to 60 inches; dark gray (5Y 4/1) medium silty clay; common fine distinct yellowish brown (10YR 5/6 and 5/8) mottles;

in silty alluvium under a native vegetation of mixed prairie grasses and trees.

In a representative profile the surface layer is very dark grayish brown silt loam about 6 inches thick. The subsurface layer is dark grayish brown silt loam about 5 inches thick. The subsoil extends to a depth of



angular blocky structure; thin discontinuous clay films; many fine dark oxides; medium acid; gradual smooth boundary.

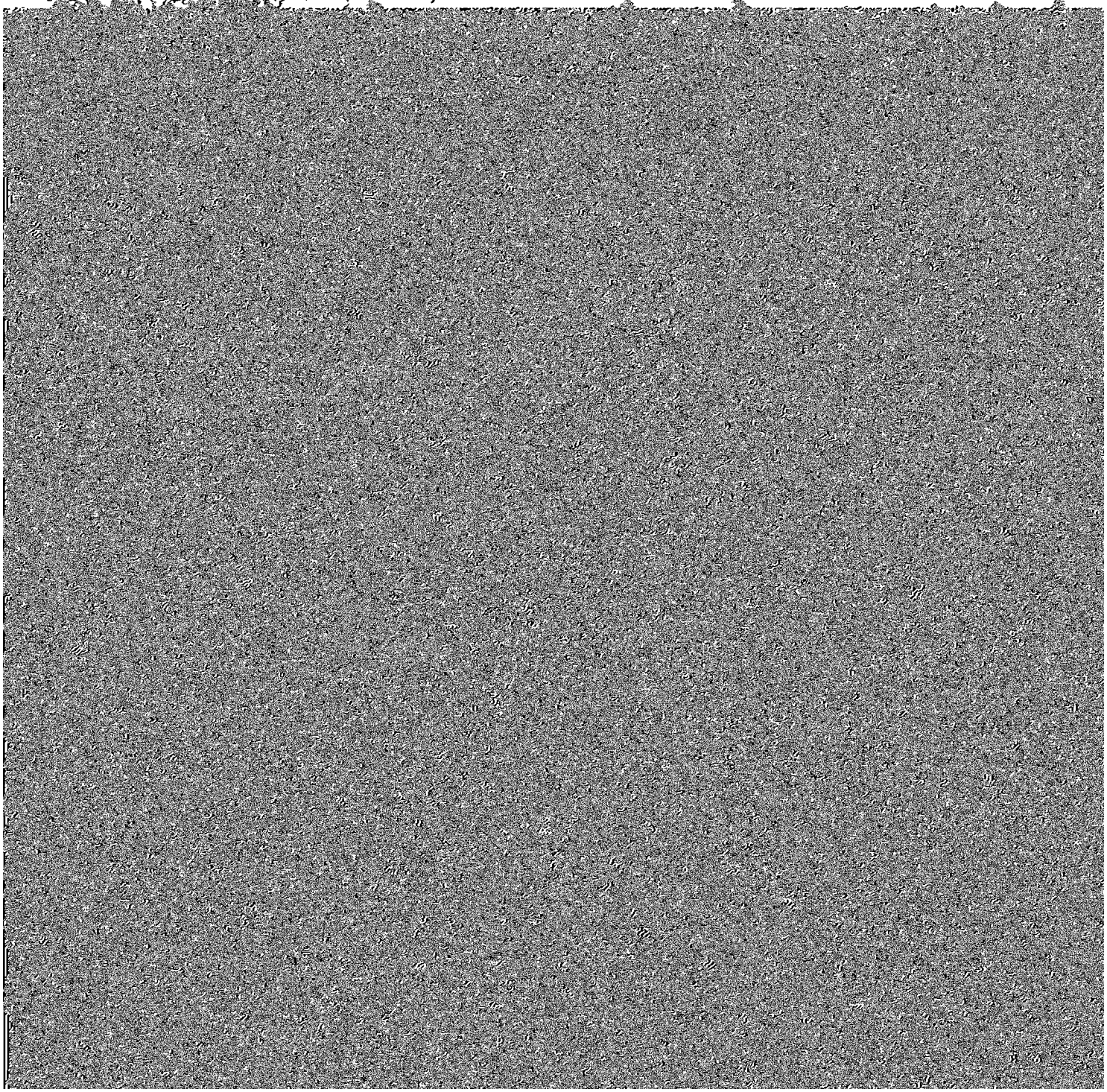
C—49 to 60 inches; yellowish brown (10YR 5/4) and grayish brown (2.5Y 5/2) light silty clay loam; few fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; many fine dark oxides; medium acid.

The solum ranges from 30 to 60 inches in thickness.

ately eroded, in a pasture, 2,050 feet east and 290 feet north of the southwest corner of sec. 36, T. 74 N., R. 22 W.:

A1—0 to 3 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; weak thin platy structure parting to weak fine granular; neutral; abrupt smooth boundary.

A2—3 to 9 inches; dark grayish brown (10YR 4/2) silt loam, light gray (10YR 7/2)



(10YR 5/2), or brown (10YR 5/3). The A2 horizon is neutral to very strongly acid.

The B2t horizon is dark yellowish brown (10YR 4/4) or yellowish brown (10YR 5/4) heavy silty clay loam or light silty clay. It is medium acid to very strongly acid.

Weller soils in this county lack mottles of chroma 2 or less in the upper part of the B horizon as defined in the range of the series. Also, the B horizon is slightly lower in content of clay than defined in the range. These differences, however, do not significantly affect the use and behavior of the soils.

Weller soils formed in parent material similar to that of Grundy and Pershing soils. They have a thinner surface layer than Grundy and Pershing soils.

132B—Weller silt loam, 2 to 5 percent slopes. This gently sloping soil is on upland ridgetops. Areas are long and narrow or irregular in shape. They range from a few acres to 60 acres or more in size. In plowed areas, the surface and subsurface layers and, in places, material from the subsoil are mixed into the plow layer.

Included with this soil in mapping are wet spots, which are indicated on the soil map by a special symbol.

This Weller soil is moderately well suited to row crops. It is susceptible to erosion. The organic matter content is low to moderately low. Capability unit IIIe–2; environmental planting group 1.

132C2—Weller silt loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on long, convex ridges and the upper part of side slopes on uplands. Areas are long and narrow or irregular in shape. They range from a few acres to 90 acres in size. This soil has a profile similar to the one described as representative of the series, but in most places the surface and subsurface layers are thinner. In cultivated areas, the surface layer and subsurface layer and, in many places, material from the subsoil are mixed into the plow layer.

Included with this soil in mapping are areas that are slightly eroded and small areas that are strongly sloping. Also included are spots of severely eroded soils and spots of red clay, both of which are indicated on the soil map by special symbols.

This Weller soil is moderately well suited to row crops, but most areas are in hay, pasture, or woodland with Gosport, Keswick, and Lindley soils downslope. The soil is susceptible to erosion. The organic matter content is low to moderately low. Capability unit IIIe–2; environmental planting group 1.

Winterset series

The Winterset series consists of deep, nearly level, poorly drained soils. These soils are on broad upland flats. They formed in loess under a native vegetation

dium in available phosphorus and medium in available potassium.

Winterset soils are used mainly for row crops. The major limitation is wetness.

Representative profile of Winterset silty clay loam, 0 to 2 percent slopes, on an upland flat in a pasture, 205 feet west and 250 feet south of the northeast corner of the NW¼ sec. 16, T. 76 N., R. 23 W.:

A11—0 to 8 inches; black (10YR 2/1) light silty clay loam; moderate fine granular structure; friable; strongly acid; gradual smooth boundary.

A12—8 to 19 inches; black (10YR 2/1) silty clay loam; moderate very fine subangular blocky structure; friable; strongly acid; gradual smooth boundary.

B1t—19 to 26 inches; very dark gray (10YR 3/1) heavy silty clay loam; moderate and strong fine and very fine subangular blocky structure; friable; strongly acid; gradual smooth boundary.

B21tg—26 to 34 inches; olive gray (5Y 5/2) light silty clay; very dark gray (10YR 3/1) faces of peds; common fine distinct olive brown (2.5Y 4/4) mottles; weak medium prismatic structure parting to strong fine subangular blocky; firm; thin continuous clay films; few fine dark oxides; medium acid; gradual smooth boundary.

B22tg—34 to 43 inches; olive gray (5Y 5/2) heavy silty clay loam; very dark grayish brown (2.5Y 3/2) faces of prisms; common fine distinct yellowish brown (10YR 5/4) mottles; moderate medium prismatic structure parting to moderate fine subangular blocky; firm; thin continuous clay films; common fine dark oxides; medium acid; gradual smooth boundary.

B23t—43 to 50 inches; gray (5Y 5/1) medium silty clay loam; common fine distinct yellowish brown (10YR 5/4) and strong brown (7.5YR 5/6 and 5/8) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm; thin discontinuous clay films on vertical faces of peds; common fine dark oxides; slightly acid; gradual smooth boundary.

B3t—50 to 60 inches; olive gray (5Y 5/2) light silty clay loam; common fine distinct yellowish brown (10YR 5/4) and strong brown (7.5YR 5/6 and 5/8) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; few dark oxides; slightly acid.

The C horizon is not described in the representative profile, but it is gray (5Y 5/1) or olive gray (5Y 5/2) light silty clay loam or heavy silt loam.

Winterset soils are associated on the landscape with Macksburg, Sharpsburg, and Sperry soils. They also formed in parent material similar to that of those soils. They have a grayer subsoil than Macksburg and Sharpsburg soils. They have a lower clay content in the subsoil than Sperry soils.

369—Winterset silty clay loam, 0 to 2 percent slopes. This nearly level soil is on broad upland flats. Areas are irregular in shape. They are large on the major divides and small on the smaller divides.

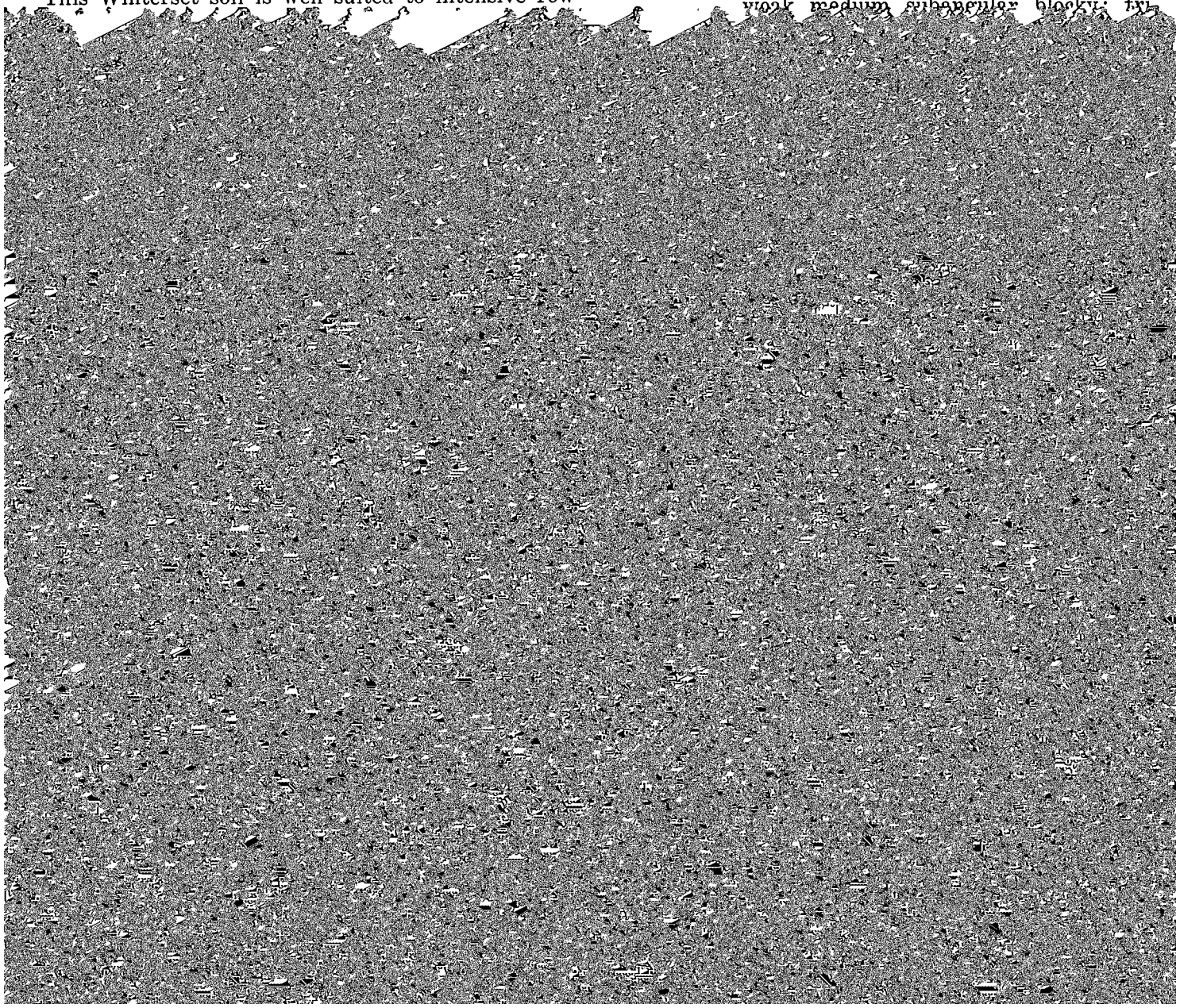
Included with this soil in mapping are small areas of Macksburg soils. Also included are small areas of Sperry soils, which are indicated on the soil map by a wet spot symbol.

This Winterset soil is well suited to intensive row

B21t—22 to 30 inches; dark brown (10YR 4/3) silty clay loam; weak medium subangular blocky structure parting to moderate very fine and fine subangular blocky; friable; strongly acid; gradual smooth boundary.

B22t—30 to 38 inches; dark yellowish brown (10YR 4/4) silty clay loam; few fine faint grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; few fine dark oxides; strongly acid; gradual smooth boundary.

B3—38 to 50 inches; dark yellowish brown (10YR 4/4) light silty clay loam; few fine faint grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; fri-



Zook series

The Zook series consists of deep, nearly level, poorly drained soils. These soils are on bottom lands. They

The solum ranges from 36 to 64 inches in thickness. The A horizon is black (10YR 2/1 or N 2/0). It is 26 to 44 inches thick and is neutral to medium acid. The Bg horizon is very dark gray (10YR 3/1) to

minor crops total only about 1,000 acres in most years.

Controlling erosion is an important consideration in management of the sloping soils. Contour tillage and methods of tillage that leave crop residue on the surface reduce erosion. Cropping systems that include grasses and legumes are also helpful. Other measures used in controlling erosion are terraces, diversions, grassed

stream. In some years water stands for fairly long periods on these soils.

Rainfall is adequate in most years for the production of the crops generally grown in the county. The distribution of rainfall during the growing season is seldom ideal, so supplemental irrigation can generally improve yields. However, the cost of an irrigation sys-

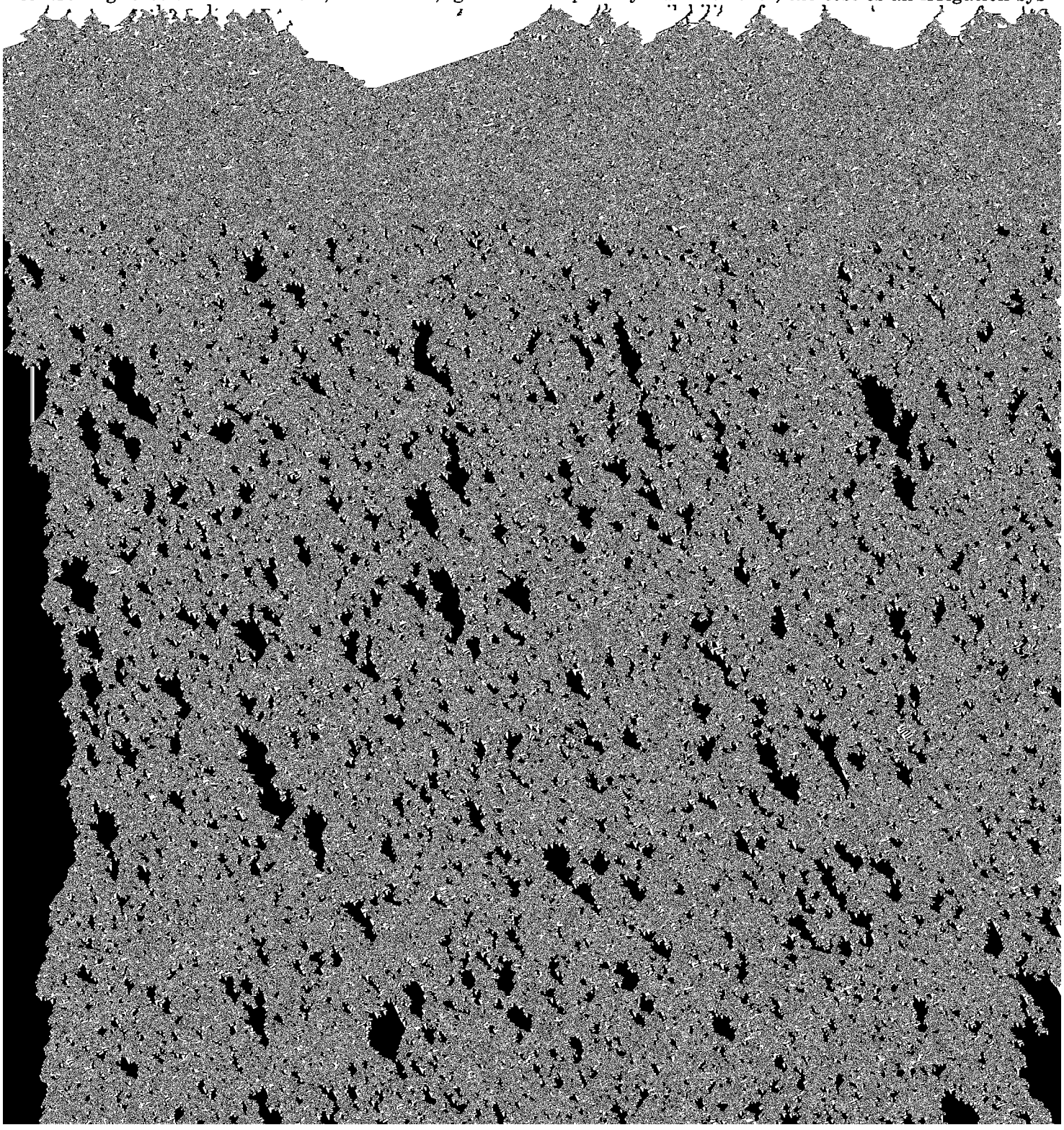


TABLE 2.—*Predicted average acre yields of principal crops under a high level of management*

[Dashes indicate the soil is not suited to the crop or that the crop is ordinarily not grown]

Soil	Corn	Soybeans	Oats	Alfalfa-grass	Pasture
	Bu	*Bu*	*Bu*	*Tons*	*AUD*[1]
Ackmore silt loam, 0 to 2 percent slopes	106	40	64	4.5	225
Adair clay loam, 9 to 14 percent slopes, moderately eroded	54	20	30	2.3	115
Adair-Shelby clay loams, 9 to 14 percent slopes, moderately eroded	67	25	37	2.8	140
Adair-Shelby clay loams, 14 to 18 percent slopes, moderately eroded	53	20	29	2.2	110
Adair-Shelby clay loams, 14 to 18 percent slopes, severely eroded				1.3	65
Alluvial land	(2)	(2)	(2)	(2)	(2)
Alluvial land, channeled					(2)
Amana silt loam, 0 to 2 percent slopes	110	42	66	4.6	230
Arbor loam, 9 to 14 percent slopes	88	33	48	3.7	185
Arispe silty clay loam, 5 to 9 percent slopes	104	39	57	4.3	215
Arispe silty clay loam, 5 to 9 percent slopes, moderately eroded	99	38	54	4.1	205
Armstrong loam, 9 to 14 percent slopes, moderately eroded	50	19	28	2.0	100
Armstrong-Gara loams, 9 to 14 percent slopes, moderately eroded	62	23	34	2.7	135
Armstrong-Gara loams, 14 to 18 percent slopes, moderately eroded				1.7	85
Armstrong-Gara clay loams, 14 to 18 percent slopes, severely eroded				1.1	55
Bauer silt loam, 9 to 14 percent slopes, moderately eroded				2.5	125
Bauer silt loam, 14 to 18 percent slopes, moderately eroded				1.5	75
Bauer soils, 14 to 18 percent slopes, severely eroded				1.0	50
Bremer silty clay loam, 0 to 2 percent slopes	106	40	64	4.5	225
Caleb loam, 9 to 14 percent slopes, moderately eroded	66	25	36	2.8	140
Chelsea loamy fine sand, 5 to 9 percent slopes					

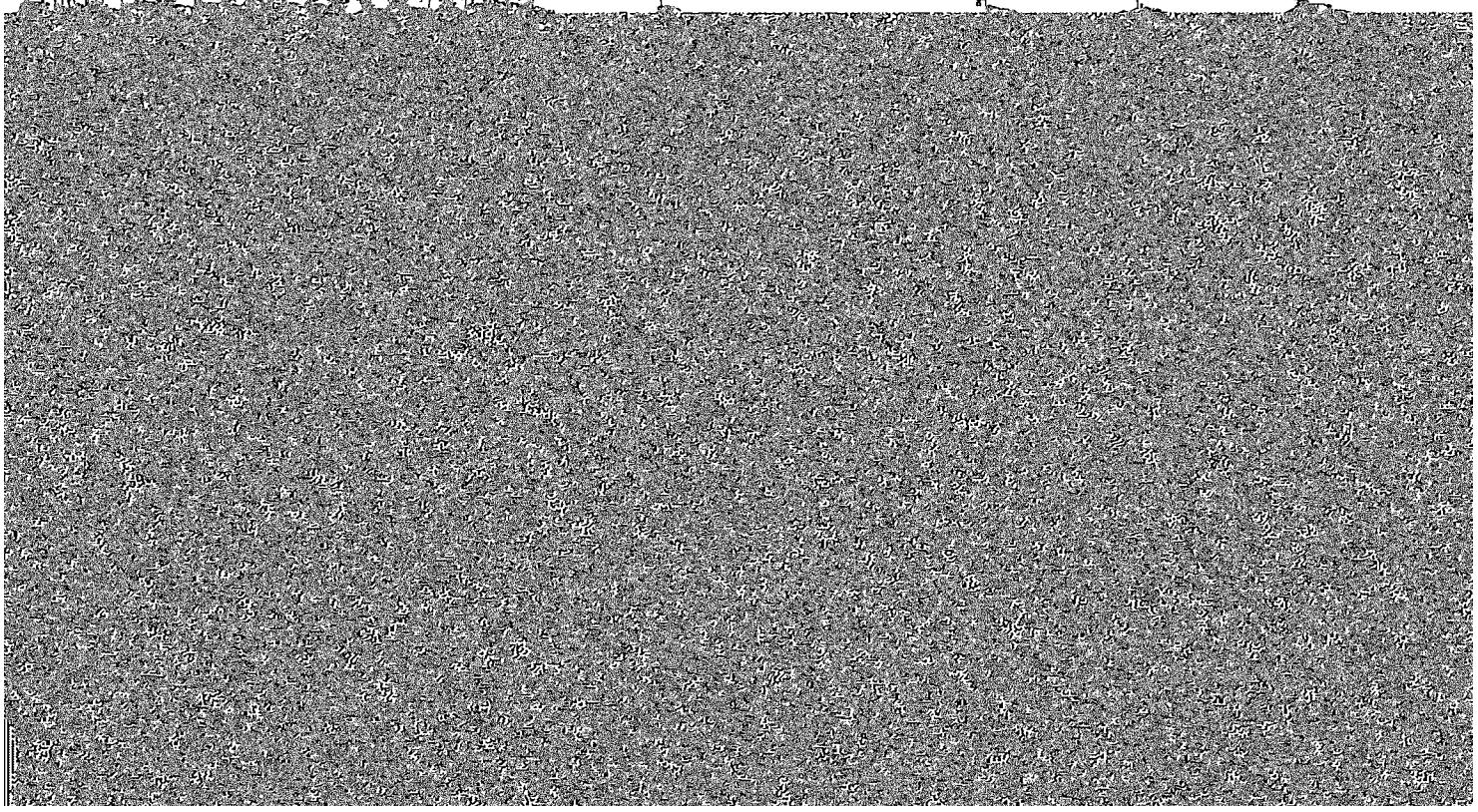
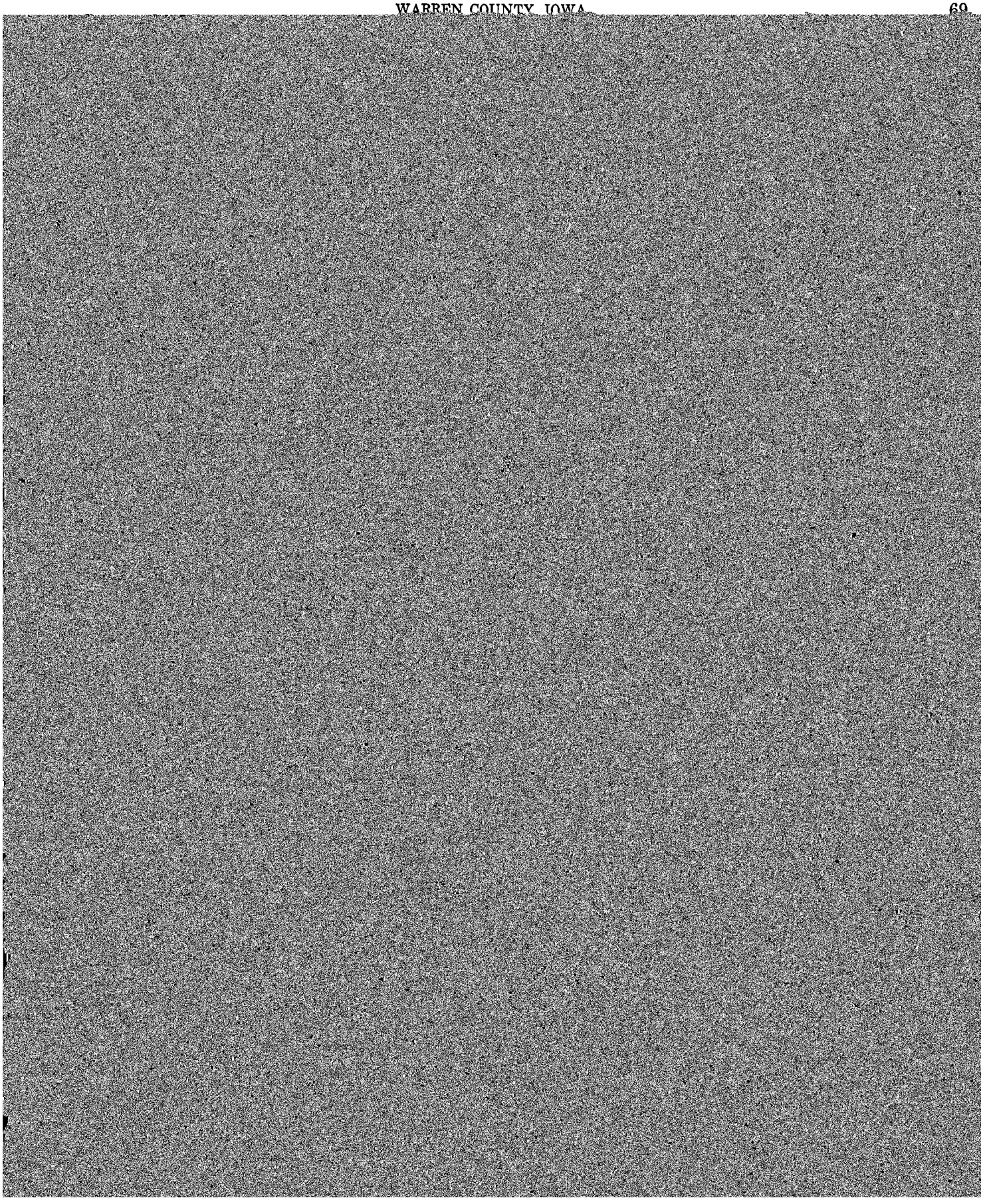


TABLE 2.—*Predicted average acre yields of principal crops under a high level of management*—Continued

Soil	Corn	Soybeans	Oats	Alfalfa-grass	Pasture
	Bu	*Bu*	*Bu*	*Tons*	*AUD*[1]
Gara loam, 9 to 14 percent slopes, moderately eroded	75	28	41	3.1	155
Gara loam, 14 to 18 percent slopes, moderately eroded				2.2	110
Gara loam, 18 to 25 percent slopes, moderately eroded				1.5	75
Gara loam, 25 to 40 percent slopes					40
Givin silt loam, 0 to 2 percent slopes	118	45	70	5.0	250
Gosport silt loam, 9 to 14 percent slopes	15				40
Gosport silt loam, 14 to 18 percent slopes					30
Gosport silt loam, 18 to 35 percent slopes					30
Gosport soils, 14 to 18 percent slopes, severely eroded					30
Grundy silty clay loam, 2 to 5 percent slopes	109	42	60	4.6	230
Gullied land-Ely-Colo complex, 2 to 5 percent slopes					(2)
Humeston silt loam, 0 to 2 percent slopes	88	33	48	3.7	185
Judson silty clay loam, 2 to 6 percent slopes	114	43	68	4.8	240
Kennebec silt loam, 0 to 2 percent slopes	122	46	73	5.1	255
Keswick loam, 9 to 14 percent slopes	44	17	24	1.8	190
Ladoga silt loam, 2 to 5 percent slopes	113	43	68	4.7	235
Ladoga silt loam, 5 to 9 percent slopes	108	41	65	4.5	225
Ladoga silt loam, 5 to 9 percent slopes, moderately eroded	105	40	63	4.4	220
Ladoga silt loam, 9 to 14 percent slopes, moderately eroded	96	36	58	4.0	200
Ladoga silt loam, benches, 2 to 5 percent slopes	113	43	68	4.7	235
Ladoga silt loam, benches, 5 to 9 percent slopes, moderately eroded	105	40	63	4.4	220
Ladoga-Chelsea complex, 5 to 9 percent slopes, moderately eroded	80	30	48	3.1	155
Ladoga-Chelsea complex, 9 to 14 percent slopes, moderately eroded				2.7	135
Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded	61	23	33	2.6	130
Lamoni soils, 9 to 14 percent slopes, severely eroded				1.5	75
Lindley loam, 9 to 14 percent slopes	72	27	40	3.0	150
Lindley loam, 14 to 18 percent slopes				2.0	100
Lindley loam, 18 to 25 percent slopes				1.0	50
Lindley loam, 25 to 40 percent slopes					40
Lindley soils, 14 to 18 percent slopes, severely eroded				1.0	50
Macksburg silty clay loam, 0 to 2 percent slopes	121	46	72	5.1	225
Macksburg silty clay loam, 2 to 5 percent slopes	117	44	70	4.9	245
Macksburg silty clay loam, benches, 1 to 3 percent slopes	121	46	72	5.1	255
Muscatine silty clay loam, 0 to 2 percent slopes	131	50	79	5.5	275
Muscatine silty clay loam, benches, 0 to 2 percent slopes	131	50	79	5.5	275
Mystic silt loam, 5 to 9 percent slopes, moderately eroded	60	23	33	2.5	125
Mystic silt loam, 9 to 14 percent slopes, moderately eroded	51	19	28	2.0	100
Mystic-Caleb complex, 9 to 14 percent slopes, moderately eroded	62	23	34	2.7	135
Mystic-Caleb complex, 14 to 18 percent slopes, moderately eroded				1.7	85
Nevin silty clay loam, 0 to 2 percent slopes	114	43	68	4.8	240
Nevin silty clay loam, 2 to 5 percent slopes	110	41	66	4.7	235
Nira silty clay loam, 2 to 5 percent slopes	110	42	66	4.7	235
Nira silty clay loam, 5 to 9 percent slopes, moderately eroded	104	39	62	4.4	220
Nodaway silt loam, 0 to 2 percent slopes	111	42	67	4.7	235
Nodaway silt loam, channeled, 0 to 2 percent slopes				(2)	(2)
Olmitz loam, 2 to 5 percent slopes	100	38	60	4.2	210
Olmitz loam, 5 to 9 percent slopes	95	36	57	4.0	200
Pershing silt loam, 2 to 5 percent slopes	104	39	57	4.2	210
Pershing silt loam, 5 to 9 percent slopes, moderately eroded	93	36	51	3.8	190
Pershing silt loam, 9 to 14 percent slopes, moderately eroded	81	31	45	3.5	175
Sharpsburg silty clay loam, 0 to 2 percent slopes	115	44	69	4.8	240
Sharpsburg silty clay loam, 2 to 5 percent slopes	113	43	68	4.7	235
Sharpsburg silty clay loam, 5 to 9 percent slopes	108	41	65	4.5	225
Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded	105	40	63	4.4	220



Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife habitat.

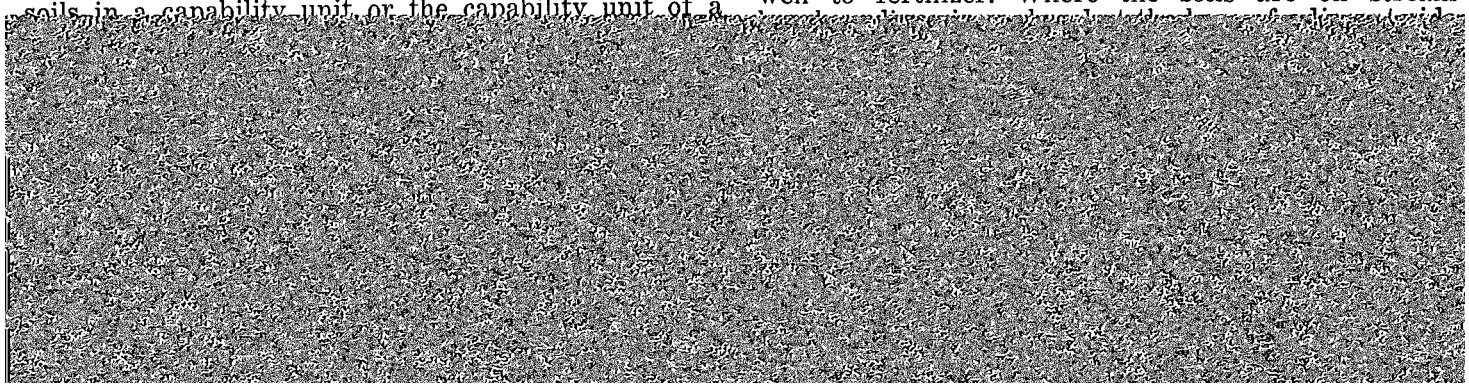
Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, water supply, or esthetic purposes. (No class VIII soils in Warren County.)

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 plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in some parts of the United States but not in Warren County, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture or range, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–1 or IIIe–3. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages the capability units in Warren County are described and suggestions for the use and management of the soils are given. To determine the soils in a capability unit or the capability unit of a



the most productive soils in the county. Artificial drainage commonly is not needed in most years on these soils.

The soils in this unit are well suited to cultivated crops. Corn and soybeans can be grown intensively. The soils respond well to fertilizer. Where these soils are on stream benches, diversions placed at the base of adjacent side slopes help to prevent runoff overflow.

Capability unit I–2

This unit consists of deep, nearly level, moderately well drained and somewhat poorly drained soils. These soils formed in recent alluvium near current stream channels and in the old stream meanders. They have a surface layer of silt loam and a subsoil of silt loam. Permeability is moderate, and available water capacity is high. Organic matter content is low to high.

These soils are easy to till and are readily penetrated by roots to a depth of several feet. They are highly productive. Artificial drainage commonly is not needed in most years on these soils. The soils are subject to flooding if they are not protected. Areas inside the Red Rock Flood Pool are flooded for extended periods in some years.

The soils in this unit are well suited to cultivated crops. Corn and soybeans can be grown intensively. The soils respond well to fertilizer. Where flooding is frequent, dikes or levees are beneficial.

Capability unit IIe–1

This unit consists of deep, gently sloping soils. These soils are well drained to somewhat poorly drained and are on uplands and stream benches. They have a surface layer of silt loam or silty clay loam and a subsoil of silty clay loam or silty clay. Permeability is moderate to slow, and available water capacity is high. Organic matter content is moderate to high. The hazard of erosion is slight.

These soils are easy to till, and most are readily penetrated by roots to a depth of several feet. The soils that have a silty clay subsoil have a narrower range of workability and inhibited root penetration. These soils are highly productive. Artificial drainage commonly is not needed in most years.

The soils in this unit are well suited to cultivated crops. Corn and soybeans can be grown intensively if the soils are protected from erosion. Farming on the contour, grassed waterways, and minimum tillage are effective erosion-control practices. These soils respond well to fertilizer. Where the soils are on stream

by roots to a depth of several feet. Artificial drainage is not needed.

The soils in this unit are well suited to cultivated crops, but they require special management because of the low organic matter content, the thin surface layer, and the structure of the subsurface layer. These soils are susceptible to puddling and crusting after rain. Row crops should be grown in rotation with legumes and grasses to increase organic matter content and to decrease erosion. Farming on the contour, terraces, grassed waterways, and minimum tillage are other effective erosion-control practices. These soils respond well to fertilizer.

Capability unit IIc–3

This unit consists of deep, gently sloping soils. These soils are well drained to somewhat poorly drained and are on foot slopes at the base of uplands along major streams and in drainageways. They have a surface layer of silty clay loam or loam and a subsoil of silty clay loam or clay loam. Permeability is moderate or moderately slow, and available water capacity is high. Organic matter content is high. The hazard of erosion is slight.

[illegible]

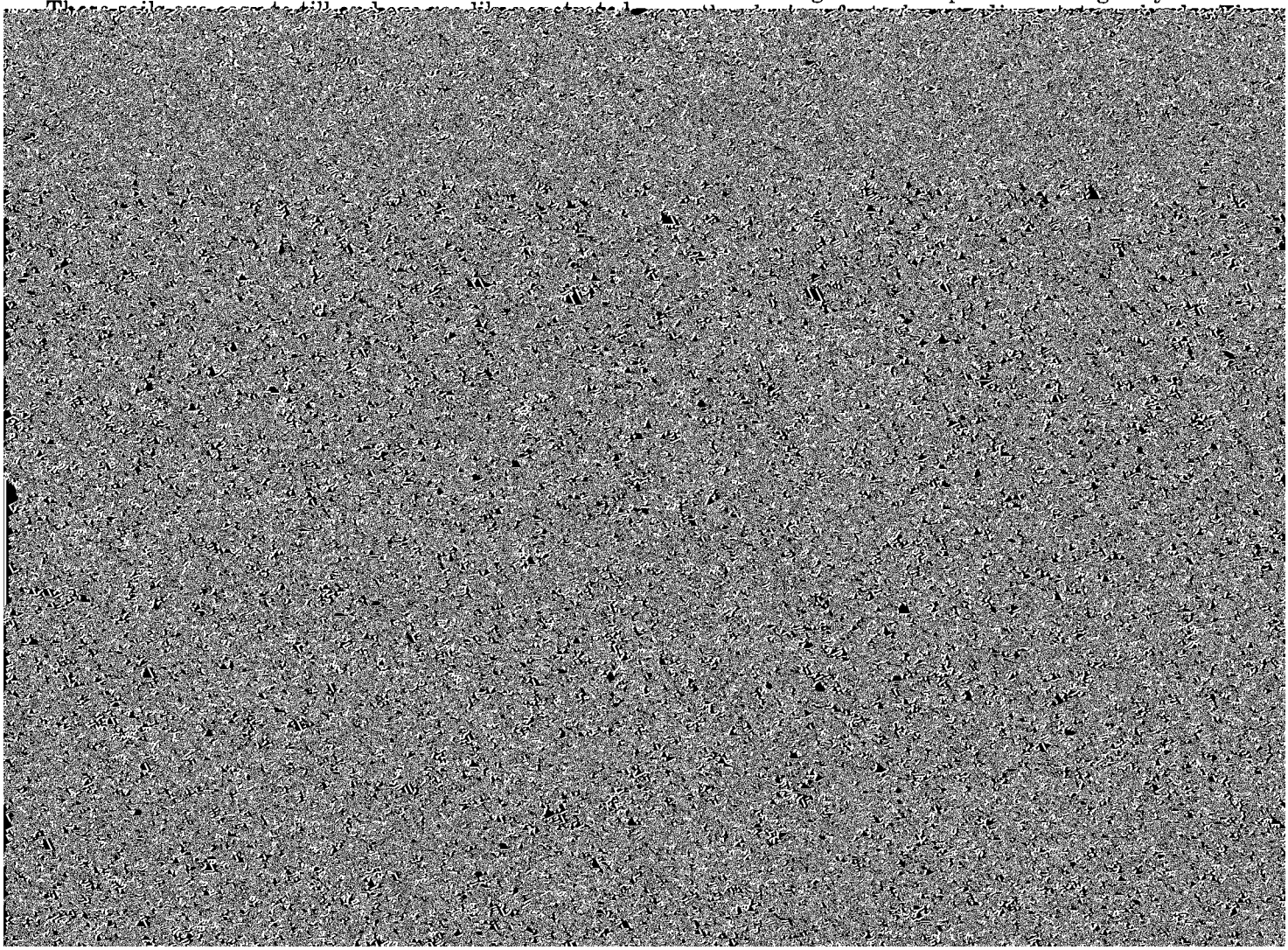
available water capacity is high. Organic matter content is high to moderate.

These soils have a narrow range of workability. They commonly are plowed in fall when they are drier. This allows clods to break up during winter, producing a better seedbed. Root growth is inhibited in the soils that have a silty clay subsoil. These soils are highly productive if properly drained. They have a seasonal high water table and require artificial drainage for optimum production. Tile drains commonly function satisfactorily if suitable outlets are available. Seasonal flooding is a hazard on the flood plains, but flooding generally is only of short duration. Where overflow occurs, sedimentation is a hazard.

The soils in this unit are well suited to moderately well suited to cultivated crops. Corn and soybeans can be grown intensively. Where flooding is frequent, dikes or levees are beneficial. These soils respond well to fertilizer.

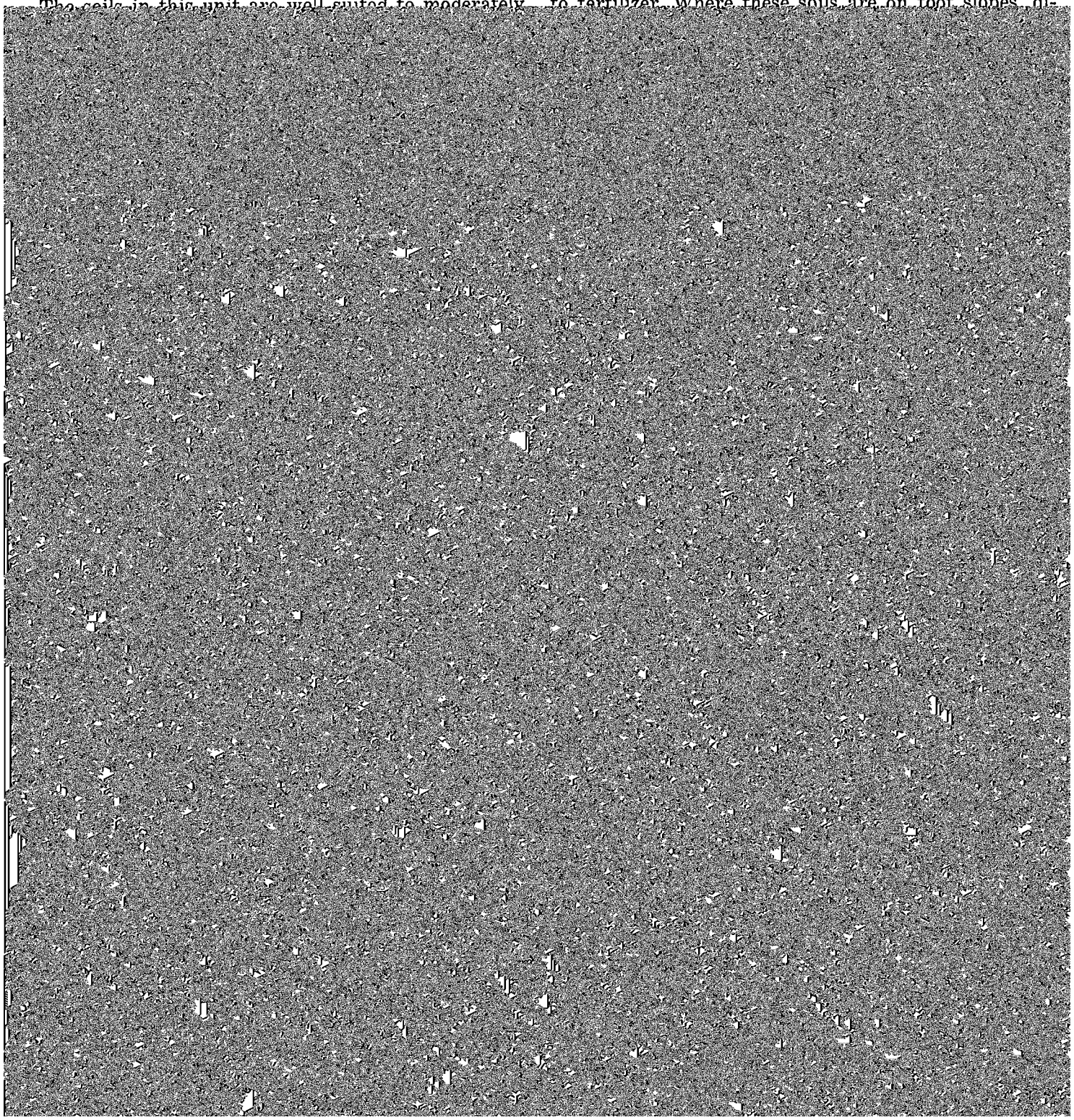
Capability unit IIw–3

This unit consists of deep, gently sloping soils. These soils are poorly drained and somewhat poorly drained and are along narrow upland drainageways and on



Most soils in this unit are easy to till and are readily penetrated by roots to a depth of several feet, but the soils in the southeastern part of the county have a narrower range of workability and a fine textured subsoil that inhibits deep root penetration. These soils are highly productive to moderately productive if properly managed.

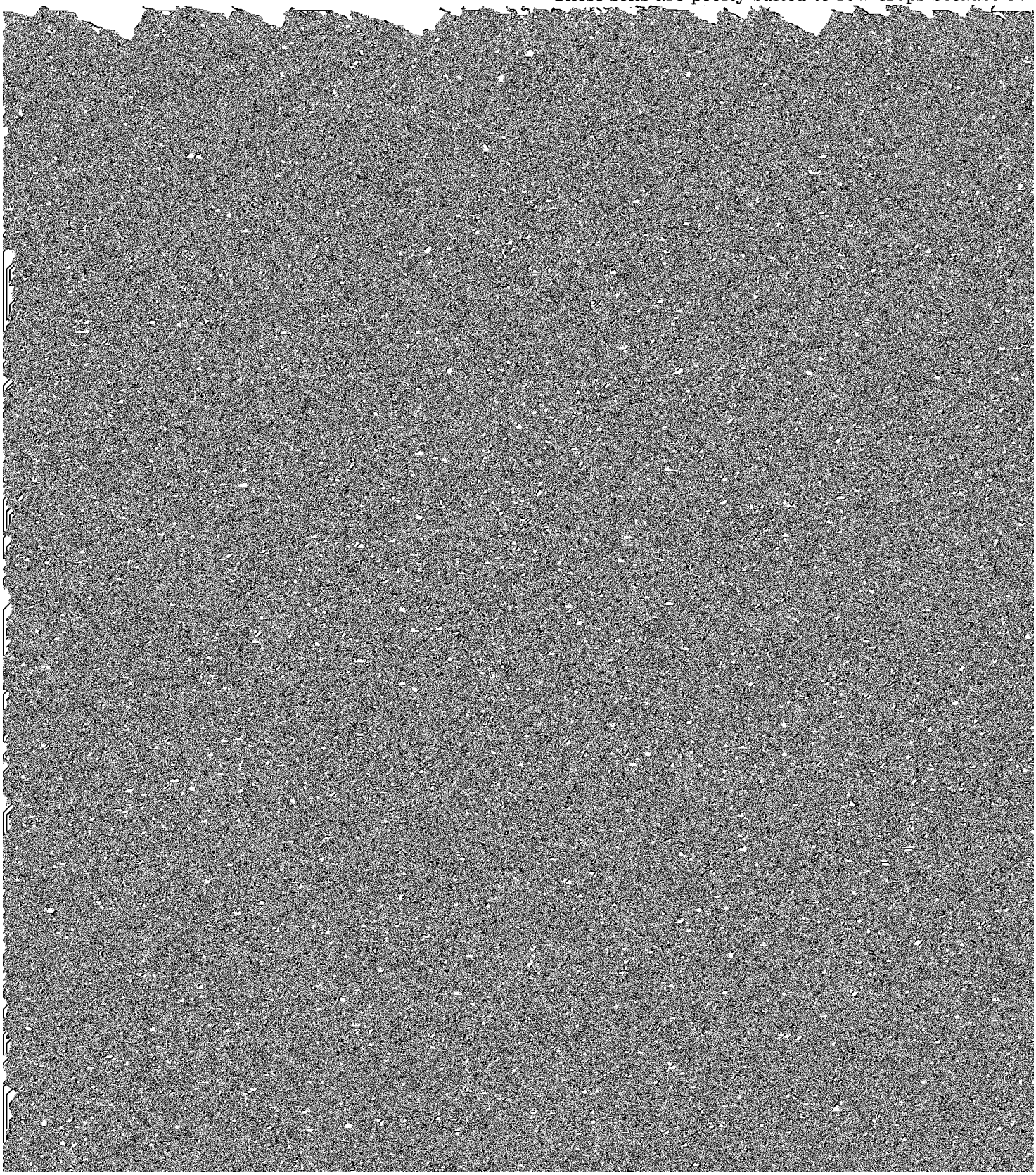
The soils in this unit are well suited to moderately well suited to cultivated crops. Corn and soybeans can be grown frequently if erosion is controlled. Terraces are not suitable where the clay or heavy clay loam subsoil is exposed, because it is difficult to obtain good plant growth on the exposed subsoil. Farming on the contour, stripcropping, and grassed waterways are effective erosion-control practices. The soils respond well to fertilizer. Where these soils are on foot slopes, di-



surrounding soils. A few areas are large enough to be managed separately.

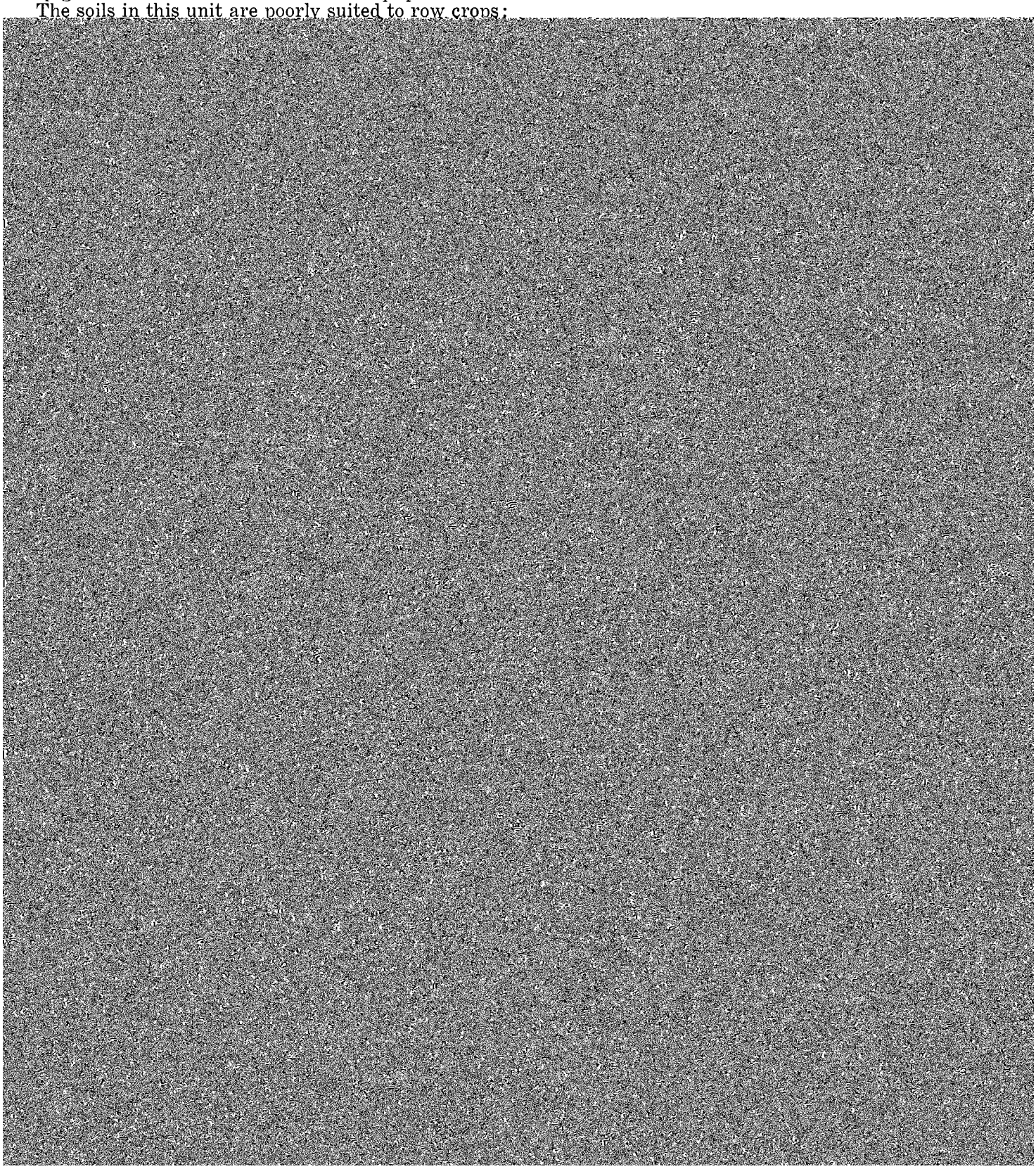
subsoil inhibits deep root penetration. Artificial drainage is not needed.

These soils are poorly suited to row crops because of



of this horizon. Properly placed interceptor tiles are beneficial in controlling these sidehill seeps. In places, deep gullies interfere with use of farm equipment.

The soils in this unit are poorly suited to row crops; and legumes, and pasture renovation are effective erosion-control practices. These soils respond poorly to fertilizer.



clay, clay loam, sandy loam, or sandy clay loam. Permeability is moderately rapid to very slow, and available water capacity is low to high. Organic matter content is moderate to very low. The hazard of erosion is severe.

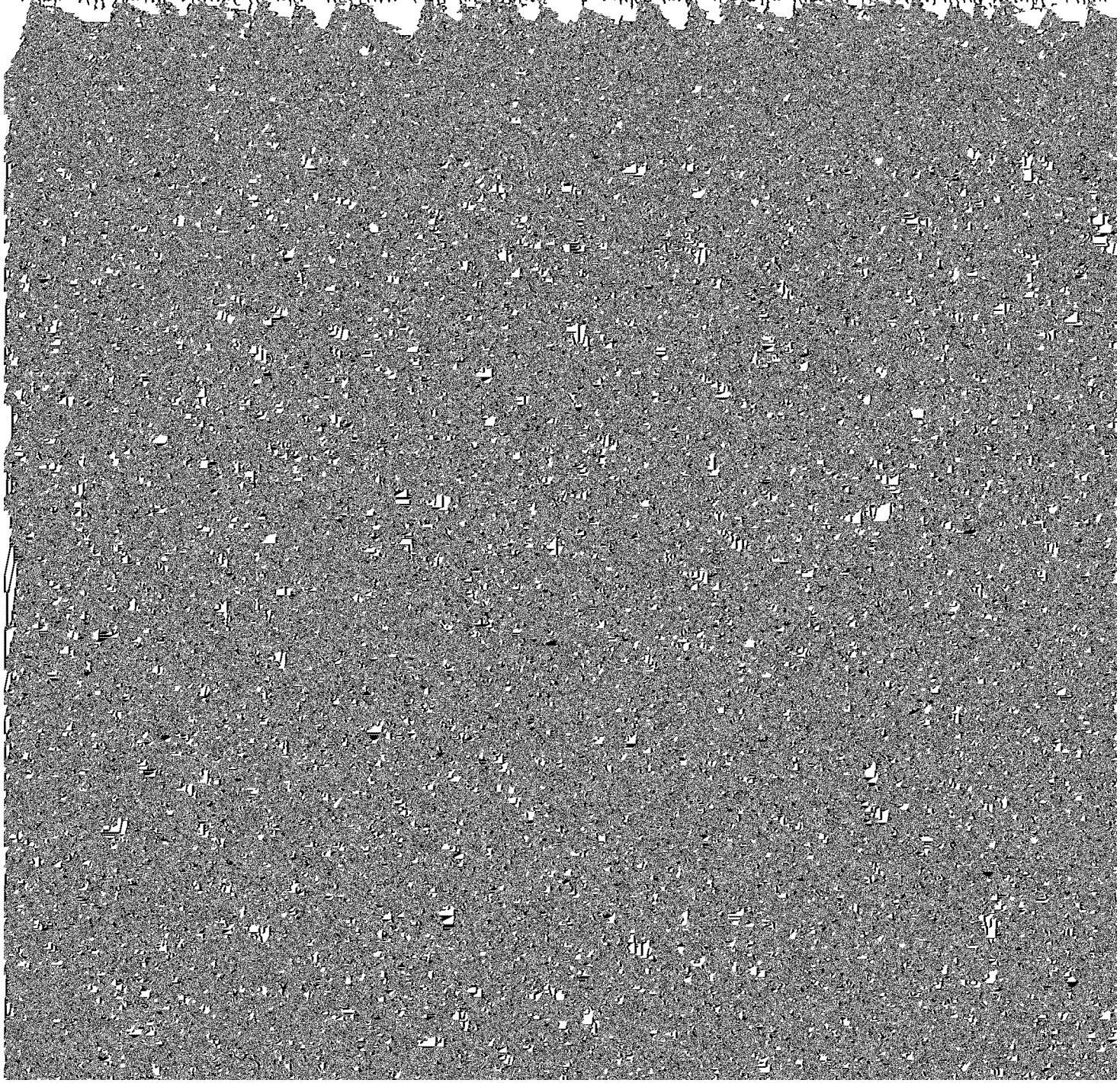
These soils are difficult to till. If tilled when wet they become cloddy and hard. Artificial drainage is not needed on these soils. Interceptor tile can help to control sidehill seeps in the wet soils. In places deep gullies interfere with the use of farm equipment (fig. 18).

These soils are generally unsuited to cultivated crops. They are better suited to hay, pasture, and woodland

subsoil. The subsoil is silty clay loam, silty clay, clay loam, or clay. One soil in this unit is less eroded and has a thin surface layer of silt loam. Permeability is moderately slow to very slow, and available water capacity ranges from high to low. Organic matter content is low or very low. The hazard of erosion is severe.

These soils are difficult to till. If tilled when wet they become cloddy and hard. Artificial drainage is not needed on these soils. Interceptor tile can help to control sidehill seeps. In places deep gullies interfere with the use of farm equipment.

These soils are not suited to cultivated crops. They



land soils. Cultural operations are limited on the steep and very steep soils. The water available to plants is sometimes less than optimum, especially on the steep and very steep soils and on south- and southwest-facing slopes. Available water capacity is lower in the Chelsea soils in the Ladoga-Chelsea complex and in Bauer, Caleb, and Gosport soils than in other soils of this group. Permeability is mainly moderate or moderately slow, but it is rapid in Chelsea soils and is slow or very slow in Bauer and Gosport soils. The surface layer of most of the soils is slightly acid or medium acid.

ENVIRONMENTAL PLANTING GROUP 2.—In this group are wet soils and some that are subject to ponding or flooding. Maximum duration of standing water is a few days to about a week, except during unusually wet periods. Artificial drainage systems have been installed in many places. Poor tilth is a concern at times.

lems, which clearly show need for careful planning and for broad understanding of the physical and economic aspects involved when the use of land is changed.

This soil survey helps in planning these developments and in solving problems that result when use of the land is changed. Planning officials and developers, as well as homeowners and others, can find useful information on the soil maps, in the text, and in the tables in this survey. The detailed soil map in the back of the survey is useful because it shows the location of each of the soils in the county. The colored general soil map that precedes the detailed soil map shows the pattern of the major soils within the county. All of the soils are discussed in detail in the section "Descriptions of the soils."

The section "Environmental plantings" is a guide for persons who are interested in planting trees and

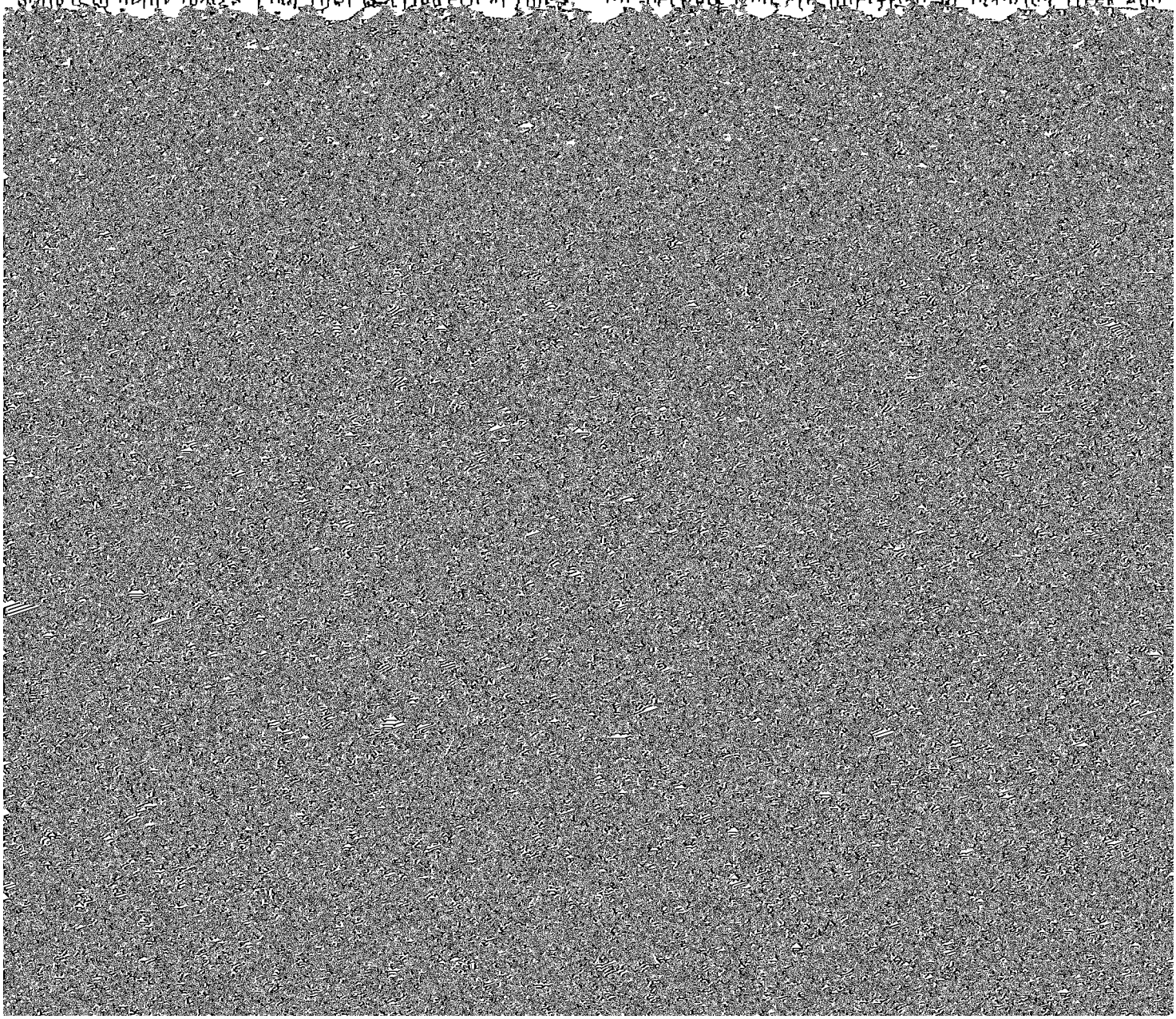
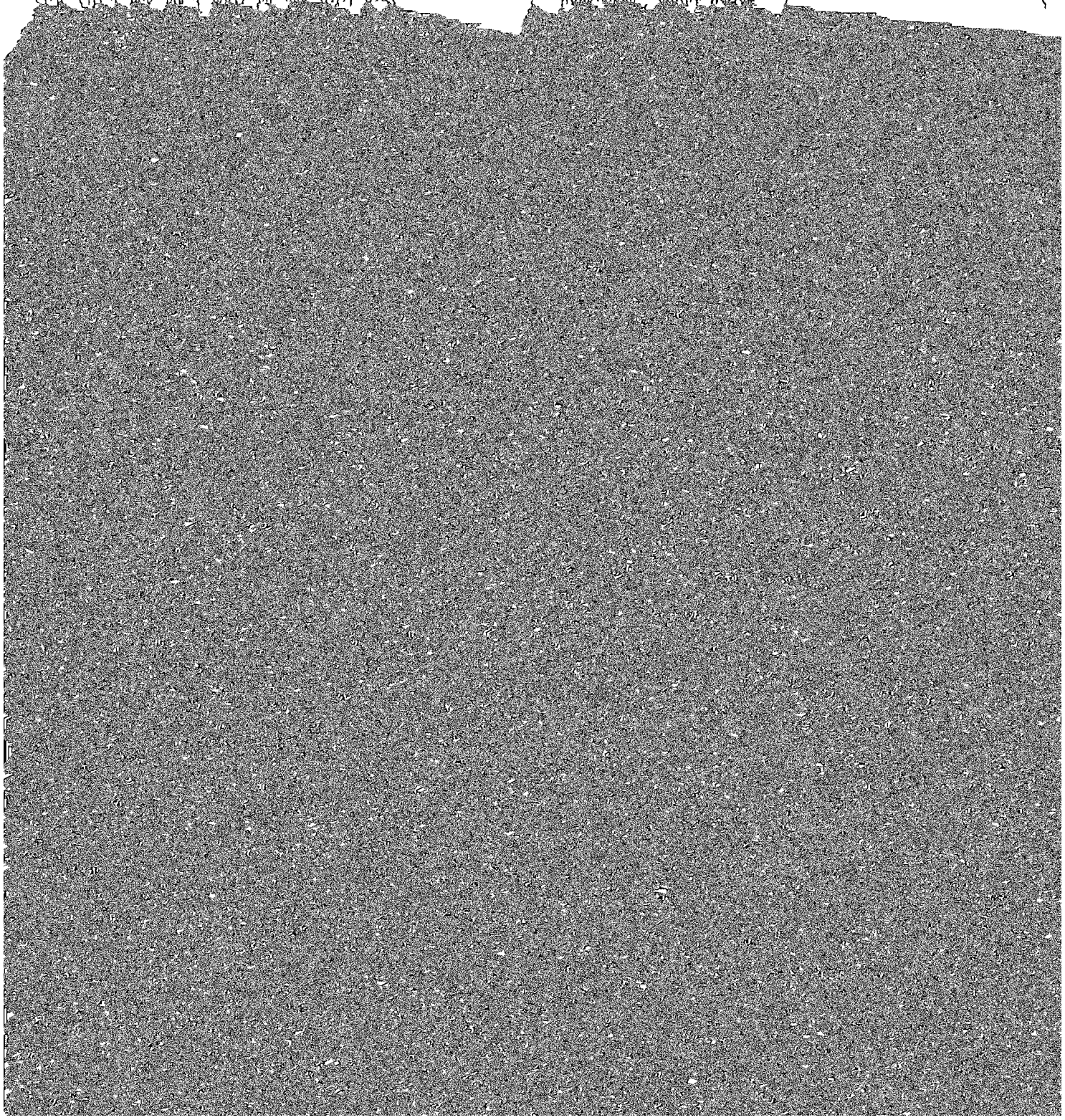


TABLE 3.—*Environmental planting groups of*

Environmental planting group	Shade trees	Street trees
Group 1: 7, 7B, 8B, 23C, 23C2, 24D2, 24E2, 24F2, 65D, 65E, 65E3, 65F, 65G, 75, 76B, 76C, 76C2, 76D2,	American basswood, honey locust, green ash,	Green ash, hackberry, pin oak, sugar maple.



soils and suited trees and shrubs for planting

Hedges and screens	Woodland planting	Windbreak planting	Wildlife planting
Lilac, American cranberrybush, Tatarian honeysuckle, silky dogwood, arrowwood viburnum, hawthorn.	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple, selected poplars.	Eastern white pine, red pine, Colorado blue spruce, Norway spruce, Scotch pine, white spruce, European larch, eastern redcedar, green ash, hackberry, eastern dogwood, Douglas-fir, Tatarian honeysuckle, pin oak, Russian-olive, silver maple, lilac.	Blackhaw, lilac, gray dogwood, alternate-leaf dogwood, autumn-olive, Tatarian honeysuckle, midwest Manchurian crabapple.
Northern white-cedar, silky dogwood, American cranberrybush, Lombardy poplar.	Eastern cottonwood	Silver maple, selected poplars, laurel willow, sycamore, green ash, hackberry [1], northern white-cedar, eastern redcedar [1], white spruce [1], Norway spruce. [1]	Red-osier dogwood, eastern redcedar, northern white-cedar, silky dogwood, American cranberrybush.
Eastern redcedar, Russian-olive, honeysuckle, lilac, Siberian peashrub.	Eastern white pine, Scotch pine, European larch, eastern redcedar.	Red pine, eastern white pine, Scotch pine, eastern redcedar, green ash, hackberry, Siberian peashrub.	Blackhaw, lilac, gray dogwood, alternate-leaf dogwood, autumn-olive.
Eastern redcedar, lilac, honeysuckle, arrowwood viburnum, hawthorn.	(2)	Eastern redcedar, green ash, hackberry, jack pine, American plum.	Eastern redcedar, gray dogwood, blackhaw, lilac, honeysuckle, autumn-olive, American plum.

[2] Woodland plantings are not recommended for environmental planting group 4.

winter. Examples include oak, maple, elm, basswood, walnut, hickory, honeysuckle, dogwood, and ninebark. Their leaves, buds, or seeds provide important food and cover for squirrels, deer, and birds.

Coniferous trees and shrubs retain their leaves throughout the year. These include eastern white pine, eastern red cedar, Austrian pine, Norway spruce, Scotch pine, jack pine, and pfitzer juniper. These plants furnish important winter cover for wild birds and mammals.

Wetland plants include smartweed, bulrush, cattail, and arrowhead. These plants provide both food and cover for the many kinds of waterfowl in Warren County.

Shallow water areas refers to the capacity of a soil to retain water in water areas that have a maximum depth of 5 feet.

The ratings in table 5 are good, fair, poor, or very poor. Generally, soils producing the most abundant crop of grain, grass or legumes, are rated *good*. Soils providing the best conditions for growing conifers, hardwoods, wild herbaceous plants, and wetland plants or for holding water for impoundment are also rated *good*.

Soils that are artificially drained can produce different vegetation than soils that are naturally poorly drained. Artificially drained soils in Warren County are used to produce grain and seed crops or grasses

uated in table 5 for their potential to develop habitat for three general kinds of wildlife: open-land, woodland, and wetland.

Open-land wildlife includes pheasant, cottontail rabbit, and bobwhite quail. Their habitat is composed of cropland, pasture, road ditches, and railroad rights-of-way. Much of Warren County is composed of this type of habitat. Poorly drained soils rated for open-land wildlife are given two ratings for drained and undrained conditions, respectively.

Woodland wildlife includes white-tailed deer, eastern fox squirrel, and red fox. Their habitat is the natural timbered areas scattered throughout Warren County.

Wetland wildlife includes mink, muskrat, beaver, raccoon, and the many species of ducks and geese. Their habitat is mainly the shallow water potholes and marsh areas. Few of these areas are present in Warren County. Some of the wetland wildlife is well adapted to creeks, ponds, and other water areas in the county.

Engineering uses of the soils [4]

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those

TABLE 4.—*Use of the soils for recreational development*

Soil series and map symbols	Degree of limitation and major features affecting use for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ackmore: 430	Severe: subject to flooding; somewhat poorly drained.	Severe: subject to flooding; somewhat poorly drained.	Severe: subject to flooding; somewhat poorly drained.	Moderate: somewhat poorly drained; subject to flooding.
Adair: 93D2	Moderate: moderately well drained to somewhat poorly drained; slow to moderately slow permeability; slopes of 9 to 14 percent; clay loam surface layer.	Moderate: moderately well drained to somewhat poorly drained; slopes of 9 to 14 percent; clay loam surface layer.	Severe: slopes of 9 to 14 percent; moderately well drained to somewhat poorly drained; slow to moderately slow permeability; clay loam surface layer.	Moderate: moderately well drained to somewhat poorly drained; clay loam surface layer.
93E2, 93F2	Severe: slopes of 14 to	Severe: slopes of 14	Severe: slopes of 14	Moderate: moderately

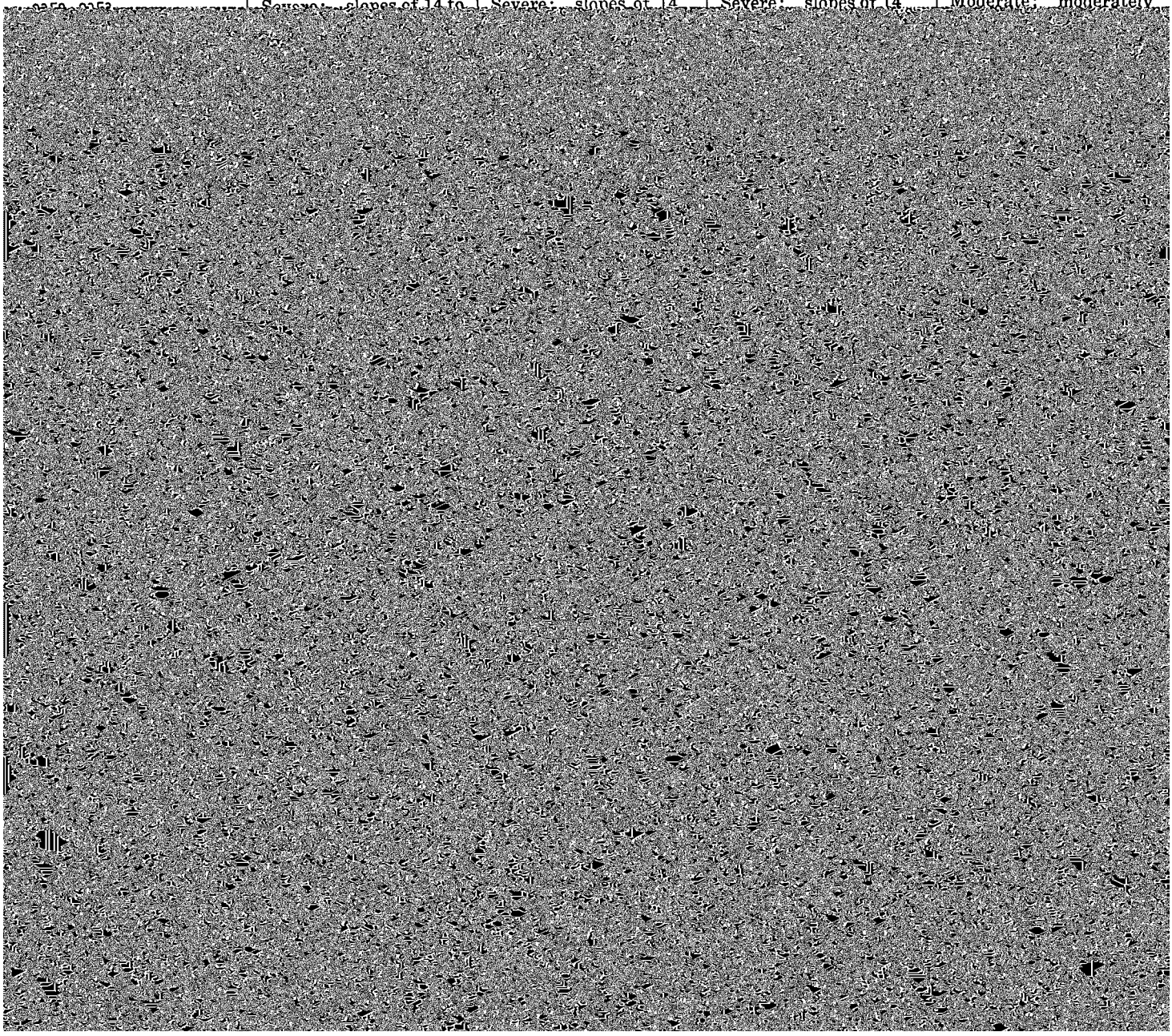


TABLE 4.—*Use of the soils for recreational development*—Continued

Soil series and map symbols	Degree of limitation and major features affecting use for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Bauer:				
185D2	Moderate: slow permeability to very slow permeability; slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent; slow permeability to very slow permeability.	Slight.
185E2, 185E3	Severe: slopes of 14 to 18 percent; slow permeability to very slow permeability.	Severe: slopes of 14 to 18 percent.	Severe: slopes of 14 to 18 percent; slow permeability to very slow permeability.	Moderate: slopes of 14 to 18 percent.
Bremer: 43	Severe: poorly drained; slow permeability; silty clay loam surface layer.	Severe: poorly drained; silty clay loam surface layer.	Severe: poorly drained; slow permeability; silty clay loam surface layer.	Severe: poorly drained; silty clay loam surface layer.
Caleb: 451D2	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.
Chelsea:				
63C2	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Severe: slopes of 5 to 9 percent; loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.
63D2	Severe: slopes of 9 to 18 percent; loamy fine sand surface layer.	Severe: slopes of 9 to 18 percent; loamy fine sand surface layer.	Severe: slopes of 9 to 18 percent; loamy fine sand surface layer.	Moderate: slopes of 9 to 18 percent; loamy fine sand surface layer.
Clarinda: 222C, 222C2, 222D2.	Severe: poorly drained; very slow permeability.	Severe: poorly drained.	Severe: poorly drained; very slow permeability; slopes of 5 to 14 percent.	Severe: poorly drained.
Clearfield: 69C, 69C2	Severe: poorly drained; moderately slow permeability; silty clay loam surface layer.	Severe: poorly drained; silty clay loam surface layer.	Severe: poorly drained; moderately slow permeability; slopes of 5 to 9 percent; silty clay loam surface layer.	Severe: poorly drained; silty clay loam surface layer.
Clinton:				
80B	Slight	Slight	Moderate: slopes of 2 to 5 percent.	Slight.
80C2	Slight	Slight	Severe: slopes of 5 to 9 percent.	Slight.
80D2	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.
Colo: 11B, 133, 133B	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.
Downs:				
162	Slight	Slight	Slight	Slight.
162B, T162B	Slight	Slight	Moderate: slopes of 2 to 5 percent.	Slight.
162C2	Slight	Slight	Severe: slopes of 5 to 9 percent.	Slight.
162D2	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.

TABLE 4.—*Use of the soils for recreational development*—Continued

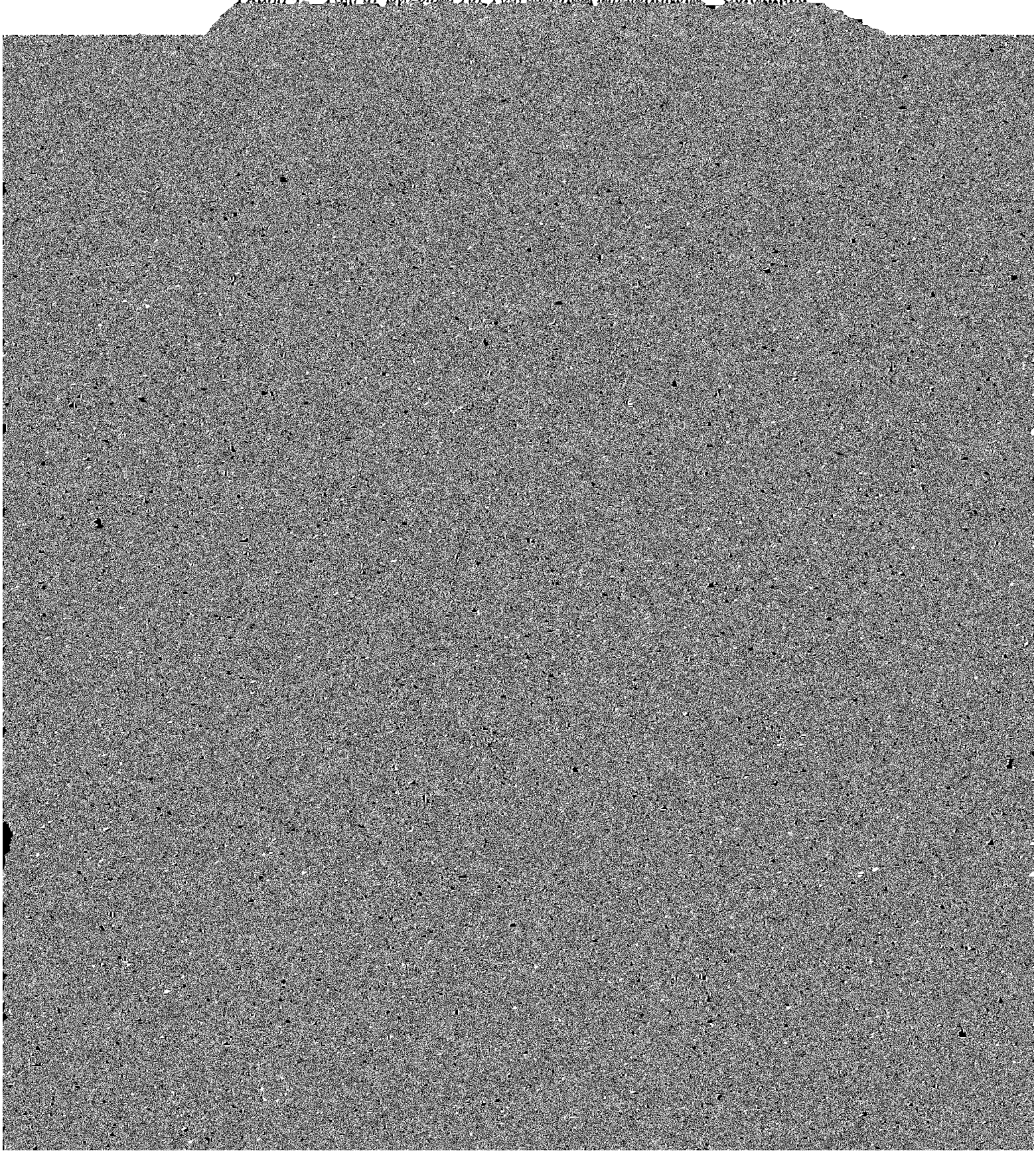


TABLE 4.—*Use of the soils for recreational development*—Continued

Soil series and map symbols	Degree of limitation and major features affecting use for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Kennebec: 212	Severe: subject to flooding.	Moderate: subject to flooding.	Severe: subject to flooding.	Moderate: subject to flooding.
Keswick: 425D	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.
Ladoga: 76B, T76B	Slight	Slight	Moderate: slopes of 2	Slight.

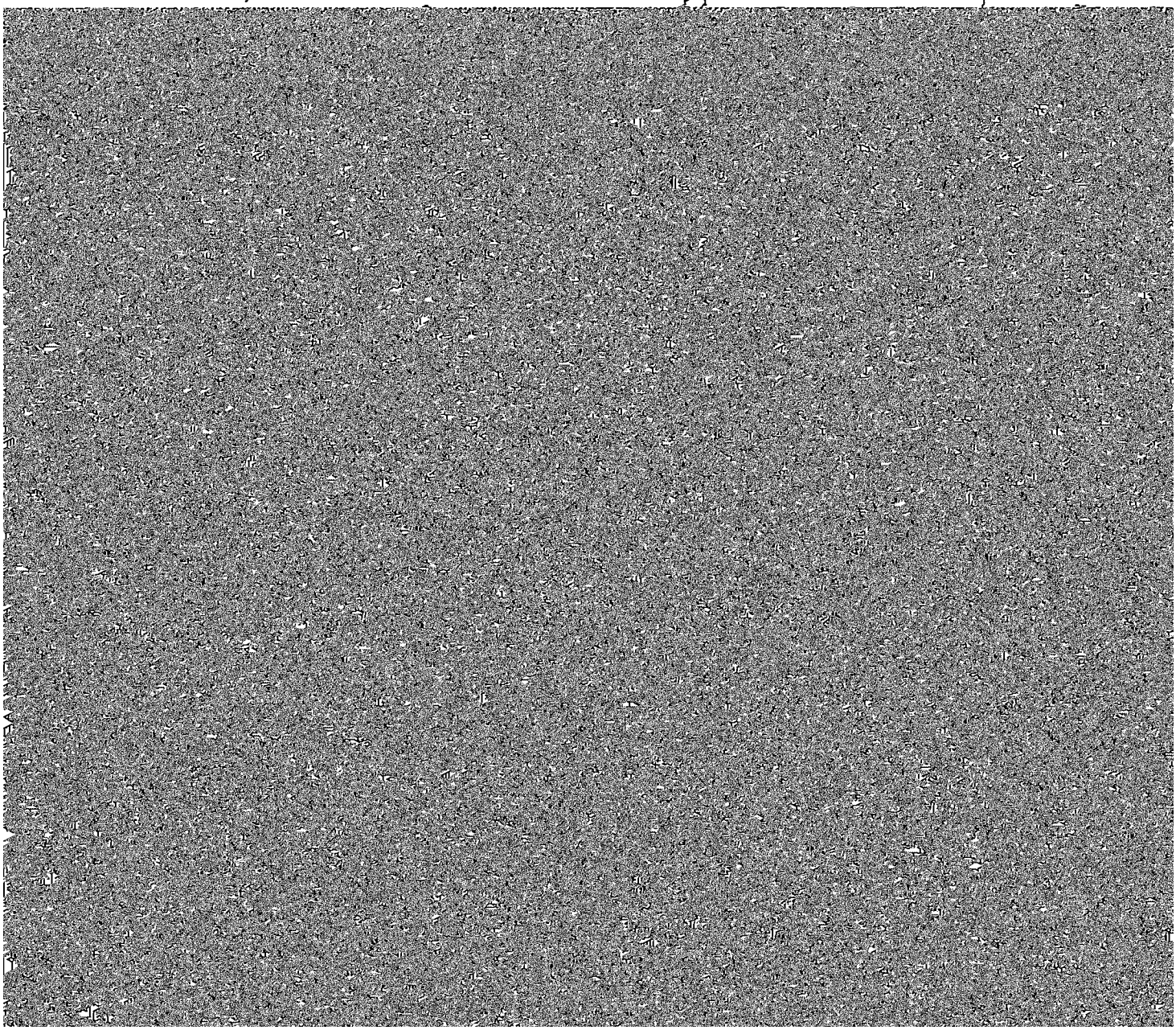


TABLE 4.—*Use of the soils for recreational development*—Continued

	Degree of limitation and major features affecting use for—
[illegible]	[illegible]

TABLE 4.—*Use of the soils for recreational development*—Continued

Soil series and map symbols	Degree of limitation and major features affecting use for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Shelby:				
24D2	Moderate: slopes of 9 to 14 percent; clay loam surface layer.	Moderate: slopes of 9 to 14 percent; clay loam surface layer.	Severe: slopes of 9 to 14 percent; clay loam surface layer.	Moderate: clay loam surface layer.
24E2, 24F2	Severe: slopes of 14	Severe: slopes of 14	Severe: slopes of 14	Moderate: slopes of 14

TABLE 5.—*Potential of the*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops [1]	Grasses and legumes [1]	Wild herbaceous plants	Hardwood trees and shrubs
Ackmore: 430	Good or fair	Good or fair	Good	Good
Adair:				
93D2	Fair	Good	Good	Good
93E2, 93E3	Poor	Fair	Good	Good
192D2	Fair	Good	Good	Good
Alluvial land: 315, C315	Poor	Fair	Fair	Good

soils for wildlife

Elements of wildlife habitat—Continued			Kinds of wildlife habitat		
Coniferous trees and shrubs	Wetland plants	Shallow water areas	Open-land [1]	Woodland	Wetland
Good	Fair	Fair	Good or fair	Good	Fair.
Good	Very poor	Very poor	Good	Good	Very poor

TABLE 5.—*Potential of the*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops [1]	Grasses and legumes [1]	Wild herbaceous plants	Hardwood trees and shrubs
Kennebec: 212	Good	Good	Good	Good
Keswick: 425D	Fair	Good	Good	Good
Ladoga:				
76B, T76B	Good	Good	Good	Good
76C, 76C2, 76D2, T76C2	Fair	Good	Good	Good
427C2, 427D2	Fair	Fair	Good	Fair
Lamoni: 822D2, 822D3	Fair	Good	Good	Good

soils for wildlife—Continued

Elements of wildlife habitat—Continued			Kinds of wildlife habitat		
Coniferous trees and shrubs	Wetland plants	Shallow water areas	Open-land [1]	Woodland	Wetland
Good	Fair	Fair	Good	Good	Fair.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Very poor	Very poor	Poor	Good	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Fair	Fair	Good	Good	Fair.

TABLE 5.—*Potential of the*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops [1]	Grasses and legumes [1]	Wild herbaceous plants	Hardwood trees and shrubs
Watkins: 687B	Good	Good	Good	Good
Weller:				
132B	Good	Good	Good	Good
132C2	Fair	Good	Good	Good

soils for wildlife—Continued

Elements of wildlife habitat—Continued			Kinds of wildlife habitat		
Coniferous trees and shrubs	Wetland plants	Shallow water areas	Open-land [1]	Woodland	Wetland
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Poor	Good	Good	Good or fair	Fair	Good.
Good	Poor	Poor	Good	Good	Poor.
Good	Poor	Very poor	Good	Good	Very poor.
Poor	Good	Good	Good or fair	Fair	Good.

when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a

semisolid to a plastic. If the moisture content is further increased, the material changes from a plastic

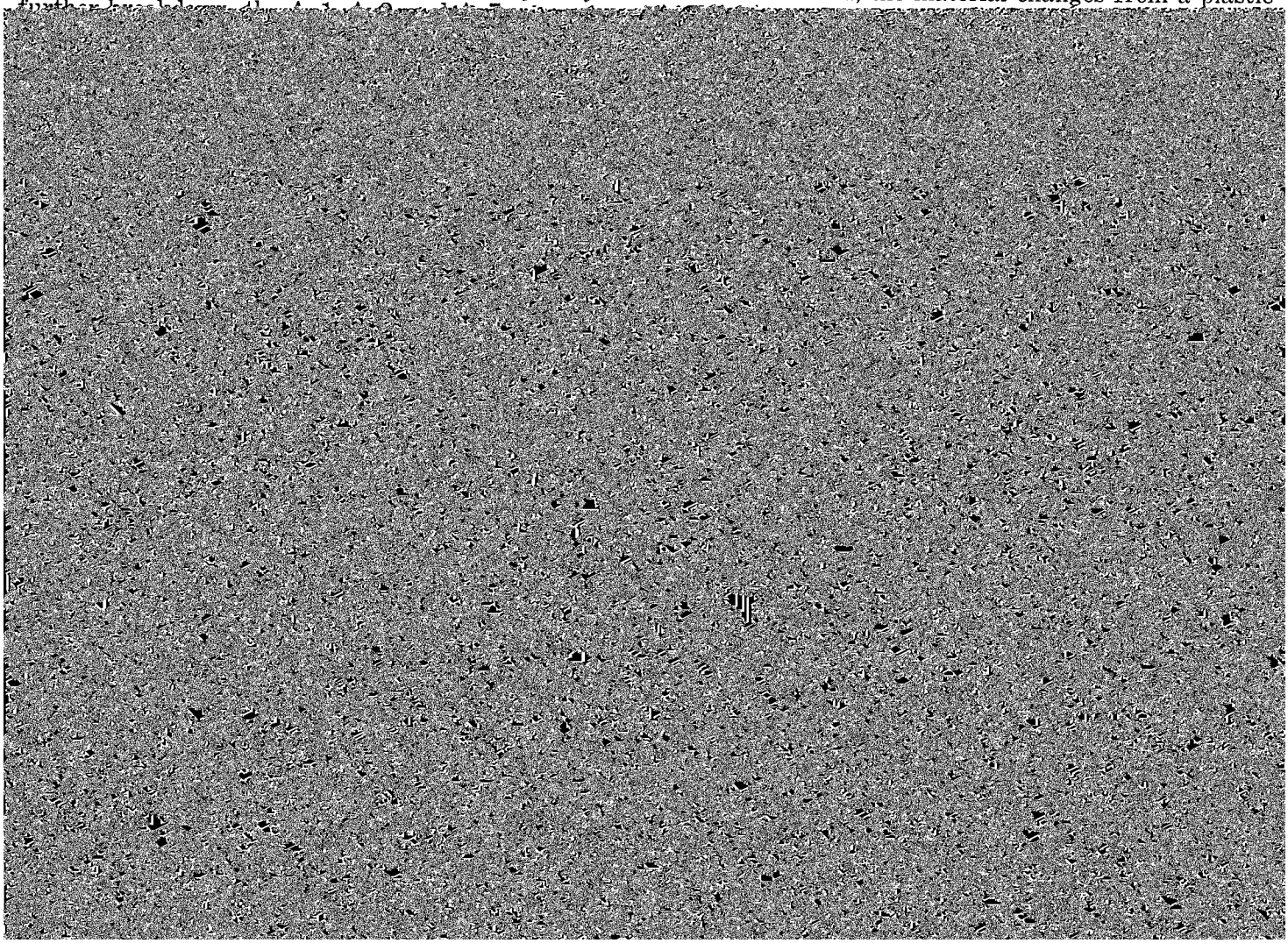


TABLE 6.—*Estimates of soil properties*

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

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHTO
	Ft	*In*			
Ackmore: 430	3–5	0–25	Silt loam	ML or CL	A–4 or A–6
		25–60	Silty clay loam	CL or CH	A–7
*Adair: 93D2, 93E2, 93E3, 192D2	1–3	0–16	Clay loam	CL	A–6
		16–26	Heavy clay loam	CH or CL	A–7
For Shelby parts of 93D2, 93E2, 93E3, see Shelby series.		26–60	Clay loam	CL	A–7 or A–6
*Armstrong: 792D2, 993D2, 993E2	3–5	0–60			
Most properties too variable to estimate.					
Amana: 422	3–5	0–44	Silt loam	ML or CL	A–6
		44–60	Loam	ML or CL	A–4 or A–6
Arbor: 434D	>5	0–14	Loam or light clay loam	CL	A–6
		14–63	Clay loam	CL	A–6 or A–7
Arispe: 23C, 23C2	>5	0–10	Light silty clay loam	CL or CH	A–6 or A–7
		10–50	Silty clay loam	CL or CH	A–6 or A–7
		50–60	Light silty clay loam	CL or CH	A–6 or A–7
*Armstrong: 792D2, 993D2, 993E2, 993E3.	1–3	0–9	Loam or silt loam	CL or ML	A–4 or A–6
		9–14	Clay loam	CL	A–6 or A–7
For Gara parts of 993D2, 993E2, and 993E3, see Gara series.		14–32	Clay	CH or CL	A–7
		32–60	Clay loam	CL	A–6 or A–7
Bauer: 185D2, 185E2, 185E3	>5	0–13	Silt loam or silty clay loam	CL	A–6
		13–60	Silty clay or clay shale	CH	A–7
Bremer: 43	1–3	0–18	Silty clay loam	CL, CH or MH	A–7
		18–47	Silty clay loam or silty clay	CH	A–7
		47–60	Silty clay loam	CH or CL	A–7
Colo: 451D2	>5	0–8	Loam	CL	A–6

significant in engineering

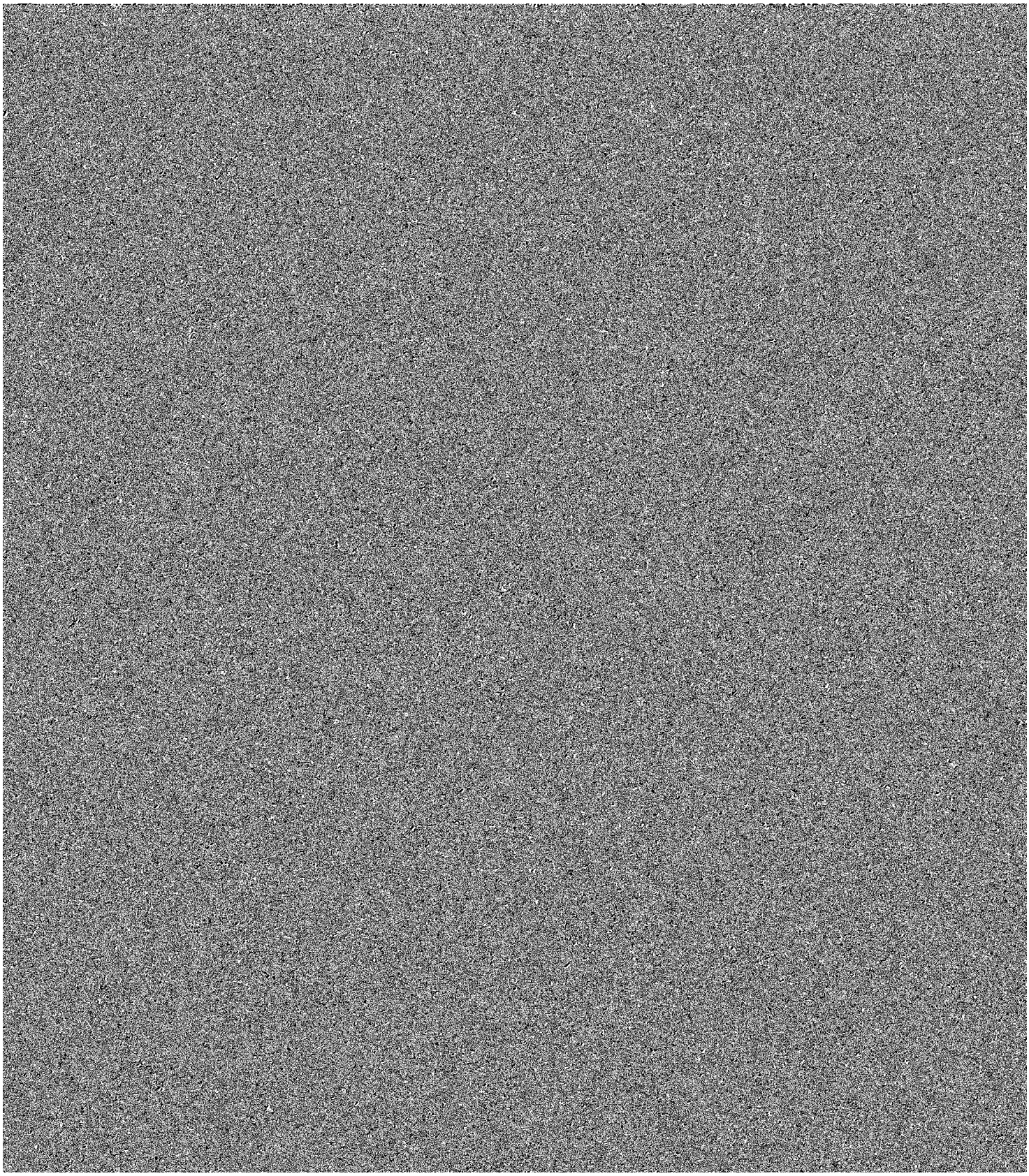


TABLE 6.—*Estimates of soil properties*

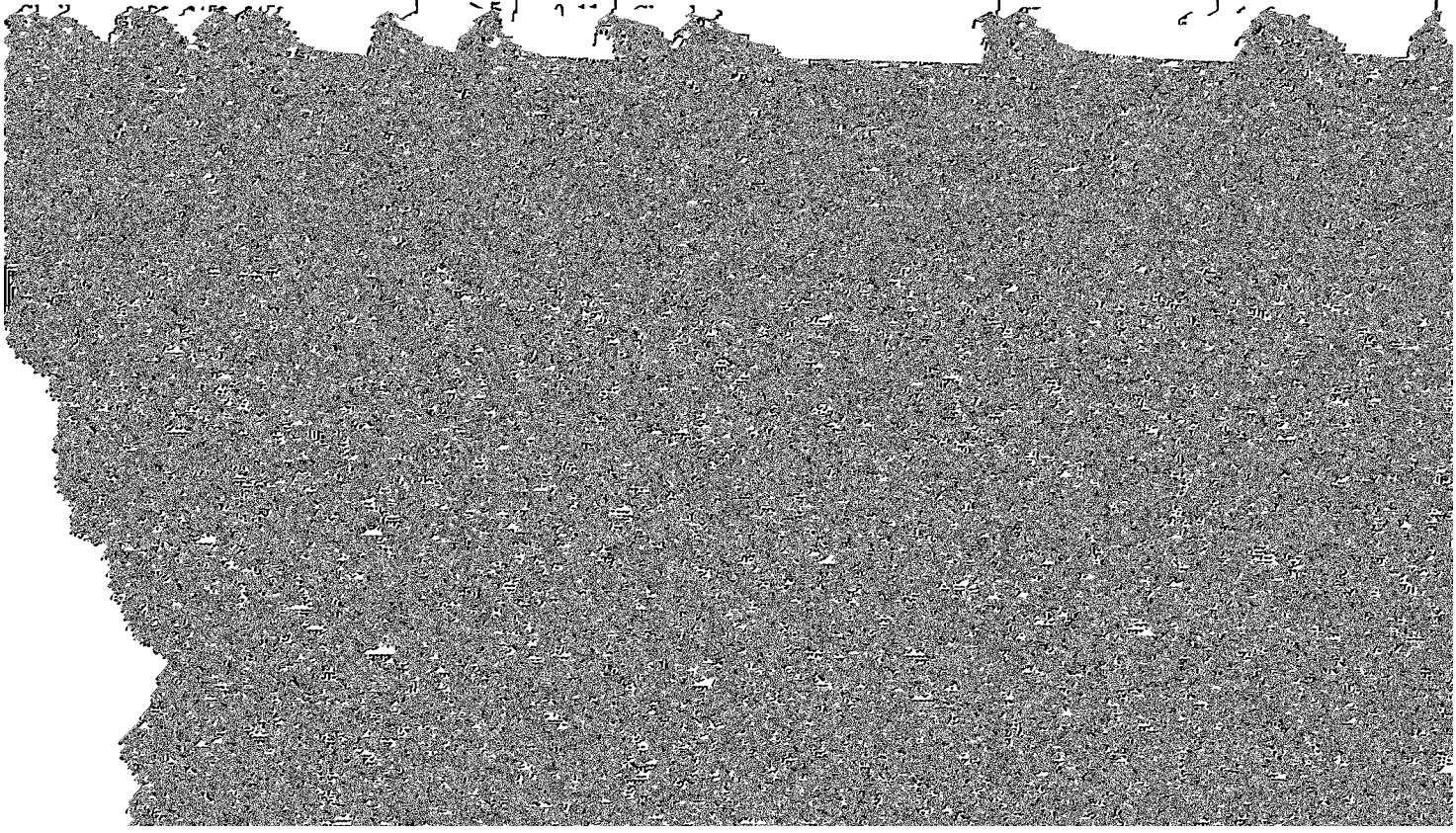
Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHTO
	Ft	*In*			
Fayette: 163B, 163C2, 163D2, 163E2, 163F2.	>5	0–11	Silt loam	ML, CL, or CL–ML	A–4 or A–6
		11–45	Silty clay loam or heavy silt loam.	CL	A–7 or A–6
		45–60	Silt loam	CL	A–6
Gara: 179D2, 179E2, 179F2, 179G	>5	0–14	Loam	CL	A–6
		14–40	Clay loam	CL	A–7
		40–60	Clay loam	CL	A–7
Givin: 75	3–5	0–11	Silt loam	ML or CL	A–4 or A–6
		11–53	Silty clay loam	CL or CH	A–7
		53–60	Silty clay loam	CL	A–6 or A–7
Gosport: 313D, 313E, 313E3, 313F	>5	0–8	Silt loam	CL	A–6
		8–23	Silty clay	CH	A–7
		23–50	Clay shale	CH	A–7
Grundy: 864B	3–5	0–13	Silty clay loam	ML or CL	A–7
		13–18	Silty clay loam	CH or CL	A–7
		18–30	Silty clay or heavy silty clay loam.	CH	A–7
		30–60	Silty clay loam	CH or CL	A–7
*Gullied land: 980B Most properties too variable to estimate. For Ely part, see Ely series. For Colo part, see Colo series.		0–60			
Humeston: 269	1–3	0–21	Silt loam	ML or CL	A–6 or A–7
		21–60	Silty clay or silty clay loam	CH	A–7
Judson: 8B	>5	0–27	Silty clay loam	CL or ML	A–6 or A–7
		27–63	Silty clay loam	CL	A–6 or A–7
Kennebec: 212	3–5	0–41	Silt loam	CL or ML	A–6 or A–7
		41–60	Silt loam	CL	A–6 or A–7
Keswick: 425D	1–3	0–11	Loam	CL	A–6
		11–32	Clay or clay loam	CH	A–7
		32–60	Clay loam or sandy clay loam	CL	A–6 or A–7
*Ladoga: 76B, 76C, 76C2, 76D2, T76B, T76C2, 427C2, 427D2. For Chelsea part of 427C2 and	>5	0–9	Silt loam	ML or CL	A–6 or A–4
		9–60	Silty clay loam	CH or CL	A–6 or A–7

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
				Pct		*In per hr*	*In per in of soil*	*pH range*	
100	100	95–100	95–100	25–35	5–15	0.6–2.0	0.22–0.24	6.1–7.3	Low.
100	100	95–100	95–100	35–45	15–25	0.6–2.0	0.16–0.18	5.6–6.5	Moderate.
100	100	95–100	95–100	30–40	11–20	0.6–2.0	0.20–0.22	5.6–6.0	Moderate.
95–100	95–100	85–95	75–85	30–40	11–20	0.6–2.0	0.20–0.22	6.6–7.3	Low.
95–100	95–100	90–100	75–85	41–50	20–30	0.2–0.6	0.16–0.18	4.5–6.5	Moderate.
95–100	95–100	90–100	75–85	41–50	20–30	0.2–0.6	0.14–0.16	7.4–7.8	Moderate.
100	100	95–100	95–100	30–40	5–15	0.6–2.0	0.22–0.24	5.6–7.3	Low.
100	100	95–100	95–100	41–55	20–35	0.2–0.6	0.18–0.20	5.1–6.0	High.
100	100	95–100	95–100	35–50	15–25	0.2–0.6	0.18–0.20	5.6–6.0	Moderate.
100	100	90–100	70–90	30–40	11–20	0.6–2.0	0.22–0.24	6.1–6.5	Low.
100	100	95–100	90–95	50–65	25–35	<0.06	0.11–0.13	5.1–5.5	High.
100	100	95–100	85–95	55–70	25–35	<0.06	0.06–0.10	5.1–5.5	High.

TABLE 6.—*Estimates of soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHTO
	Ft	*In*			
*Mystic: 94D2, 94E2, 592C2, 592D2 — For Caleb part of 94D2 and 94E2, see Caleb series.	1–3	0–8 8–60	Silt loam Heavy clay loam, clay, or silty clay.	ML or CL CL or CH	A–4 or A–6 A–6 or A–7
Nevin: 88, 88B	3–5	0–16 16–43 43–50	Silty clay loam Silty clay loam Silty clay loam	ML or CL CL CL	A–6 or A–7 A–7 A–6 or A–7
Nira: 570B, 570C2	>5	0–14 14–37 37–60	Silty clay loam Silty clay loam Silty clay loam	ML or CL CL CL	A–6 or A–7 A–7 A–6 or A–7
Nodaway: 220, C220	3–5	0–60	Silt loam	CL–ML, ML, or CL	A–6
Olmitz: 273B, 273C	>5	0–29 29–60	Loam or light clay loam Clay loam	CL CL	A–6 or A–7 A–6 or A–7
Pershing: 131B, 131C2, 131D2	3–5	0–13 13–43 43–60	Silt loam Silty clay loam or silty clay Silty clay loam	ML or CL CH CL or CH	A–4 or A–6 A–7 A–7
Sharpsburg: 370, 370B, 370C, 370C2, 370D2, T370, T370B, T370C.	>5	0–16 16–32 32–50	Silty clay loam Silty clay loam Silty clay loam	ML or CL CH CL or CH	A–7 A–7 A–7



significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
				Pct		*In per hr*	*In per in of soil*	*pH range*	
100	100	95–100	90–100	30–40	5–15	0.6–2.0	0.22–0.24	6.1–7.3	Low.
100	95–100	85–95	65–80	35–55	15–30	0.06–0.2	0.13–0.15	4.5–6.5	High.
100	95–100	90–100	90–100	35–45	11–20	0.6–2.0	0.21–0.23	5.6–7.3	Moderate.
100	95–100	90–100	90–100	41–50	20–30	0.2–2.0	0.18–0.20	5.6–7.3	Moderate.
100	95–100	90–100	90–100	35–50	20–30	0.2–2.0	0.18–0.20	6.6–7.3	Moderate.
100	100	95–100	95–100	35–50	15–25	0.6–2.0	0.21–0.23	6.6–7.3	Moderate.
100	100	95–100	95–100	41–50	20–30	0.2–0.6	0.18–0.20	6.1–7.3	Moderate.
100	100	95–100	95–100	35–45	15–25	0.6–2.0	0.18–0.20	6.6–7.8	Moderate.
100	95–100	90–100	70–90	25–40	5–15	0.6–2.0	0.20–0.22	6.6–7.3	Moderate.
100	90–100	90–95	60–80	35–45	15–25	0.2–2.0	0.19–0.21	5.1–6.0	Low.
100	90–100	90–95	60–80	35–50	15–25	0.2–2.0	0.16–0.18	5.6–6.5	Moderate.
100	100	95–100	95–100	25–40	5–15	0.6–2.0	0.22–0.24	5.6–7.3	Low.
100	100	95–100	95–100	50–65	30–40	0.06–0.2	0.14–0.16	5.1–6.0	High.
100	100	95–100	95–100	45–60	25–35	0.2–0.6	0.18–0.20	6.1–6.5	Moderate.
100	100	95–100	95–100	41–50	15–25	0.6–2.0	0.21–0.23	6.1–6.5	Moderate.
100	100	95–100	95–100	50–60	25–35	0.2–0.6	0.18–0.20	5.1–6.0	High.
100	100	95–100	95–100	41–55	20–30	0.6–2.0	0.18–0.20	5.6–6.0	Moderate.
90–100	90–100	80–90	60–80	25–40	15–25	0.6–2.0	0.17–0.19	6.6–7.3	Moderate.
90–100	90–100	80–90	60–80	35–50	20–30	0.2–0.6	0.16–0.18	5.6–7.3	Moderate.
90–100	90–100	80–90	60–80	30–45	20–30	0.2–0.6	0.14–0.16	7.4–7.8	Moderate.
100	100	95–100	95–100	30–40	5–15	0.6–2.0	0.22–0.24	5.1–6.0	Low.
100	100	95–100	95–100	50–65	25–35	<0.06–0.2	0.11–0.13	5.6–7.3	High.
100	100	95–100	95–100	41–50	20–30	0.2–0.6	0.18–0.20	6.6–7.3	Moderate.
---	---	---	---	50–70	20–40	<0.06	0.08–0.10	4.5–6.0	
100	100	95–100	95–100	35–50	11–20	0.6–2.0	0.21–0.23	5.1–6.0	Moderate.
100	100	95–100	95–100	35–45	15–25	0.6–2.0	0.18–0.20	5.6–6.5	Moderate.
100	100	95–100	95–100	30–45	11–20	0.6–2.0	0.22–0.24	5.6–6.0	Moderate.
100	100	95–100	95–100	41–55	20–30	0.2–2.0	0.18–0.20	6.1–7.3	High.
100	100	95–100	95–100	60–85	45–55	<0.06	0.12–0.14	5.6–7.3	High.
100	100	95–100	95–100	20–35	40–50	<0.06	0.11–0.13	5.6–7.3	High.
100	100	95–100	90–100	45–70	60–85	0.2–0.6	0.21–0.23	7.4–7.8	High.
100	100	95–100	95–100	60–85	40–55	<0.06	0.11–0.13	5.6–7.3	High.
100	100	95–100	85–95	25–40	5–15	0.6–2.0	0.22–0.24	6.6–7.3	Low.
100	100	95–100	85–95	35–45	11–20	0.6–2.0	0.18–0.20	5.6–7.3	Moderate.
100	100	95–100	85–95	35–45	15–25	0.6–2.0	0.18–0.20	5.6–6.0	Moderate.
100	100	95–100	95–100	30–40	5–15	0.6–2.0	0.22–0.24	6.6–7.3	Low.
100	100	95–100	95–100	50–65	30–40	0.06–0.2	0.15–0.17	5.1–6.0	High.
100	100	95–100	95–100	35–45	15–25	0.2–0.6	0.18–0.20	5.6–6.5	Moderate.

TABLE 6.—*Estimates of soil properties*

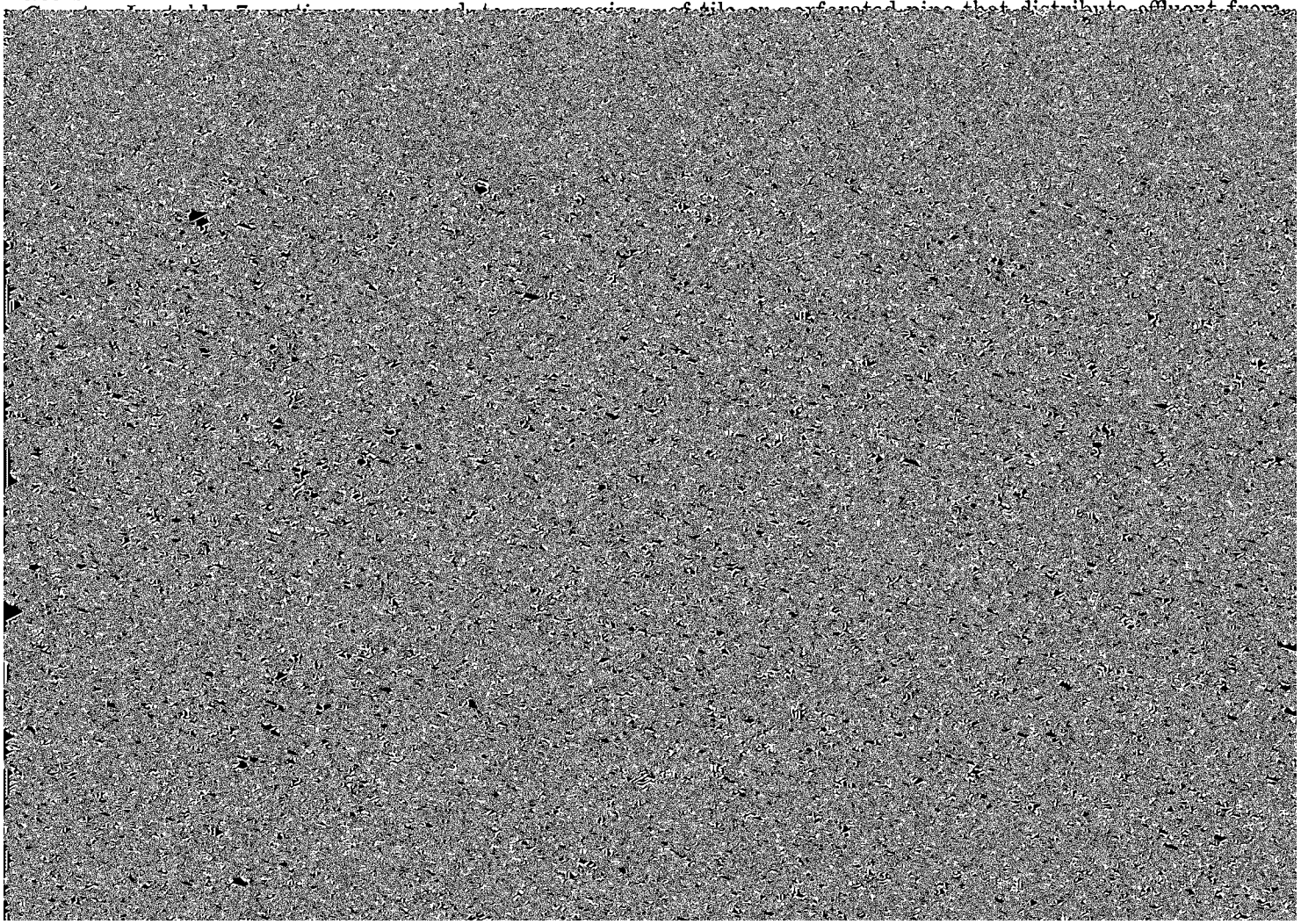
Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHTO
	Ft	*In*			
Winterset: 369	1–3	0–19	Silty clay loam	CL	A–7
		19–43	Silty clay or silty clay loam	CH	A–7
		43–60	Silty clay loam	CL or CH	A–7
Wiota: 7, 7B	>5	0–22	Silt loam or silty clay loam	CL	A–6
		22–50	Silty clay loam	CL or CH	A–6 or A–7
Zook: 54	1–3	0–7	Silty clay loam	CH or CL	A–7
		7–60	Silty clay, silty clay loam	CH	A–7

[1] NP means nonplastic.

6, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Warren

Following are explanations of some of the columns in table 7.

Septic tank absorption fields are subsurface systems



significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
				Pct		*In per hr*	*In per in of soil*	*pH range*	
100	100	95–100	95–100	41–50	15–25	0.2–0.6	0.21–0.23	5.1–5.5	Moderate.
100	100	95–100	95–100	50–60	30–40	0.06–0.2	0.15–0.17	5.1–6.0	High.
100	100	95–100	95–100	41–55	20–30	0.2–0.6	0.18–0.20	6.1–6.5	Moderate.
100	100	95–100	90–100	30–40	11–20	0.6–2.0	0.21–0.23	5.1–5.5	Moderate.
100	100	95–100	90–100	35–55	15–30	0.6–2.0	0.18–0.20	5.1–5.5	Moderate.
100	100	95–100	95–100	41–55	15–25	0.2–0.6	0.21–0.23	0.6–7.3	High.
100	100	95–100	95–100	50–65	35–45	0.06–0.2	0.13–0.15	6.1–7.3	High.

tion ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than that. Even though reliable predictions can be made to a depth of 10 or 15 feet for some soils, every site should be investigated before it is selected.

Local roads and streets, as rated in table 7, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand.

Soil properties that most affect design and construction of roads and streets are load supporting capacity and stability of the subgrade, and the workability and quantity of cut and fill material available. The AASHTO and Unified classifications of the soil material, and also the shrink-swell potential, indicate

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected by ease of working and spreading the soil material, as in preparing a seedbed; natural fertility of the material, or its response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments affect suitability, but also considered in the ratings is damage that results at the area from which topsoil is taken.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage and piping and that has favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in a soil are unfavorable factors.

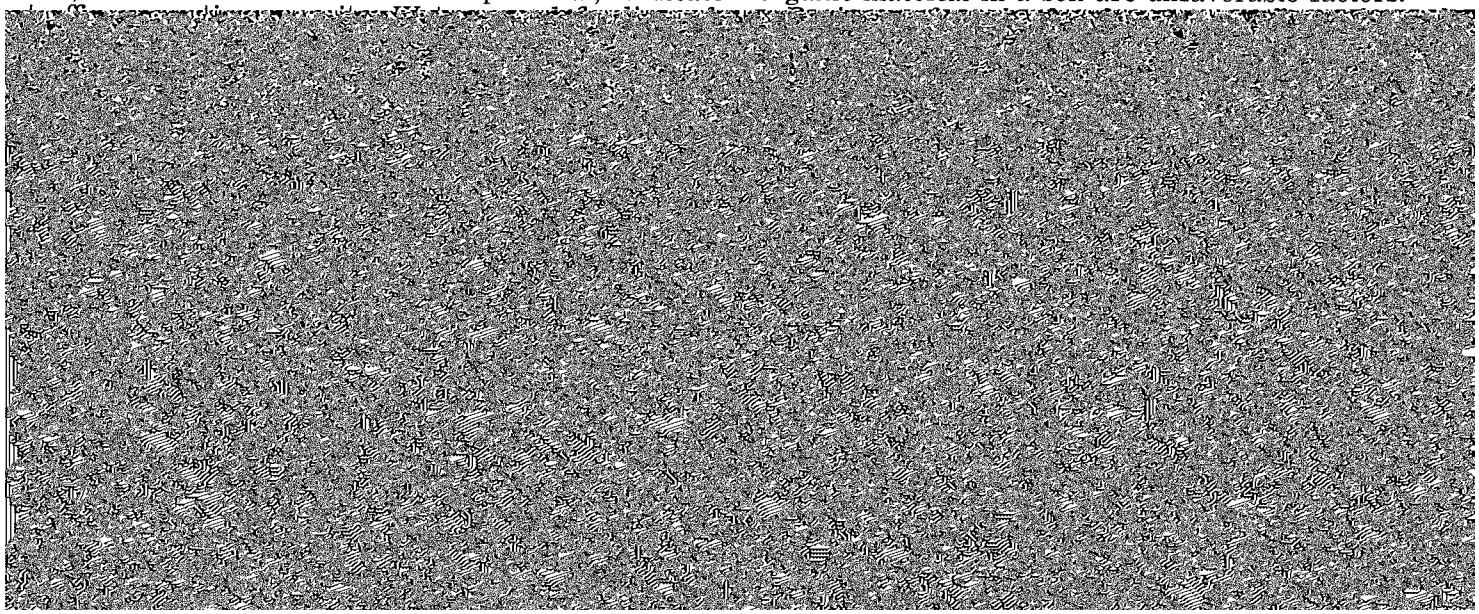


TABLE 7.—*Engineering*

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

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
Ackmore: 430 ------	Severe: seasonal high water table; subject to flooding.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; susceptible to frost action; low strength.	Poor: low strength; high shrink-swell potential; susceptible to frost action;	Not suitable ---

interpretations

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

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Good	Moderate permeability; seasonal high water table at a depth of	Medium to low shear strength; medium com-pressibility;	Moderate per-meability; seasonal high water at a depth of 3 to	Slopes of 0 to 2 percent; some-what poorly drained; sea-sonal high	Slopes of 0 to 2 percent; on bottom lands.	Slopes of 0 to 2 percent; on bottom lands.

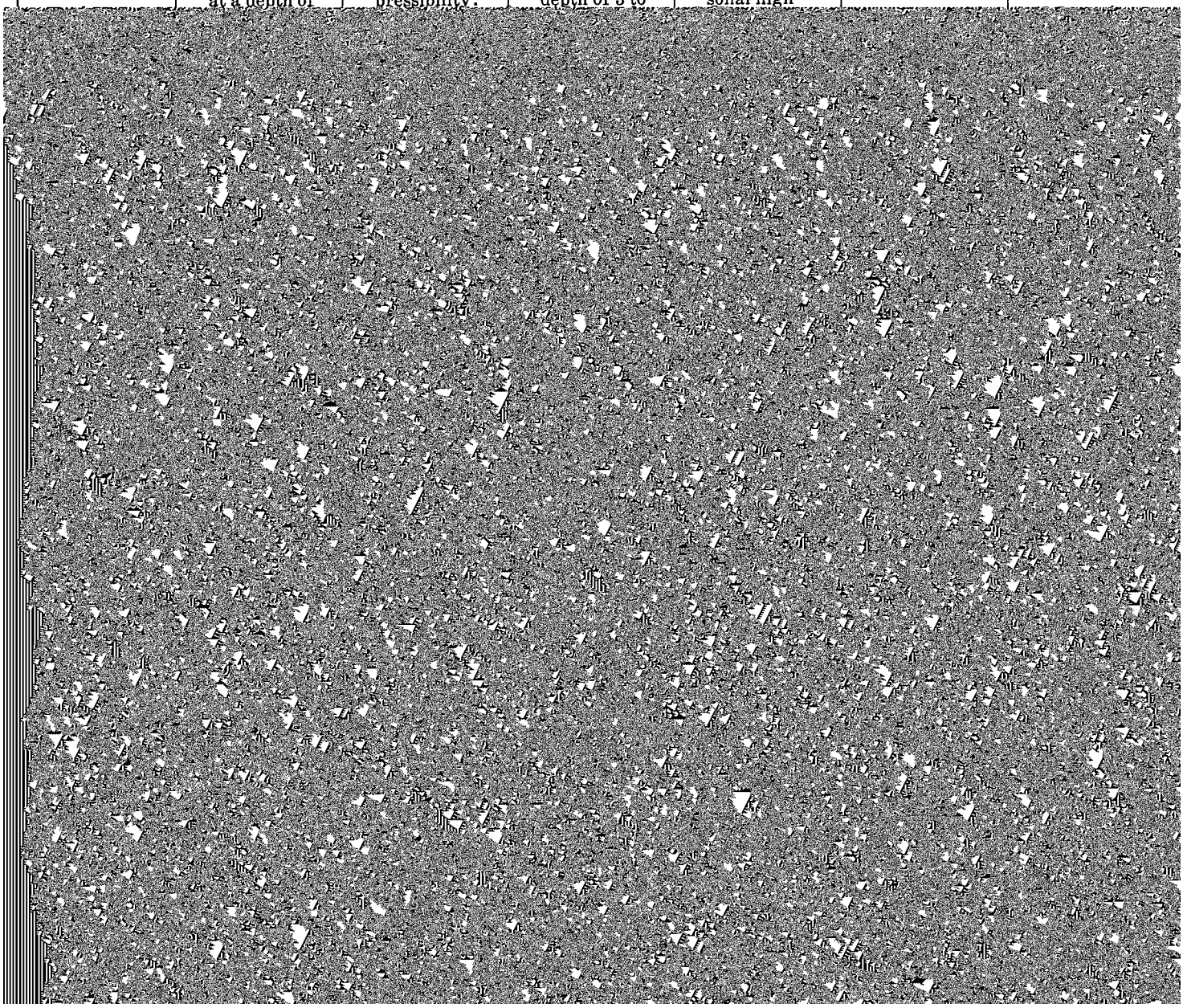


TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
Arbor: 434D	Moderate: slopes of 9 to 14 percent; moderately slow permeability.	Severe: slopes of 9 to 14 percent.	Slight	Moderate: slopes of 9 to 14 percent; moderate shrink-swell potential.	Poor: low shear strength; moderate shrink-swell potential.	Not suitable
Arispe: 23C, 23C2	Severe: moderately slow permeability.	Severe: slopes of 5 to 9 percent.	Moderate: moderately well drained to somewhat poorly drained; silty clay loam texture.	Severe: low strength; high shrink-swell potential; susceptible to frost action.	Poor: low strength; high shrink-swell potential; susceptible to frost action.	Not suitable
*Armstrong: 792D2, 993D2, 993E2, 993E3. For Gara parts of 993D2, 993E2, and 993E3, see Gara series.	Severe: slow permeability; slopes of 9 to 18 percent.	Severe: slopes of 9 to 18 percent.	Severe: moderately well drained to somewhat poorly drained; clay loam texture; seasonal high water table at a depth of 1 foot to 3 feet.	Severe: somewhat poorly drained; moderate to high shrink-swell potential.	Poor: high shrink-swell potential; low strength.	Not suitable
Bauer: 185D2, 185E2, 185E3.	Severe: very slow permeability; slopes of 9 to 18 percent.[1]	Severe: slopes of 9 to 18 percent.	Severe: less than 30 inches to rippable bedrock; silty clay or clay texture.	Severe: slopes of 9 to 18 percent; high shrink-swell potential; low strength.	Poor: low strength; high shrink-swell potential.	Not suitable

interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Fair: slopes of 9 to 14 percent.	Moderately slow permeability to moderate permeability; slopes of 9 to 14 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Natural drainage adequate.	Slopes of 9 to 14 percent; moderate permeability to moderately slow permeability.	Slopes of 9 to 14 percent; hazard of erosion.	Hazard of erosion; slopes of 9 to 14 percent.
Fair: silty clay loam texture.	Moderately slow permeability; slopes of 5 to 9 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Moderately slow permeability; slopes of 5 to 9 percent.	Slopes of 5 to 9 percent; moderately well drained to somewhat poorly drained; moderately slow permeability; hazard of erosion.	Slopes of 5 to 9 percent; hazard of erosion; silty clay loam subsoil; moderately slow permeability.	Hazard of erosion; moderately well drained to somewhat poorly drained.
Fair: clay loam texture below a depth of 9 inches; slopes of 9 to 18 percent.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 9 to 18 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility	Water seeps downslope along slowly permeable layer and causes perched seasonal high water table at a depth of 1 foot to 3 feet;	Slopes of 9 to 18 percent; seasonal high water table at a depth of 1 foot to 3 feet; hazard of erosion; slow permeability.	Slopes of 9 to 18 percent; hazard of erosion; clay subsoil; slow permeability; plant cover difficult to establish.	Hazard of erosion; clay subsoil at a depth of 14 inches; moderately well drained to somewhat poorly drained.

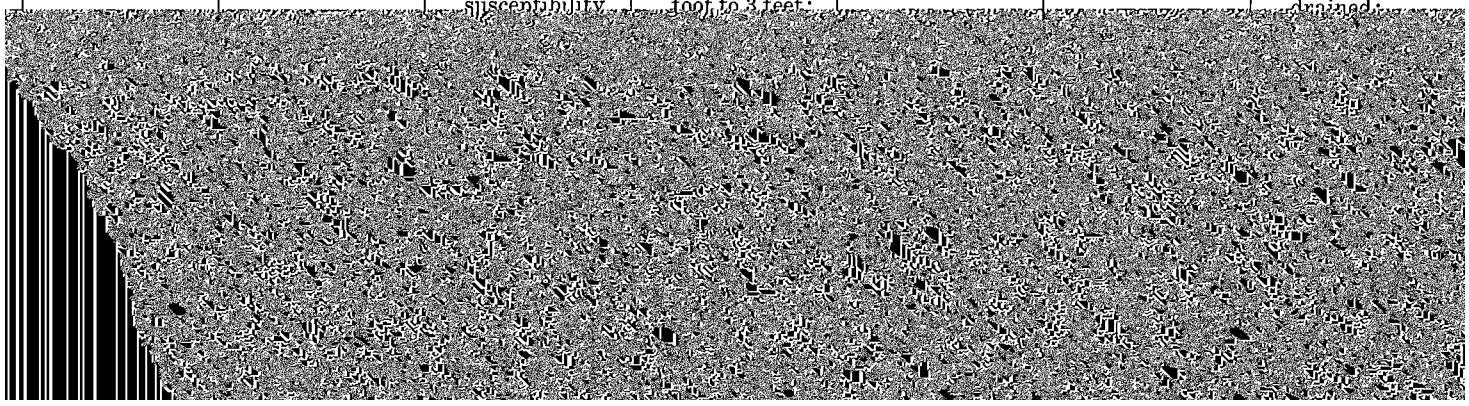


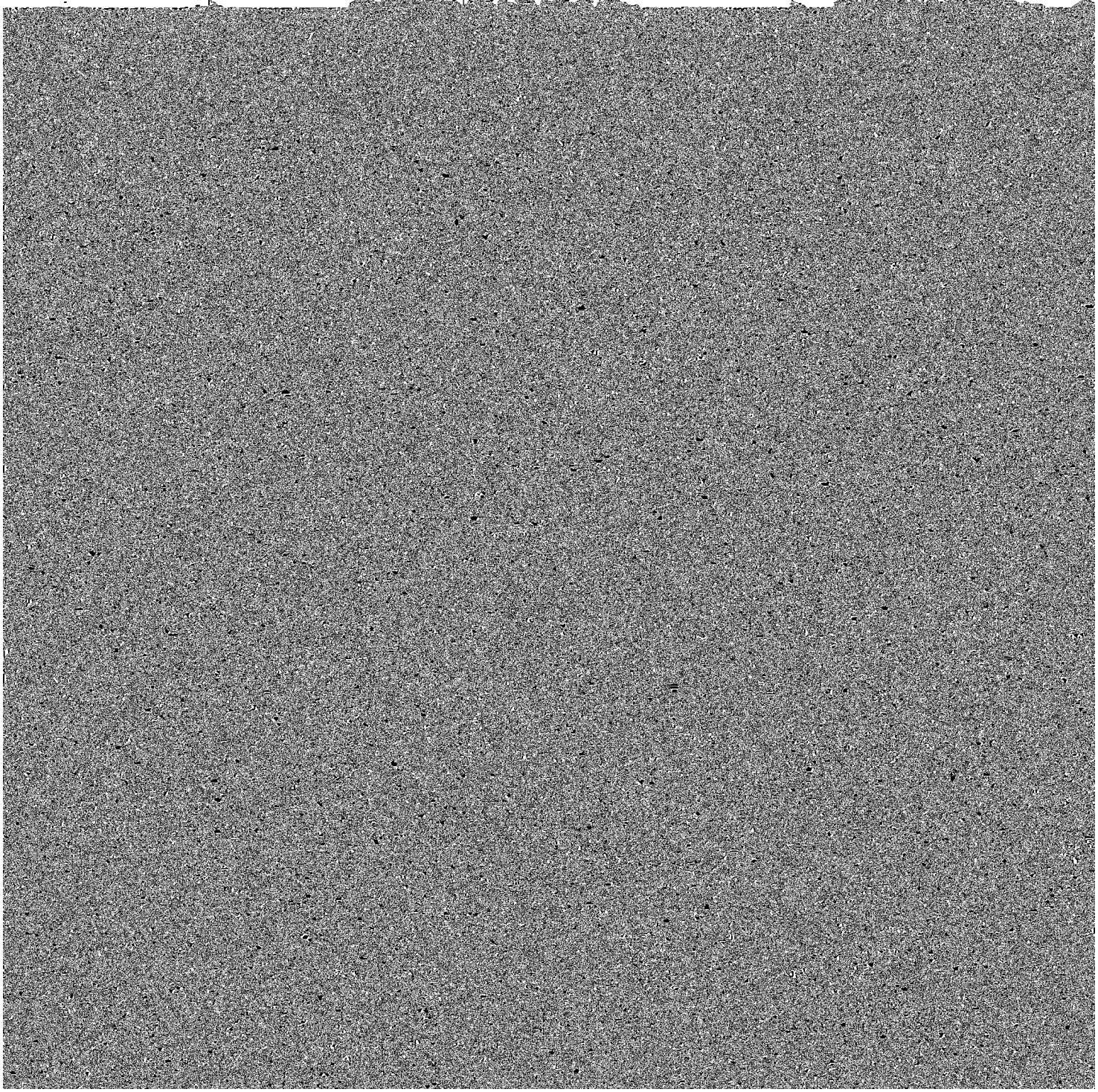
TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
Bremer: 43	Severe: seasonal high water table; slow permeability.	Severe: high organic matter content; seasonal high water table.	Severe: seasonal high water table; poorly drained; silty clay loam texture.	Severe: poorly drained; high shrink-swell potential; low strength.	Poor: high shrink-swell potential; low strength; poorly drained.	Not suitable
Caleb: 451D2	Severe: permeability of stratified material not predictable; slopes of 9 to 18 percent.[1]	Severe: slopes of 9 to 14 percent; permeability of stratified material not predictable.	Severe: permeability of stratified material not predictable.	Moderate if slopes are 9 to 14 percent; moderate shrink-swell potential; moderate strength. Severe if slopes are 14 to 18 percent.	Fair: moderate to high strength; moderate shrink-swell potential.	Not suitable
Chelsea: 63C2, 63D2	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 14 percent. Severe if slopes are more than 14 percent.	Severe: rapid permeability; slopes of 5 to 18 percent.	Severe: rapid permeability.	Moderate: slopes of 9 to 18 percent.	Good	Good source of poorly graded fine sand; lacks gravel.
Clarinda: 222C, 222C2, 222D2.	Severe: very slow permeability.	Severe: seasonal high water table; slopes of 5 to 14 percent; moderate to high organic matter content.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; high shrink-swell potential; slopes of 5 to 14 percent; low strength.	Poor: low strength; high shrink-swell potential; poorly drained.	Not suitable

interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Poor: poorly drained; silty clay loam texture.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent.	Slopes of 0 to 2 percent; poorly drained; seasonal high water table at a depth of 1 to 3 feet; slow permeability.	Slopes of 0 to 2 percent; on stream benches.	Slopes of 0 to 2 percent; on stream benches.
Fair: clay	Permeability	Medium to low	Natural drain-	Moderate to high	Slopes of 9 to 18	Hazard of

TABLE 7.—*Engineering*



interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Poor: some-	Moderately slow	Medium to low	Very slow per-	Slopes of 5 to 9	Slopes of 5 to 9	Hazard of

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel

interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Fair: silty clay loam texture.	Moderate permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 2 to 5 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Moderate permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 2 to 5 percent; subject to run-on water from upslope.	Slopes of 2 to 5 percent; somewhat poorly drained; seasonal high water table at a depth of 3 to 5 feet; subject to run-on water from upslope; hazard of erosion.	Slopes are 2 to 5 percent; high potential for siltation from run-on water from upslope; on foot slopes.	Somewhat poorly drained; slopes of 2 to 5 percent; high potential for siltation and wetness from run-on water from upslope.
Good if slopes are less than 9 percent. Fair if slopes are 9 to 14 percent. Poor if slopes are more than 14 percent.	Moderate permeability; slopes of 2 to 5 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction character-	Natural drainage adequate.	Slopes of 2 to 25 percent; well drained; hazard of erosion.	Slopes of 2 to 25 percent; hazard of erosion; moderate permeability.	Hazard of erosion; well drained; slopes of 2 to 25 percent.

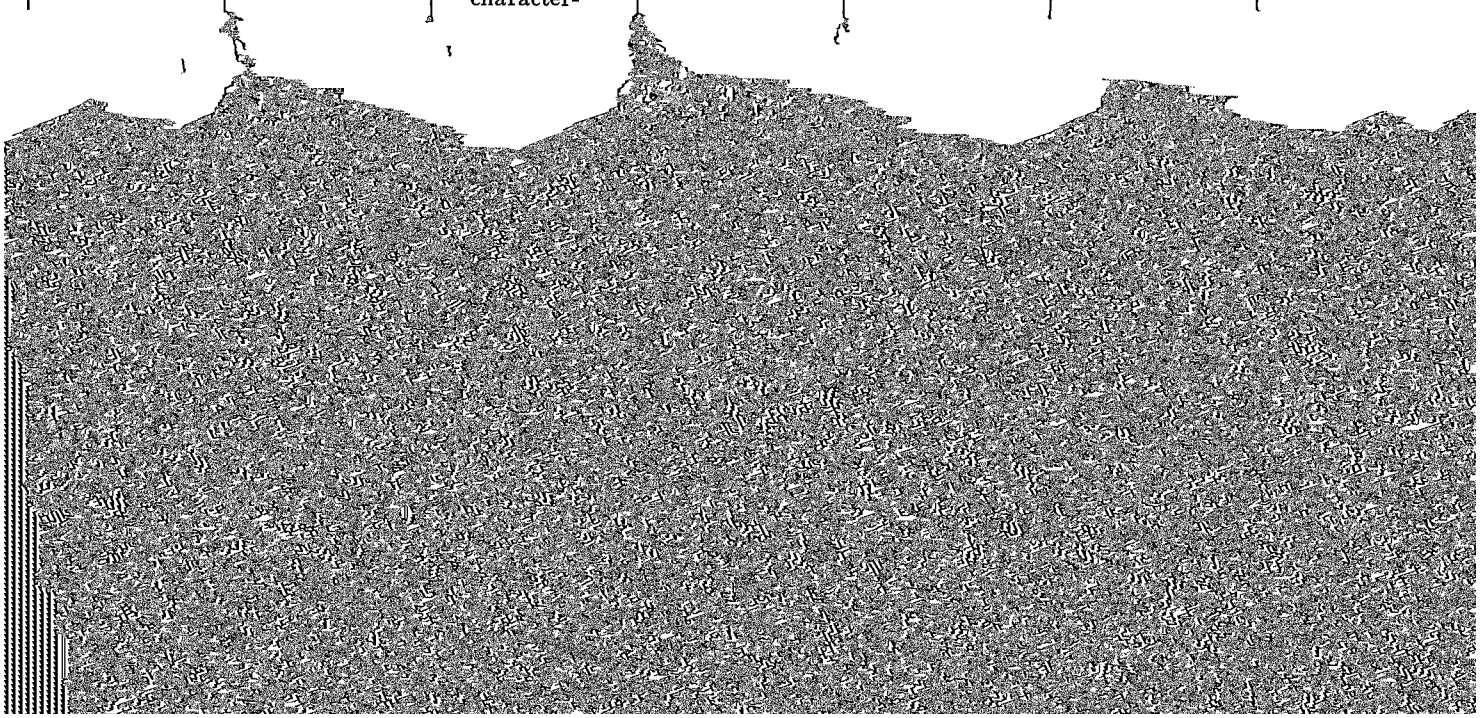
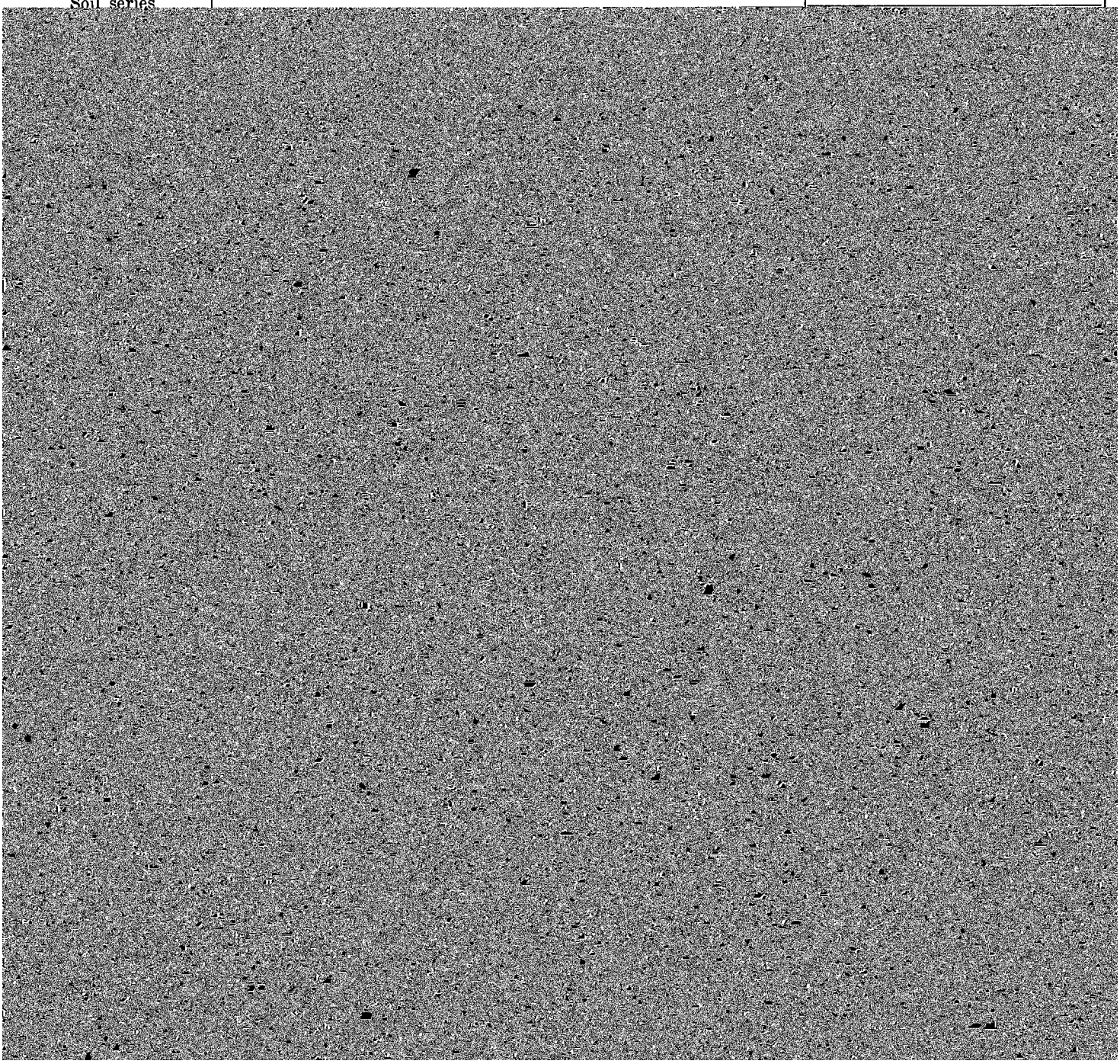


TABLE 7.—*Engineering*

Soil series	Degree and kind of limitation for—	Suitability as source of—



interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Poor: silty clay or clay texture below a depth of 8 inches; slopes of 9 to 35 percent.	Very slow permeability; shallow to bedrock; slopes of 9 to 35 percent.	Low shear strength; high compressibility; low compacted permeability; low susceptibility to piping; poor compaction characteristics.	Natural drainage adequate.	Low to moderate available water capacity; shallow to clayey shale; moderately well drained; very slow permeability; hazard of erosion.	Slopes of 9 to 45 percent; shallow to bedrock; hazard of erosion; silty clay subsoil at a depth of 8 inches.	Hazard of erosion; silty clay subsoil at a depth of 8 inches; shallow to bedrock; low to moderate available water capacity.
Fair: silty clay loam texture.	Slow permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 2 to 5 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Slow permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 2 to 5 percent.	Slopes of 2 to 5 percent; somewhat poorly drained; seasonal high water table at a depth of 3 to 5 feet; slow permeability; hazard of erosion.	Slopes of 2 to 5 percent; hazard of erosion; silty clay or heavy silty clay loam subsoil at a depth of 18 inches.	Hazard of erosion; silty clay or heavy silty clay loam subsoil at a depth of 18 inches; slopes of 2 to 5 percent.
Fair: silty clay loam texture; poorly drained in places.	Moderate permeability to moderately slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 2 to 5 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; medium susceptibility to piping; fair compaction characteristics.	Gully generally makes drainage impractical.	Gully generally makes drainage impractical.	Hazard of gully erosion; slopes of 2 to 5 percent; on foot slopes; hazard of siltation.	Waterways impractical unless gully filled in and controlled.
Poor: poorly drained to very poorly drained.	Very slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; medium susceptibility to	Very slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent; subject to	Slopes of 0 to 2 percent; poorly drained to very poorly drained; seasonal high water table at a depth of 1	Slopes of 0 to 2 percent; on bottom lands.	Slopes of 0 to 2 percent; on bottom lands.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
Judson: 8B	Moderate: moderate permeability.	Moderate: moderate permeability; slopes of 2 to 6 percent; high organic matter content.	Moderate: silty clay loam texture.	Moderate: moderate shrink-swell potential; moderate strength.	Poor: low strength; moderate shrink-swell potential.	Not suitable
Kennebec: 212	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; moderate permeability; seasonal high water table; high organic matter content.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; moderately well drained; susceptible to frost action.	Poor: low strength; moderate shrink-swell potential; susceptible to frost action; moderately well drained.	Not suitable
Keswick: 425D	Severe: slow permeability; seasonal high water table.	Severe: slopes of 9 to 14 percent; seasonal high water table.	Severe: seasonal high water table; clay or clay loam texture.	Severe: high shrink-swell potential; low strength; slopes of 9 to 14 percent.	Poor: low strength; high shrink-swell potential.	Not suitable
*Ladoga: 76B, 76C, 76C2, 76D2, T76B [2], T76C2, 427C2, 427D2. For Chelsea parts of 427C2 and 427D2, see Chelsea series.	Severe: moderately slow permeability.	Moderate if slopes are less than 5 percent. Severe if slopes are more than 5 percent.	Moderate: silty clay loam texture.	Severe: high shrink-swell potential; low strength; slopes of 2 to 14 percent.	Poor: low strength; high shrink-swell potential.	Not suitable

interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Fair: silty clay loam texture.	Moderate permeability; slopes of 2 to 6 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Natural drainage adequate.	Slopes of 2 to 6 percent; well drained to moderately well drained; susceptible to run-on water from upslope; hazard of erosion.	Slopes of 2 to 6 percent; on foot slopes; hazard of siltation; moderate permeability.	Well drained to moderately well drained; slopes of 2 to 6 percent; hazard of siltation.
Good	Moderate permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 2 percent.	Medium to low shear strength; medium compressibility; low to medium compacted permeability; medium susceptibility to piping; fair compaction characteristics.	Moderate permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 2 percent; subject to flooding.	Slopes of 0 to 2 percent; moderately well drained; seasonal high water table at a depth of 3 to 5 feet; subject to flooding.	Slopes of 0 to 2 percent; on bottom lands.	Slopes of 0 to 2 percent; on bottom lands.
Fair: slopes of 9 to 14 percent.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 9 to	Medium to low shear strength; medium to high compressibility; low [illegible]	Water seeps downslope along slowly permeable layer and causes perched [illegible]	Moderate to high available water capacity; slopes of 9 to 14 percent; slow [illegible]	Slopes of 9 to 14 percent; hazard of erosion; clay or heavy clay loam subsoil at a depth of	Hazard of erosion; clay or heavy clay loam subsoil at a depth of 11 inches; moderately

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
Lamoni: 822D2, 822D3.	Severe: slow permeability to very slow permeability; seasonal high water table.	Slopes of 9 to 14 percent; seasonal high water table.	Severe: seasonal high water table; clay loam texture.	Severe: high shrink-swell potential; low strength; slopes of 9 to 14 percent.	Poor: low strength; high shrink-swell potential; somewhat poorly drained.	Not suitable
Lindley: 65D, 65E, 65F, 65G, 65E3.	Severe: moderately slow permeability; slopes of 9 to 40 percent.	Severe: slopes of 9 to 40 percent.	Moderate if slopes are less than 14 percent. Severe if slopes are more than 40 percent; clay loam texture.	Severe: slopes of 9 to 14 percent.	Poor: low strength; moderate shrink-swell potential; slopes of 9 to 40 percent.	Not suitable
Macksburg: 368, 368B, T368.[2]	Severe: moderately slow permeability; seasonal high water table.	Moderate: moderately slow permeability; seasonal high water table.	Severe: seasonal high water table; silty clay loam texture.	Severe: high shrink-swell potential; low strength.	Poor: low strength; high shrink-swell potential; somewhat poorly drained.	Not suitable
Muscatine: 119, T119.[2]	Moderate: moderate permeabil-	Moderate: moderate permeability;	Severe: seasonal high water table;	Severe: low strength; susceptible to	Poor: low strength; moderate	Not suitable

interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Poor: heavy clay loam below a depth of 11 inches; slopes of 9 to 14 percent.	Slow permeability to very slow permeability; seasonal high water table at a depth of 1	Medium to low shear strength; high to medium compressibility; low compacted	Water seeps downslope along slowly permeable to very slowly permeable layer and	Slopes of 9 to 14 percent; somewhat poorly drained; seasonal high water table at a depth of 1	Slopes of 9 to 14 percent; heavy clay loam subsoil at a depth of 11 inches; hazard of	Hazard of erosion; heavy clay loam subsoil at a depth of 11 inches; slopes of 9 to 14 percent;

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
*Mystic: 94D2, 93E2, 592C2, 592D2. For Caleb parts of 94D2 and 94E2, see Caleb series.	Severe: slow permeability; seasonal high water table.[1]	Severe: slopes of 5 to 18 percent; seasonal high water table.	Severe: seasonal high water table; slopes of 5 to 18 percent; silty clay, clay, or heavy clay loam texture.	Severe: low strength; slopes of 5 to 18 percent.	Poor: low strength; somewhat poorly drained to moderately well drained.	Not suitable
Nevin: 88, 88B	Severe: moderate permeability to moderately slow permeability; seasonal high table.	Moderate: moderate permeability to moderately slow permeability; seasonal high water table; high organic matter content.	Severe: seasonal high water table; silty clay loam texture.	Severe: low strength; moderate shrink-swell potential; somewhat poorly drained; susceptible to frost action.	Poor: low strength; moderate shrink-swell potential; somewhat poorly drained; susceptible to frost action.	Not suitable
Nira: 570B, 570C2	Severe: moderately slow permeability.	Moderate if slopes are less than 5 percent. Severe if slopes are more than 5 percent; moderate to high organic matter content.	Moderate: silty clay loam texture.	Severe: low strength; moderate shrink-swell potential; slopes of 2 to 9 percent.	Poor: low strength; moderate shrink-swell potential.	Not suitable
Nodaway: 220, C220	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; moderate permeability; seasonal high water table.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; susceptible to frost action; moderate shrink-swell potential.	Poor: low strength; moderate shrink-swell potential; susceptible to frost action.	Not suitable

interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Poor: clay, heavy clay loam, or silty clay loam texture below a depth of 8 inches; slopes of 5 to 18 percent.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; underlying material porous in places; slopes of 5 to 18 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Water seeps downslope along slowly permeable layer and causes perched seasonal high water table at a depth of 1 foot to 3 feet; slopes of 5 to 18 percent.	Slopes of 5 to 18 percent; moderately well drained to somewhat poorly drained; seasonal high water table at a depth of 1 foot to 3 feet; hazard of erosion.	Slopes of 5 to 18 percent; hazard of erosion; clayey subsoil at a depth of 8 inches; plant cover difficult to establish.	Hazard of erosion; clayey subsoil at a depth of 8 inches; slopes of 5 to 18 percent; seeps in places; moderate to high available water capacity.
Fair: silty clay loam texture.	Moderate permeability to moderately slow permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 5 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Moderate permeability to moderately slow permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 5 percent.	Slopes of 0 to 5 percent; somewhat poorly drained; seasonal high water table at a depth of 3 to 5 feet; hazard of erosion on slopes of more than 2 percent.	Slopes of 0 to 5 percent; on stream benches.	Somewhat poorly drained; slopes of 0 to 5 percent; on stream benches.
Fair: silty clay loam texture.	Moderately slow permeability; slopes of 2 to 9 percent	Medium to low shear strength; medium com-	Natural drainage adequate.	Slopes of 2 to 9 percent; moderately well	Slopes of 2 to 9 percent; hazard of	Hazard of erosion; moderately well

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
Olmitz: 273B, 273C	Moderate: moderate permeability to moderately slow permeability.	Moderate: moderate permeability to moderately slow permeability; slopes of 2 to 9 percent.	Moderate: clay loam texture.	Severe: low strength; moderate shrink-swell potential; susceptible to frost action.	Poor: low strength; moderate shrink-swell potential; susceptible to frost action.	Not suitable
Pershing: 131B, 131C2, 131D2.	Severe: slow permeability; seasonal high water table.	Moderate if slopes are less than 5 percent. Severe if slopes are more than 5 percent; seasonal high water table.	Severe: seasonal high water table; silty clay and silty clay loam texture.	Severe: high shrink-swell potential; low strength.	Poor: low strength; high shrink-swell potential; moderately well drained to somewhat poorly drained.	Not suitable
Sharpsburg: 370, 370B, 370C, 370C2, 370D2, T370, T370B, T370C.[2]	Moderate if slopes are less than 9 percent. Severe if slopes are more than 9 percent; moderately slow permeability.	Slight if slopes are less than 2 percent. Moderate if slopes are 2 to 5 percent. Severe if slopes are more than 5 percent.	Moderate: silty clay loam texture.	Severe: high shrink-swell potential; low strength; slopes of 0 to 14 percent.	Poor: low strength; high shrink-swell potential.	Not suitable
Shelby: 24D2, 24E2, 24F2.	Severe: moderately slow permeability; slopes of 9 to 25 percent.	Severe: slopes of 9 to 25 percent.	Moderate if slopes are less than 14 percent. Severe if slopes are more than 14 percent; clay loam texture.	Severe: low strength; slopes of 9 to 25 percent; moderate shrink-swell potential.	Poor: low strength; moderate shrink-swell potential; slopes of 9 to 25 percent.	Not suitable

interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Good	Moderate permeability to moderately slow permeability; slopes of 2 to 9 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Natural drainage adequate.	Slopes of 2 to 9 percent; well drained to moderately well drained; receives run-on water from upslope; hazard of erosion.	Slopes of 2 to 9 percent; on foot slopes; hazard of siltation.	Well drained to moderately well drained; slopes of 2 to 9 percent; on foot slopes; hazard of siltation.
Good if slopes are less than 9 percent. Fair if slopes are more than 9 percent.	Slow permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 2 to 14 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Slow permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 2 to 14 percent.	Slopes of 2 to 14 percent; moderately well drained to somewhat poorly drained; seasonal high water table at a depth of 3 to 5 feet; slow permeability; hazard of erosion.	Slopes of 2 to 14 percent; silty clay or heavy silty clay loam subsoil at a depth of 13 inches; hazard of erosion.	Hazard of erosion; silty clay or heavy silty clay loam subsoil at a depth of 13 inches; moderately well drained to somewhat poorly drained.
Fair: silty clay loam texture; slopes of 0 to 14 percent.	Moderately slow permeability; slopes of 0 to 14 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Natural drainage adequate.	Slopes of 0 to 14 percent; moderately well drained; moderately slow permeability; hazard of erosion on slopes of more than 2 percent.	Slopes of 0 to 14 percent; hazard of erosion; moderately slow permeability.	Hazard of erosion; moderately well drained; slopes of 0 to 14 percent.
Fair if slopes are less than 14 percent. Poor if slopes are more than 14 percent; clay loam texture.	Moderately slow permeability; slopes of 9 to 25 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Natural drainage adequate.	Slopes of 9 to 25 percent; moderately well drained; moderately slow permeability; hazard of erosion.	Slopes of 9 to 25 percent; hazard of erosion; moderately slow permeability.	Hazard of erosion; moderately well drained; slopes of 9 to 25 percent.

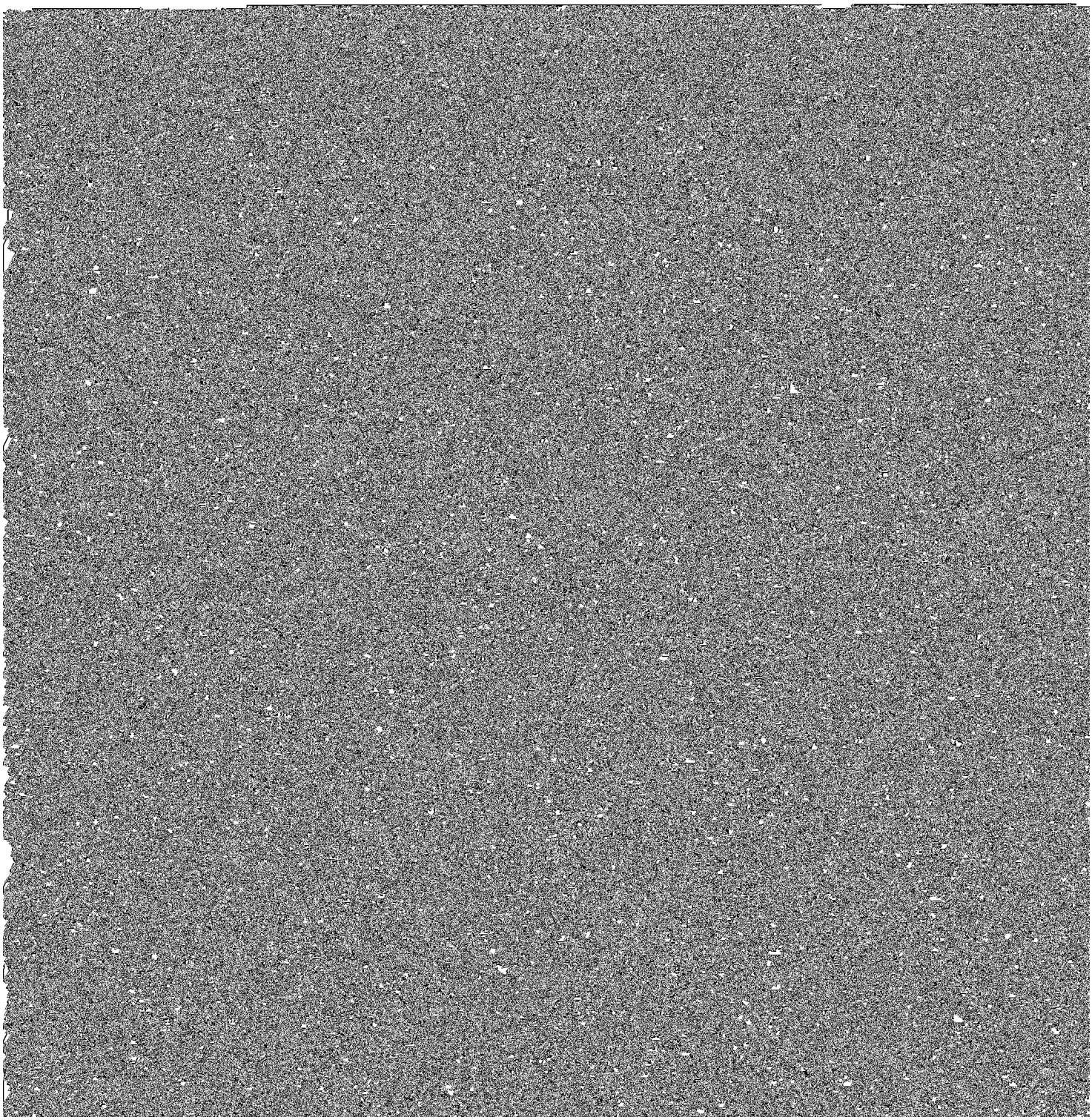
TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
Sperry: 122	Severe: slow permeability to very slow permeability; seasonal high water table.	Severe: seasonal high water table; high organic matter content.	Severe: poorly drained to very poorly drained; seasonal high water table.	Severe: poorly drained to very poorly drained; high shrink-swell potential.	Poor: low strength; high shrink-swell potential; poorly drained to very poorly drained.	Not suitable
Steep rock land: 478.	Severe: slopes of more than 15 percent.	Severe: slopes of more than 15 percent.	Severe: slopes of more than 15 percent.	Severe: slopes of more than 15 percent.	Poor: shallow to bedrock; slopes of more than 15 percent.	Not suitable
Strip mines: 502	Severe: very slow permeability.	Slight if slopes are less than 2 percent. Moderate or severe if slopes are more than 2 percent.	Severe: silty clay or clay texture.	Severe: generally very poorly drained; irregular slopes; low strength.	Poor: low strength; high shrink-swell potential; generally very poorly drained.	Not suitable
Tama: 120, 120B, 120C2, 120D2, T120B.[2]	Slight if slopes are less than 9 percent. Moderate if slopes are more than 9 percent.	Moderate if slopes are less than 5 percent. Severe if slopes are more than 5 percent; moderate permeability.	Moderate: silty clay loam texture.	Severe: low strength; moderate shrink-swell potential; slopes of 0 to 14 percent.	Poor: low strength; moderate shrink-swell potential.	Not suitable
Vesser: 51, 51B	Severe: seasonal high water table; subject to flooding; moderate permeability to moderately slow permeability.	Severe: subject to flooding; seasonal high water table; high organic matter content.	Severe: subject to flooding; poorly drained to somewhat poorly drained; seasonal high water table.	Severe: somewhat poorly drained to poorly drained; subject to flooding; high shrink-swell potential; susceptible to frost action.	Poor: low strength; high shrink-swell potential; susceptible to frost action; somewhat poorly drained to poorly drained.	Not suitable

interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Poor: poorly drained to very poorly drained.	Slow permeability to very slow permeability; seasonal high water table at a depth of 0 to 2 feet; slopes of 0 to 1 percent.	Medium to low shear strength; high compressibility; low compacted permeability; low susceptibility to piping; fair to poor compaction characteristics.	Slow permeability to very slow permeability; seasonal high water table at a depth of 0 to 2 feet; slopes of 0 to 1 percent; ponding; outlets not readily available.	Slopes of 0 to 1 percent; poorly drained to very poorly drained; seasonal high water table at a depth of 0 to 2 percent; slow permeability to very slow permeability.	Slopes of 0 to 1 percent; in upland depressions.	Slopes of 0 to 1 percent; in upland depressions.
Poor: slopes of more than 15 percent.	Variable permeability; shallow to bedrock; slopes of more than 15 percent.	Shallow to bedrock.	Natural drainage adequate.	Slopes of more than 15 percent; shallow to bedrock.	Slopes of more than 15 percent; shallow to bedrock.	Slopes of more than 15 percent; shallow to bedrock.
Poor: clayey texture; generally very poorly drained; irregular slopes.	Generally very slow permeability; shallow to bedrock; irregular slopes.	Low shear strength; high compressibility; low compacted permeability; low susceptibility to piping; poor compaction characteristics.	Very slow permeability; shallow to bedrock.	Irregular slopes; shallow to bedrock.	Irregular slopes; shallow to bedrock.	Irregular slopes; shallow to bedrock.
Fair: silty clay loam texture; slopes of 0 to 14 percent.	Moderate permeability; slopes of 0 to 14 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Natural drainage adequate.	Slopes of 0 to 14 percent; well drained; moderate permeability; hazard of erosion on slopes of more than 2 percent.	Slopes of 0 to 14 percent; hazard of erosion; moderate permeability.	Hazard of erosion; well drained; slopes of 0 to 14 percent.
Poor: somewhat poorly drained to poorly drained.	Moderate permeability to moderately slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 5 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; medium susceptibility to piping; fair compaction characteristics.	Moderate permeability to moderately slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; subject to flooding; slopes of 0 to 5 percent.	Slopes of 0 to 5 percent; somewhat poorly drained; subject to flooding; moderate permeability to moderately slow permeability; hazard of erosion on slopes of more than 2 percent.	Slopes of 0 to 5 percent; on foot slopes or bottom lands; hazard of siltation.	Somewhat poorly drained to poorly drained; slopes of 0 to 5 percent; on foot slopes or bottom lands; hazard of siltation.

TABLE 7.—*Engineering*



interpretations—Continued

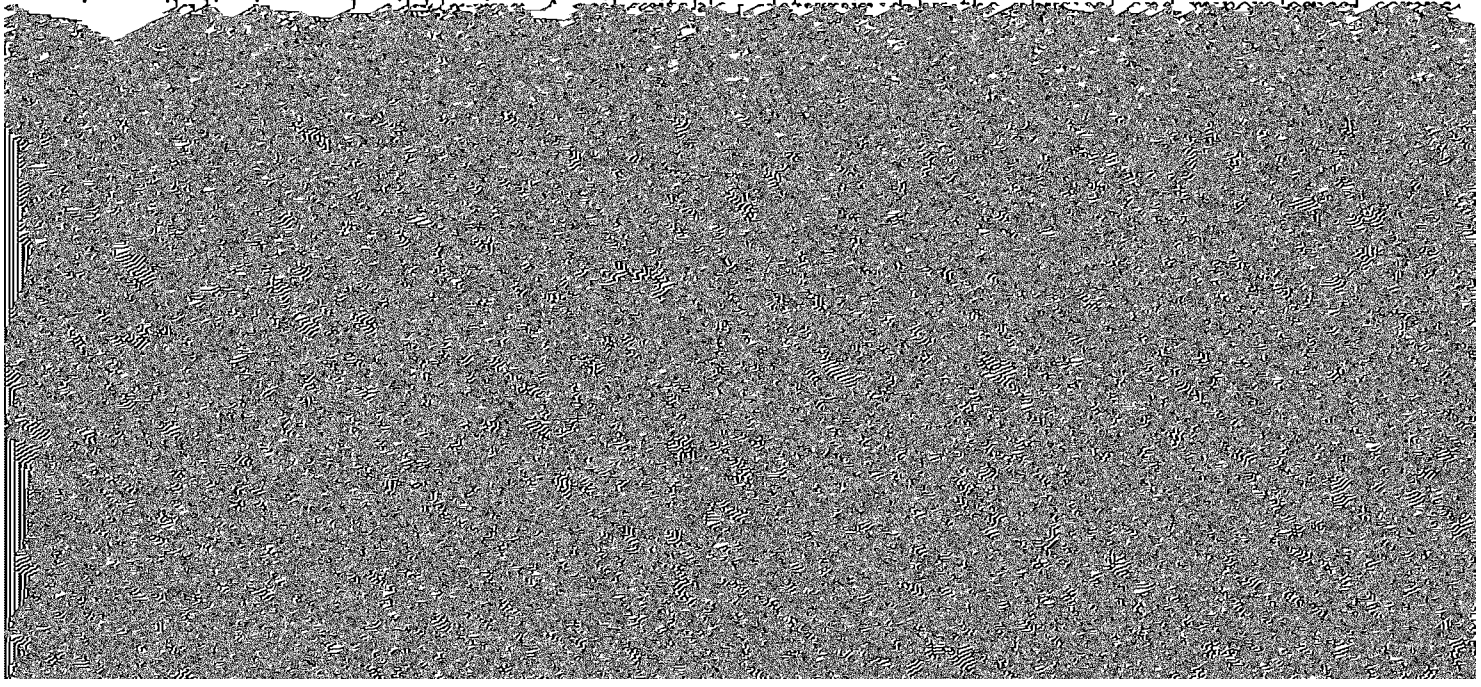
Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Poor: silty clay or silty clay loam texture; very poorly drained.	Very slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent.	Medium to low shear strength; high compressibility; low compacted permeability; low susceptibility to piping; fair to poor compaction characteristics.	Very slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent; subject to flooding; outlets not readily available.	Moderate available water capacity; slopes of 0 to 2 percent; very poorly drained; seasonal high water table at a depth of 1 foot to 3 feet; subject to flooding; very slow permeability.	Slopes of 0 to 2 percent; on bottom lands.	Slopes of 0 to 2 percent; on bottom lands.
Good	Moderate permeability; slopes of 1 to 4 percent.	Medium to low shear strength; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Natural drainage adequate.	Slopes of 1 to 4 percent; well drained to moderately well drained; moderate permeability; hazard of erosion.	Slopes of 1 to 4 percent; on stream benches; moderate permeability.	Slopes of 1 to 4 percent; on stream benches; well drained to moderately well drained.
Fair: silty clay or silty clay loam texture below a depth of 9 inches.	Slow permeability; seasonal high water table at a depth of 2 to 4 feet; slopes of 2 to 9 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Slow permeability; seasonal high water table at a depth of 2 to 4 feet; slopes of 2 to 9 percent.	Slopes of 2 to 9 percent; moderately well drained; seasonal high water table at a depth of 2 to 4 feet; slow permeability; hazard of erosion.	Slopes of 2 to 9 percent; hazard of erosion; silty clay or heavy silty clay subsoil at a depth of 9 inches; slow permeability.	Hazard of erosion; silty clay or heavy silty clay loam at a depth of 9 inches; moderately well drained; slopes of 2 to 9 percent.
Poor: poorly drained; silty clay loam texture.	Moderately slow permeability to slow permeability;	Medium to low shear strength; medium to	Moderately slow permeability to slow permeability; sea-	Slopes of 0 to 2 percent; poorly drained; sea-	Slopes of 0 to 2 percent; on ridgetops.	Slopes of 0 to 2 percent; on ridgetops.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—	
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill	Sand and gravel
Wiota: 7, 78	Moderate: moderate permeability.	Moderate: moderate permeability; high organic matter content.	Moderate: silty clay loam texture.	Severe: low strength; susceptible to frost action.	Poor: low strength; moderate shrink-swell potential.	Not suitable
Zook: 54	Severe: subject to flooding; slow permeability.	Severe: subject to flooding seasonal high water table; high organic matter content.	Severe: subject to flooding; poorly drained; seasonal high water table.	Severe: poorly drained; subject to flooding; high shrink-swell potential.	Poor: low strength; high shrink-swell potential; poorly drained.	Not suitable

[1] Danger of pollution of ground water through porous material or through cracks in bedrock.

ence of stones; permeability; and resistance to water logic agencies. The characteristics of the soil are



interpretations—Continued

Suitability as source of—Cont.	Soil features affecting—					
Topsoil	Pond reservoir areas	Embankments, dikes and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions	Grassed waterways
Good	Moderate permeability; slopes of 0 to 5 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Natural drainage adequate.	Slopes of 0 to 5 percent; well drained to moderately well drained; moderate permeability; hazard of erosion on slopes of more than 2 percent.	Slopes of 0 to 5 percent; on stream benches; moderate permeability.	Slopes of 0 to 5 percent; on stream benches; well drained to moderately well drained.
Poor: poorly drained; silty clay texture below a depth of 7 inches.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent.	Medium to low shear strength; low compacted permeability low susceptibility to piping; fair to poor compaction characteristics.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent; subject to flooding; outlets not readily available.	Moderate to high available water capacity; slopes of 0 to 2 percent; poorly drained; seasonal high water table at a depth of 1 foot to 3 feet; slow permeability; subject to flooding.	Slopes of 0 to 2 percent; on bottom lands.	Slopes of 0 to 2 percent; on bottom lands.

[2] Bench phases, indicated by a "T" prefix, generally are underlain by stratified alluvium instead of glacial till. In places the alluvium is coarse textured and is at a depth as shallow as 5 feet.

Parent material

The soils in Warren County formed in material weathered from shale (residual material), in glacial till (ice-laid material), in loess (windblown material), and in alluvium (water-laid material). Small areas of eolian sands are along the major streams.

Shale.—Before the glaciers covered Iowa, shale, limestone, and sandstone were exposed on the land surface. This shale bedrock consists of the Cherokee and Marmaton Groups of the Des Moines Series which is of Pennsylvanian age (*4*). Most of these materials were later covered by glacial till. In some areas geologic erosion has removed the till and reexposed the residual material. Shale is on the lower part of side slopes, and it is mainly north and east of a line drawn diagonally across Warren County from the northwest corner to the southeast corner of the county.

Soils that formed in shale residuum commonly show only minimal profile development and a B horizon that is only weakly expressed or absent. They are commonly quite acid and are low in fertility. Bauer and Gosport soils are the only soils in the county that formed in such material.

Glacial till.—Two glaciers, the Nebraskan and Kansan, left deposits in Warren County (*9*). The Kansan drift is identifiable throughout the county and is on side slopes that form an extensive part of the landscape. Nebraskan drift is not readily identifiable on the surface in Warren County.

Soils formed on the Kansan till plain during the Yarmouth and Sangamon interglacial ages. This was before the loess was deposited. On nearly level interstream divides, the soils were strongly weathered and had a gray plastic subsoil called gumbotil (*6*). This gumbotil remains; it is several feet thick and very slowly permeable. Clarinda soils formed in this gumbotil and are extensive throughout Warren County. Because the gumbotil in the Lamoni soils is partly truncated, the clay material is not so thick as in the Clarinda soils.

During late Sangamon Time, geologic erosion cut through the Yarmouth-Sangamon paleosol and into the Kansan till. At the depth to which this erosion has cut, generally there is a stone line or subjacent till that is overlain by pedisediment. A paleosol formed in this material (*7, 8*). Geologic erosion removed the loess from many slopes and exposed the paleosol on the surface. Adair soils formed in these reexposed paleosols.

Caleb and Mystic soils formed in pre-Sangamon sediments of valley fills. These sediments are of

glacial origin and vary in texture (7). They are on low, stepped interfluves above the present valley floor. They owe their landscape partly to valley fill, but their surface merges with the present erosional uplands. Caleb and Mystic soils are above the flood plain, but they are lower than Gara, Lindley, and Shelby soils, which formed in Kansan till on dissected slopes of late Wisconsin age.

Loess.—Loess of Wisconsin age covers most of Warren County and is an extensive parent material

ties that are intermediate between the properties of soils that formed under grasses and soils that formed under trees.

Relief

Relief indirectly influences soil formation through its effect on drainage and on geologic erosion. In Warren County soils range from level to very steep.

Most nearly level soils on bottom lands are frequently flooded. Water ponds in depressional areas

Classification of the soils

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

The narrow categories of classification such as

differences resulting from the climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order. An example is *Aquoll* (*Aqu*, meaning water or wet, and *oll*, from Mollisol).

GREAT GROUP: Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated; those that have pans that interfere with growth of roots, movement of water, or both; and thick, dark colored surface horizons. The features used are the self-mulching properties of clay, soil temperature, major differences

TABLE 8.—*Classification of soil series*

Series	Family	Subgroup	Order
Ackmore	Fine-silty, mixed, nonacid, mesic	Aeric Fluvaquents	Entisols.
Adair [1]	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols.

ber of hens and pullets of laying age declined from 79,314 in 1962 to 28,211 in 1970. Turkeys also decreased from 33,907 to 12,016.

Climate [5]

Climate for Warren County is represented by data taken at Indianola. Temperature and precipitation are given in table 9, and the probability of freezing temperatures in spring and fall is given in table 10.

There is little gradient in the precipitation pattern across Warren County. The average annual precipitation is between 31 and 32 inches. No consistent gradient is evident for individual months. Average monthly values are given in table 9, as well as the extreme values which may be expected in 1 year in 10. June is the wettest month, and May is second wettest. Precipitation is concentrated in the warm season, and about 75 percent occurs as showers. Showers vary widely across the county; some are of sufficient intensity and duration to cause erosion. From 1951 to 1960, an average of 19 days per year had one-half inch precipitation or more, and 57 days had one tenth inch or more.

The temperatures at Indianola are representative of all of Warren County, particularly for maximum temperatures. An average of 39 days per year have a maximum temperature of 90° F or more. These temperatures are too high for optimum crop growth. Minimum temperatures are more variable. Areas that

[5] This section was prepared by ROBERT H. SHAW, climatologist.

lower minimum temperatures than urban or upland areas on clear, calm nights.

The average date of the last 32° temperature in spring is April 29 and the first in fall is October 13. This gives an average growing season of 166 days.

For good crop production, warm-season rainfall and good subsoil moisture reserves are needed. On April 15, the average moisture reserve is 7 to 8 inches; there is about a 10 percent chance of having less than 5 inches in the east edge of the county and about a 25 percent chance of having less than 5 inches in the central and western parts of the county. An adequate moisture reserve in spring is 7 to 8 inches, and 5 inches is considered very low. In years of such low moisture reserve, more than normal rainfall is needed in the warm season for average crop production.

References

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487–69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Hutton, Curtis E. 1947. Studies of loess-derived soils in southwestern Iowa. Soil Sci. Soc. Am. Proc. 12: 424–431, illus.

(4) Iowa Geological Survey. 1960. Geologic map of Iowa. Iowa

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

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

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

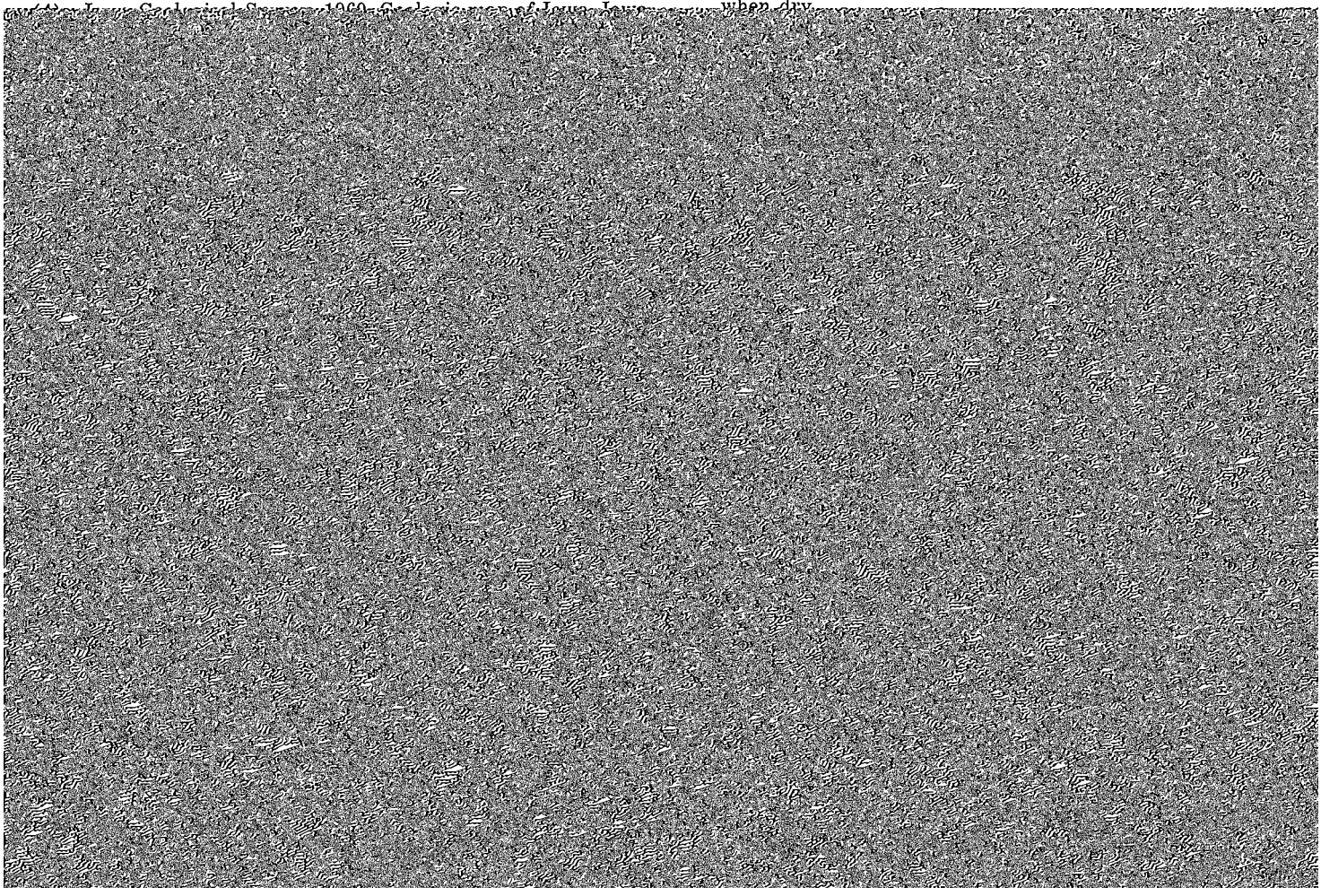
Soft.—When dry, breaks into powder or individual grains under slight pressure.

Cemented.—Hard; little affected by moistening.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Gumbotil. A massive deposit of clay-rich till that weathered into gray to dark-colored clay during the interglacial period. It is very sticky and plastic when wet and very hard and firm when dry.



Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH		pH
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in the horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

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

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

Substratum. The part of the soil below the solum.

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

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

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

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

☆ U.S. GOVERNMENT PRINTING OFFICE: 1978—230-730/19

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