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HOW TO USE THE SOIL SURVEY REPORT

THIS SURVEY of Monona County will help you to plan the kind of farming that will protect your soils and provide good yields. It describes the soils, shows their location on a map, and tells what is required for their proper management.

brush, or trees; and, in fact, recorded all the things about the soils that they believed might affect their suitability for farming.

After they mapped and studied the soils, the scientists talked with farmers and others about the use and managemen

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SOIL SURVEY OF MONONA COUNTY, IOWA

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United States Department of Agriculture in cooperation with the Iowa Agricultural Experiment Station

General Nature of the Area

Monona County is largely agricultural. Many of the soils are suitable for a number of different crops. Others can be made suitable if drainage is provided. Some are too eroded or steep to warrant cultivating.

Location and Extent

Monona County is in the extreme western part of Iowa, about halfway between the northern and southern boundaries of the State. The Missouri River forms its western boundary. The county covers approximately 446,080 acres, of which about 423,211 acres is farmland. Onawa, [illegible]

The Little Sioux, Maple, and Soldier Rivers flow through the uplands.

The uplands are between 90 and 300 feet higher than the bottom lands. Onawa has an elevation of 1,055 feet; Blencoe, 1,040 feet; and Whiting, 1,060 feet. All are on bottom lands.

Geology

The geological materials from which the soils of Monona County have formed were deposited (1) by glaciers (glacial till), (2) by wind (loess), and (3) by rivers (alluvium).

[illegible]

Some of the alluvium, especially that from which the soils of association 1 have formed (see fig. 3), was probably deposited within the past few hundred years. In fact recent floods, such as the one in 1952 when the Missouri River overflowed its banks, left sediments. Most of the alluvium from which soils in association 2 were formed is much older than that in association 1.

In parts of association 3, some sediments, mostly silty in texture, have been left with each local flood. In large part these sediments were washed down from the loessal hills. The McPaul soil is forming in some of these materials. Generally, the soils in associations 2 and 3 are fairly high in content of organic matter and have a dark surface layer.

Monona-Harrison drainage ditch, the Little Sioux River, and the Maple River.

There were 24 drainage districts in the county in 1940. These served about 240,000 acres, or about half the county. Drainage ditches extended for approximately 247 miles. There are more than 15 miles of drains and 11 miles of levees and dikes. Road ditches are important aids in removing excess water.

In the eastern part of the county, runoff is rapid from the rolling to steep slopes. It is increased when row crops are grown without terracing and contouring. Another serious problem in associations 4 and 5 stems from the development of deep, wide gullies that damage the farms

July period is 11.93 inches, 25.82 inches fell in those months in 1903, the wettest year, and only 3.96 inches during those months in 1936.

Vegetation

Although the temperature was favorable for trees and rainfall was apparently adequate, the native vegetation at the time of settlement was predominantly prairie

Types and sizes of farms

In 1954, 3.7 percent of the farms in Monona County were miscellaneous and unclassified. The rest were classified by major source of income as follows:

	Percent
Cash-grain farms	42.4
Dairy farms	1.0
Poultry farms	1.0
Livestock farms other than dairy and poultry	47.2
General farms	4.7

tively, was not harvested in these bottom-land townships, and in 1944 and 1945, about 45 percent was not harvested. In contrast, nearly all of the crops were harvested in Willow and Cooper Townships, which are in the uplands. Most of the crops not harvested were damaged by excessive wetness caused by floods or by too much rainfall.

TABLE 2.—*Principal soil uses and estimated proportionate extent of soil in each use* [1]

Soil	Corn	Oats	Wheat	Soybeans	Hay	Pasture	Native timber	Miscellaneous [2]
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Albaton clay, 0 to 1 percent slopes	50	10	10	10	5	5	5	5
Blencoe silty clay, 0 to 1 percent slopes	55	10	10	15	5	5	(3)	(3)
Blencoe silty clay, clayey substratum variant, 0 to 1 percent slopes	50	10	15	15	5	5	(3)	(3)
Castana silt loam, 8 to 14 percent slopes	50	30	(3)	(3)	15	5	(3)	(3)
Castana silt loam, 14 to 22 percent slopes	40	30	(3)	(3)	15	10	(3)	5
Castana silt loam, 22 to 30 percent slopes	20	10	(3)	(3)	5	55	5	5
Colo silty clay loam, 0 to 1 percent slopes	45	10	15	15	5	5	(3)	5
Colo silty clay loam, moderately shallow over silt loam phase, 0 to 1 percent slopes	50	10	10	15	5	5	(3)	5
Colo silty clay loam, calcareous variant, 0 to 1 percent slopes	50	10	10	15	5	5	(3)	5
Cooper silty clay loam, 0 to 1 percent slopes	50	10	10	15	5	5	(3)	(3)
Hamburg silt loam, 30 to 60 percent slopes	0	0	0	0	0	80	5	15

TABLE 3.—*Acreage of principal crops*

Crop	1929	1939	1949	1954
Corn	165, 610	139, 936	164, 063	127, 090
Oats, threshed	38, 978	27, 388	60, 452	50, 624
Soybeans	56	1, 226	12, 113	57, 065
Wheat, threshed	40, 319	36, 272	26, 883	8, 041
Barley, threshed	5, 899	9, 673	592	205
Popcorn	9	32	177	444
Rye, threshed	244	1, 733	73	77
Flax, threshed	829	40	(1)	(1)
Field seed crops	1, 395	2, 477	579	814

between aggregates, gives us clues to the ease or difficulty with which the soil is penetrated by plant roots and by moisture. The aggregates may have prismatic, columnar, blocky, platy, or granular structure.

Consistence, or the tendency of the soil to crumble or to stick together, indicates whether it is easy or difficult to keep the soil open and porous under cultivation.

Other characteristics observed in the course of the field study and considered in classifying the soil include the following: The depth of the soil over bedrock or compact layers; the presence of gravel or stones in amounts that will interfere with cultivation; the steepness and pattern

Soil Associations

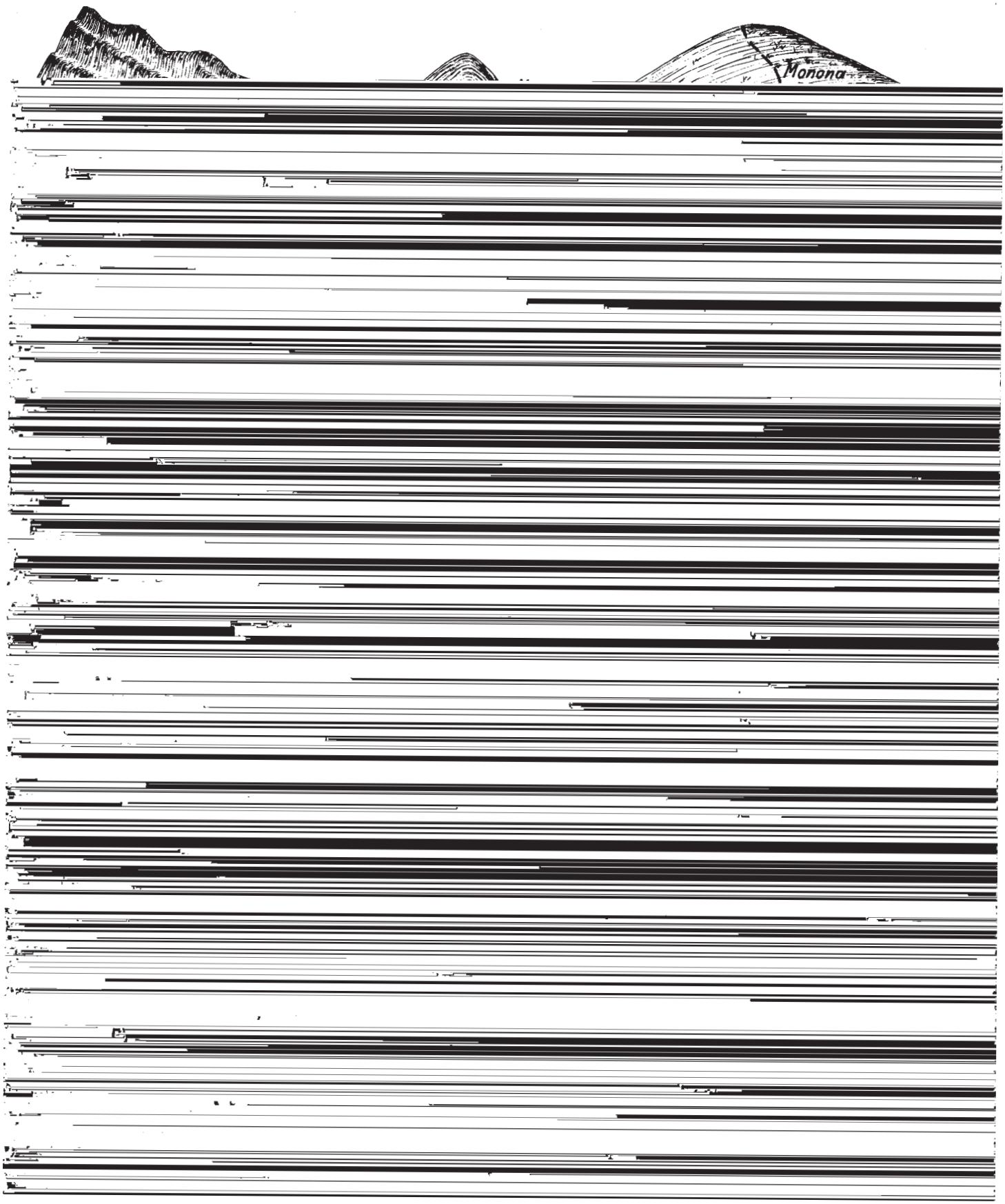
The map of soil associations (fig. 3) shows the general patterns of the soils in Monona County. This map is helpful in studying the soils of the county in general, or it can be an aid to broad program planning. Each association contains several different soils, arranged in a characteristic pattern. In most places the pattern is related to the nature of the soil materials and the shape of the land surface.

The five associations in Monona County are briefly discussed in the following pages. Figure 4, a schematic diagram, shows the relative position on the landscape of some of the dominant soils and the broad range of slope on which each occurs. It also shows the typical profiles of six of the principal soils.

1. Recent Alluvial Light-Colored Soils of the Missouri River Flood Plain: Albaton, Onawa, Haynie

In association 1, as shown on the soil association map, are soils of the Missouri River flood plain. The major soils are the Albaton, Onawa, and Haynie. Less extensive are the McPaul, Modale, and Sarpy soils, and Mixed alluvial land. All were derived from sediments deposited by the river. Many areas occasionally receive fresh sediments when the river overflows. Because the river sediments vary considerably, the texture of the soils varies.

This association is all nearly level to gently sloping. Some parts have so little slope that surface runoff is slow. Consequently, these soils may be too wet, especially if they have a fine texture so that moisture moves through


Monona

border between associations 2 and 3. All of the soils have formed from silty or clayey alluvial sediments.

Most of association 3 is subject to flooding, and the

Descriptions of Soils

This section contains detailed descriptions of the soils

rotation may be difficult to follow. In wet seasons some farmers substitute soybeans for corn in the rotation or grow wheat.

TABLE 4.—*Acreage and proportionate extent of the soils mapped*

Soil	Acres	Percent
Albaton clay, 0 to 1 percent slopes	32, 033	7. 2
Blencoe silty clay, 0 to 1 percent slopes	7, 939	1. 8
Blencoe silty clay, clayey substratum variant, 0 to 1 percent slopes	3, 114	. 7
Castana silt loam, 8 to 14 percent slopes	1, 574	. 4
Castana silt loam, 14 to 22 percent slopes	24, 698	5. 5
Castana silt loam, 22 to 30 percent slopes	93	(1)
Colo silty clay loam, 0 to 1 percent slopes	5, 382	1. 2
Colo silty clay loam, moderately shallow over		

If the surface layer becomes cloddy, careful tillage and cropping is necessary. Some farmers plow in the fall so that winter freezing will break up the larger clods. Crop residues and manure returned to the soil over a period of 1 or 2 years will improve the structure of the soil.

This soil is low in organic matter and available nitrogen. It contains moderate amounts of available phosphorus and potassium. Lime is generally not needed. This soil is in capability class III, subclass IIIw.

Blencoe Soils

The Blencoe soils occur in the eastern half of the bottom lands along the Missouri River. Most of the soils occupy nearly level areas or slight depressions next to Salix and

bed can be maintained. This soil is in capability class II, subclass IIw.

Blencoe silty clay, clayey substratum variant, 0 to 1 percent slopes (Bb).—This soil occupies level areas or slight depressions where slopes are less than 1 percent.

Typical profile:

A_1 0 to 9 inches, black (10YR 2/1) light silty clay; hard when dry, firm when moist; fine granular structure; neutral to slightly acid.

A_{12} 9 to 14 inches, very dark brown (10YR 2/2) light silty clay; hard when dry, firm when moist; fine granular

slope. Their surface layer contains an estimated 22 to 25 percent clay, less than 10 percent sand, and considerable coarse silt. Their substratum contains an estimated 12 to 18 percent clay, less than 10 percent sand, and considerable coarse silt.

The Castana soils grade toward the Napier soil that generally occurs on less steep slopes. Separation of the Castana and Napier soils was somewhat arbitrary, but the degree of slope was ordinarily used as a guide. Although the Castana soils do not have sharply differentiated

should be established in natural waterways and in other places where water from runoff concentrates.

If contour tillage and terraces are impractical, it will be necessary to use a rotation that includes a considerable

A_3–B_1 12 to 24 inches, very dark gray (10YR 3/1) silty clay loam; a few faint yellowish-brown mottles in the lower part of the layer; somewhat hard when dry, slightly firm when moist; fine granular structure; neutral to slightly acid.

VARIATIONS.—In a few areas the subsoil is light gray. A few faint yellowish-brown mottles occur in many areas.

Use and management.—This soil generally is not cultivated, and because of the steep slopes, few areas are suited to cultivation. As a rule the soil is used for pasture.

The best use for this soil is permanent pasture, but the yield of forage is low. The steep slopes make pasture renovation and care difficult. Native grasses are the principal vegetation on the pastures, but brush and trees often invade. It is best to restrict grazing so that the native grasses will be maintained.

The content of nitrogen and phosphorus is low in this soil. Application of fertilizer may not be warranted, however, because the slopes are too steep for machines to be used and the pastures make poor response to fertilizer. This soil is in capability class VII, subclass VIIe.

Haynie Soils

The Haynie soils occupy level or gently sloping areas near the Missouri River. They have formed from recently deposited Missouri River sediments. Some areas still receive deposits from the river when it overflows. Floods have not reduced yields on these soils as much as on some of the Albaton and Onawa soils, and floodwaters recede faster on these soils than on the lower lying areas of Albaton and Onawa soils. The Haynie soils are low in fertility. As a rule they are calcareous throughout. They are classified as Alluvial soils.

Haynie silt loam, 0 to 1 percent slopes (Hd).—Generally this soil has less fine sand in the subsoil than Haynie [illegible] 0 to 2 percent slopes. In some places it [illegible]

Haynie fine sandy loam, 0 to 1 percent slopes (Hb).—This soil is more droughty than Haynie silt loam, 0 to 1 percent slopes.

Typical profile:

A_1 0 to 10 inches, very dark grayish-brown (10YR 3/2) fine sandy loam; breaks into granules and sand when moist; weakly calcareous.

D_1 10 to 20 inches, very dark grayish-brown to dark grayish-brown (10YR 3/2 to 4/2) coarse silt loam; some very fine sand; friable when moist; structureless; weakly calcareous.

D_2 20 to 50 inches, dark grayish-brown coarse silt loam (thin layers of very fine sand are common, and horizon contains a few ½-inch layers of silty clay loam); strongly calcareous.

VARIATIONS.—The surface layer ranges from loamy fine sand to silt loam, but fine sandy loam is predominant. In most places the surface layer is calcareous, but in some it is neutral to very slightly acid. The proportion of silt loam and very fine sand varies in the subsoil, but the texture is mainly silt loam.

Use and management.—Wind erosion is a problem on this soil. Therefore, fall plowing should be avoided unless trash is left on the surface. Corn and soybeans are easily damaged by drifting sand; therefore, trash tilling or stripcropping with row crops and meadow may be needed. Most of this soil can be tilled within a wide range of moisture content.

This soil is low in organic matter, moderately low to low in available phosphorus, and somewhat low in available potassium. Soil tests will help to determine the need for plant nutrients. This soil is in capability class III, subclass IIIs.

Haynie loamy fine sand, 0 to 2 percent slopes (Hc).—This soil has a surface layer of loamy fine sand. Its

Figure 6.—**Ida soils on steep slopes and narrow ridges in Monona County.**

similar in texture and consistence to the Ida soils, but below the surface layer, they are light olive gray in color. A profile description of a slightly eroded Dow silt loam follows the profile description of Ida silt loam, 1 to 7

is difficult to form and to maintain, even under grass. Erosion should be reduced or minimized by plowing on the contour and by building terraces. The terraces must be carefully designed and constructed, so a local representative of the Soil Conservation Service or the county extension director should be consulted for help.

A suggested rotation if this soil is terraced and farmed on the contour is corn 2 years, oats 1 year, and meadow 1 year. This soil is in capability class III, subclass IIIe.

Ida silt loam, 7 to 14 percent slopes (Ib).—Except for stronger slopes and greater susceptibility to erosion, this soil resembles Ida silt loam, 1 to 7 percent slopes.

Use and management.—In most places this soil is extremely low in available phosphorus, fairly low in available nitrogen, and moderately high in potassium. It is calcareous throughout. Except that an additional year of meadow should be added to the rotation, management practices are the same as for Ida silt loam, 1 to 7 percent slopes. The soil is in capability class III, subclass IIIe.

Ida silt loam, 14 to 22 percent slopes (Ic).—Except that it is more susceptible to erosion, this soil is similar to the Ida silt loams that occupy milder slopes.

Use and management.—The use and management of this soil is like that of Ida silt loam, 1 to 7 percent slopes,

is a fairly fertile soil that, in some places, is subject to flooding.

Typical profile:

A_1 0 to 12 inches, very dark brown (10YR 2/2) silt loam; friable when moist; fine granular structure; slightly acid to neutral.

A_3B_1 12 to 30 inches, very dark grayish-brown (10YR 3/2) silt loam with a few faint yellowish-brown mottles; friable when moist; fine, indistinct, weak subangular blocky structure; neutral to very slightly acid.

C_1 30 to 45 inches, dark grayish-brown to dark-gray (10YR 4/2 to 4/1) silt loam with a few faint yellowish-brown mottles; friable when moist; fine, indistinct, granular structure; weakly calcareous.

D_1 45 to 55 inches, dark grayish-brown (10YR 4/2) lenses of fine sand or silt loam; friable when moist; no distinct structure; moderately calcareous.

VARIATIONS.—Some areas, especially those that lie next to Colo and Zook soils, have a black surface layer. In a few places, the texture of the lower layers is silty clay instead of silt loam. In areas that adjoin the McPaul soil, a thin layer of calcareous silt loam occurs in places in the surface soil. In areas that adjoin the Napier soil, the subsoil contains more yellowish material than occurs in the typical profile.

Use and management.—Floods sometimes limit the use of Kennebec silt loam, 0 to 1 percent slopes. The areas are flooded if dikes and banks give way when the water is high. The frequency and severity of floods vary on different areas. Normally, this soil does not need artificial drainage to grow corn and alfalfa. It has moderate permeability, and tile drainage would function well if needed.

This soil generally has enough lime for crops. It has a moderate to high content of available phosphorus, potassium, and nitrogen.

Because flooding varies on different areas of the soil, it is not possible to suggest a rotation suited to all areas. Where flooding is not a hazard, or can be prevented, the soil is suited to corn. Areas that are frequently or seriously flooded should be used for trees or permanent pasture. This soil is in capability class I.

Kennebec silt loam, calcareous variant, 0 to 1 percent slopes (Kb).—This soil occurs on the old Missouri River bottoms. It has formed from silty alluvium.

Typical profile:

A_1 0 to 16 inches, black to very dark gray (10YR 2/1 to 3/1) silt loam; friable when moist; fine granular structure; medium to strongly calcareous.

C 16 to 38 inches, dark-gray (10YR 4/1) silt loam in the upper part and grayish-brown (10YR 5/2) silt loam in the lower part; a few faint yellowish-brown mottles

few isolated areas occur farther east where the smaller rivers emerge onto the broad bottom lands. The soils have formed under swampgrasses from river deposits high in clay. Some areas of the Luton soils are flooded when dikes and drainage ditches break. A few areas receive some floodwaters from the Missouri River. The soils are classed as Humic Gley (Wiesenboden).

Luton clay, 0 to 1 percent slopes (La).—The texture of this soil is generally uniform to depths of 4 or 5 feet.

Typical profile:

A_1 0 to 6 inches, black (10YR 2/1) clay (about 50 percent clay, about 40 percent silt, and a little sand), firm to very firm when moist; hard when dry and tends to be cloddy; fine granular structure; neutral to slightly acid.

A_1A_3 6 to 14 inches, very dark gray (10YR 3/1) clay (similar to the surface layer in texture and consistence).

B_2 14 to 24 inches, very dark gray (10YR 3/1) clay; firm to very firm when moist; hard when dry; very fine angular blocky structure; neutral to slightly acid.

B_3 24 to 36 inches, dark grayish-brown (10YR 4/2) clay in upper part, but color grades to dark gray (10YR 4/1); in lower part, medium distinct yellowish-brown mottles; when moist, firm to very firm; moderate to strong very fine blocky structure; neutral to very slightly acid.

C 36 to 50 inches, dark-gray (10YR 4/1) to olive-brown (2.5Y 4/4) clay; distinct yellowish-brown mottles; firm to very firm when moist, hard when dry; fine blocky structure; neutral; because of the generally high water table, layer has been somewhat modified since the material was deposited; high water table has caused poor aeration, so layer has a mottled gray color.

VARIATIONS.—The thickness of the dark surface and subsurface layers ranges from about 10 to 20 inches. The B and C horizons, though generally dark gray, in places are yellowish to olive gray. In some places silty layers and lenses of a few inches to occasionally a foot thick occur within 3 to 4 feet of the surface. Apparently these are not continuous and do not have any appreciable effect on the internal drainage or surface drainage.

Although the surface layers are generally neutral, a few areas are slightly calcareous and contain a few snail shells. In many places the B and C horizons are calcareous and contain lime concretions.

In some areas, where this soil occurs near the Albaton soil, it is difficult to distinguish between it and the Albaton soil. A variation or intergrade of Luton-Albaton soils is not so dark as Luton clay, 0 to 1 percent slopes but is darker than the typical Albaton soil. This intergrade was generally mapped as Luton clay, 0 to 1 percent slopes.

The lighter colored variation of Luton clay, 0 to 1 percent slopes, commonly occurs near areas of Luton clay, overwash phase, 0 to 1 percent slopes. The sediments from which this variation developed probably were laid down

Crops cannot be cultivated when this soil is wet, so weeds frequently are not adequately controlled.

Corn, soybeans, and wheat are the principal crops grown. Regular rotations are not generally followed. Some alfalfa is grown. Once established, it grows well in dry seasons but is drowned out in seasons of above-normal rainfall. On the average, according to census records, about 20 percent of the crops are not harvested, usually because they are damaged or ruined by excess water or weeds. This soil is in capability class III, subclass IIIw.

Luton clay, overwash phase, 0 to 1 percent slopes (Lb).—This soil has a clay overwash over a profile similar to that of Luton clay, 0 to 1 percent slopes. The overwash layer is very dark grayish brown to dark grayish brown when moist. It is a clay deposit laid down by the Missouri River at flood stage. Probably it was laid down at the same time that the Albaton and Onawa soil materials were deposited. This layer is generally 4 to 15 inches thick and is composed of about 50 percent clay, about 40 percent silt, and a little sand. It has fine granular or fine angular blocky structure. When it is moist, firm pressure is necessary to mold it.

VARIATIONS.—The buried profile below the overwash layer has properties and variations similar to those of Luton clay, 0 to 1 percent slopes.

cultivation problems are generally less serious than they are for Luton clay, 0 to 1 percent slopes.

Except for the slight differences indicated, the properties and management are the same for this soil as for the Luton clays. The soil is in capability class III, subclass IIIw.

McPaul Soils

Only one of the McPaul soils, McPaul silt loam, 0 to 2 percent slopes, is mapped in Monona County. The McPaul soils occur along streams and ditches in the uplands and along streams that flow from the uplands. The soils are forming from recently deposited silty sediments, most of which have been deposited during the past 50 years. Each time the streams and ditches overflow, new deposits are added. The sediments consist of materials washed from the dark-colored surface layer of other soils or of material washed from other soils when gullies were formed. The materials are generally calcareous.

Because roads and fences have determined the course of the floodwaters in many places, they have also frequently determined the boundaries of these soils. These soils are classified as Alluvial.

McPaul silt loam, 0 to 2 percent slopes (Ma).—This soil has nearly level relief, and most slopes are less than

Mixed Alluvial Land

Mixed alluvial land is a miscellaneous land type. It is composed of the most recent sediments deposited by rivers during floods. The sediments are of various textures. There is no well-defined profile.

Mixed alluvial land (Mb).—In Monona County this land type is near the Missouri River. Each flood adds new sediments. Sometimes clay is deposited on sand, and sometimes sand on clay. Some areas of Albaton, Modale, and Sarpy soils are included in this mapping unit. The vegetation consists of trees, brush, and swamp plants.

Use and management.—Flooding is the chief problem on this land type. The land is often wet. It is generally moderately low in fertility and is especially low in available nitrogen and phosphorus. Some areas have been cleared and occasionally planted to corn and other crops, but the crops are often ruined by floods. Some areas of out. Soil tests are the best way of determining the need for plant nutrients for different crops. Corn and soybeans can be grown in most years. If the soil is fertilized properly, fairly good yields of corn are obtained. Good tilth is easy to maintain, and legume-grass meadow is not needed often in the rotation to maintain tilth. This soil is in capability class I.

Modale sandy loam, 0 to 1 percent slopes (Md).—This soil is similar to Modale silt loam, 0 to 1 percent slopes, but it is droughty and subject to wind erosion.

Typical profile:

A_1 0 to 10 inches, very dark grayish-brown (10YR 3/2) sandy loam; friable when moist; fine granular structure; mildly calcareous.

C_1 10 to 20 inches, very dark grayish-brown (10YR 3/2) fine sandy loam with thin lenses of silt; contains a few faint yellowish-brown mottles; friable when moist; indistinct granular structure; strongly calcareous.

D_1 20 to 25 inches, very dark grayish-brown (10YR 3/2) silty

Use and management.—This soil is erodible, but it is less eroded than the other Monona soils. It is moderately permeable so that level terracing and listing on the contour can be used to help control erosion. As further protection, 1 year of legume-grass meadow generally should be included in the rotation following 2 years of corn and 1 year of oats.

large enough to be mapped as Ida soils if erosion continues at the same rate as in the past 50 years.

Use and management.—A stable structure is harder to maintain in Monona silt loam, 14 to 22 percent slopes, eroded, than in soils with a less silty surface layer. Lime is not generally needed for alfalfa, but the nitrogen content is very low. The supply of available phosphorus is

at the same rate as in the past 50 years, it is probable that this mapping unit eventually will be classed as an Ida soil.

Use and management.—Terraces cannot be used on Monona silt loam, 30 to 40 percent slopes. This soil is best used for permanent pasture. It is in capability class VII, subclass VIIe.

Napa Soils

The Napa soils occur in small areas, each about an acre in size. Some areas are so small that they are indicated on the map by alkali-spot symbols. Normally, they occur in slight depressions within larger areas of Luton soils. They contain exchangeable sodium and are true alkali soils. Below a thin surface layer, their texture is silty clay throughout. They are classed as Humic Gley (Wiesenboden) soils but resemble the Solonetz soils. In this county there is only one soil of this series, Napa clay, 0 to 1 percent slopes.

Napa clay, 0 to 1 percent slopes (Na).—This poorly drained soil occurs in slight depressions within larger areas of Luton soils.

Typical profile:

A_1 0 to 9 inches, very dark gray (10YR 3/1) silty clay; hard when dry, firm when moist; coarse blocky structure in upper part of layer, or plow layer, and medium blocky below; because of the exchangeable and water-soluble sodium, slightly alkaline but noncalcareous.

B 9 to 14 inches, very dark gray (10YR 3/1) silty clay; firm when moist; medium blocky structure; because of the soluble and exchangeable sodium, reaction is alkaline; soil is also calcareous.

C_1 14 to 20 inches, mostly dark gray (10YR 4/1) silty clay; some olive-brown (2.5Y 4/4) mottles; firm when moist; medium blocky structure; because of the soluble and exchangeable sodium, reaction is alkaline; soil is also calcareous.

They have formed from material washed from slopes where the Monona, Ida, Castana, and Hamburg soils are dominant. As all these soils are high in silt, the Napier soils are silty. Most of the materials were washed down slowly a long time before the soils were cultivated, and rather indistinct horizons have had time to develop. The Napier soils are Brunizems.

Napier silt loam, 4 to 10 percent slopes (Nb).—This soil has thick dark upper layers and moderately dark to yellowish-brown lower layers. Except in the areas where it lies next to Monona soils, the upper layers are thicker and darker than those of Monona silt loam, 1 to 7 percent slopes.

Typical profile:

A_1 0 to 10 inches, black to very dark brown (10YR 2/1 to 2/2) silt loam; friable when moist; fine granular structure; slightly acid.

A_3 10 to 20 inches, very dark grayish-brown (10YR 3/2) silt loam; friable when moist; indistinct, fine subangular blocky structure; slightly acid.

A_3B_1 20 to 30 inches, dark grayish-brown (10YR 4/2) silt loam; contains about enough clay to be classed as a light silty clay loam; friable when moist; indistinct fine subangular blocky structure; slightly acid.

C_1 30 to 45 inches, chiefly dark grayish-brown (10YR 4/2) silt loam; contains a few faint yellowish-brown mottles; friable when moist; indistinct structure more granular than blocky; slightly acid to nearly neutral.

VARIATIONS.—As a rule the nearly level areas of Napier silt loam, 4 to 10 percent slopes, especially the areas near the middle of drainageways, have some dark gray in the lower layers and a moderate amount of yellowish-brown mottles. Calcium carbonate, in some places, causes an alkaline reaction in the lower layers. In some areas the calcium carbonate occurs at depths of 20 to 25 inches. Many areas of Napier silt loam, 4 to 10 percent slopes, have received recent sediments that have formed a layer, up to 10 inches thick, on the surface. These sediments were washed mainly from Ida and Monona soils, partly through gully erosion. Their color and texture are similar to the dark grayish-brown silt loam

These soils are commonly associated with the Albaton line. Therefore, its supply of available phosphorus is

Typical profile:

A_1 0 to 12 inches, black to very dark brown (10YR 2/1 to 2/2) silty clay loam approaching silt loam; firm when moist; fine granular structure; slightly acid; gradual transition to layer below.

B_2 12 to 25 inches, very dark grayish-brown in upper part, grading to dark grayish-brown in lower part (10YR 3/2 to 4/2), silty clay loam approaching silt loam; contains a few faint yellowish-brown mottles in the lower part; firm when moist; distinct fine subangular blocky structure; slightly acid; gradual transition to layer below.

B_3 25 to 35 inches, dark grayish-brown (10YR 4/2) silty clay loam, almost a silt loam; common fine yellowish-brown mottles; firm to friable when moist; indistinct fine subangular blocky structure; slightly acid to neutral.

CD 35 to 50 inches, yellowish-brown (10YR 5/4) silt loam; common strong-brown and olive-gray mottles; friable when moist; structureless; calcareous.

Use and management.—Because of the sandy surface texture of this soil, wind erosion is often serious. The water-holding capacity is low, and the soil is moderately low to low in plant nutrients, particularly in available nitrogen and phosphorus. Lime is generally not needed. Soil tests can be used as a guide to the need for fertilizers for different crops.

The soil is rather droughty for corn and soybeans, but alfalfa and other deep-rooted legumes usually can obtain moisture from the deep layers. Many areas of this soil are small and are farmed the same as Haynie, Onawa, or other adjacent soils. If corn is grown on the larger areas, a suggested rotation is corn 1 year, oats 1 year, and meadow 2 years. The meadow will help to control wind erosion. Stripcropping and keeping crop residues on the surface will also help. Unless trash is kept on the surface to prevent wind blowing, this soil should not be

Some small areas of Steinauer soils are also included.

In many places narrow bands of Adair soils are mapped with the Shelby soils, and in some places Malvern soils are included in the mapping unit. The Adair soils have a clay subsoil that is very slowly permeable to water. On sidehill seepage areas, the Adair or Malvern soils

serious problem than on Shelby loam, 8 to 14 percent slopes. This soil should be used only for permanent pasture. It is in capability class VI, subclass VIe.

Steinauer Soils

It is best to cultivate on the contour, but because of the somewhat slow permeability of the subsoils, level terraces and contour listing are not generally practicable. The complex is in capability class IV, subclass IVe.

Zook Soils

The Zook soils occupy nearly level areas and depressions, which in some places were old stream channels. They occur along the rivers that flow from the uplands onto the eastern edge of the Missouri River bottom lands.

low because the soil is often cold and wet early in spring. Soil tests should be made before determining the fertilizer needs for different crops. This soil is in capability class III, subclass IIIw.

Zook silty clay, calcareous variant, 0 to 1 percent slopes (Zb).—This soil occurs in the eastern part of the Missouri River bottom lands. It is calcareous throughout. Because of its limited extent in Monona County and its possibly greater extent in Woodbury County, the final naming of this soil has been deferred and it was included in the Zook series.

Except that it is calcareous, the profile is similar to that

TABLE 5.—*Estimated average acre yields of principal crops to be expected for the various soils under two levels of management*

Map symbol	Soil	Estimated average yield of corn per acre under present practices	Fertilizer elements other than nitrogen [1] most likely to be deficient, and other factors that limit yields	Estimated average yields per acre under improved management [2]				Major practices needed, besides fertility programs [3]
				Corn	Oats	Soybeans	Hay [4]	
		Bu.		*Bu.*	*Bu.*	*Bu.*	*Tons*	
Aa	Albaton clay, 0 to 1 percent slopes.	40	Phosphorus; tilth, wetness.	50	32	22	2.2	Tilth maintenance, drainage improvement.
Ba	Blencoe silty clay, 0 to 1 percent slopes.	44	Same	56	36	24	2.2	Tilth maintenance, drainage improvement.
Bb	Blencoe silty clay, clayey substratum variant, 0 to 1 percent slopes.	42	Same	54	36	24	2.2	Tilth maintenance, drainage improvement.
Ca	Castana silt loam, 8 to 14 percent slopes.	39	Erosion, moisture deficiency.	60	42	------	2.2	Contouring, terraces; CCOM [5] rotation.
Cb	Castana silt loam, 14 to 22 percent slopes.	31	Same	50	32	------	2.0	Contouring, terraces;[6] COMM rotation.
Cc	Castana silt loam, 22 to 30 percent slopes.	(7)	Same	(7)	(7)	(7)	[8] 85	Permanent vegetation.
Cd	Colo silty clay loam, 0 to 1 percent slopes.	44	Tilth, wetness	66	52	29	2.4	Tilth maintenance, drainage improvement.
Ce	Colo silty clay loam, moderately shallow over silt loam, 0 to 1 percent slopes.	48	Tilth, wetness	68	53	29	2.6	Tilth maintenance, drainage improvement.
Cg	Colo silty clay loam, calcareous variant, 0 to 1 percent slopes.	42	Phosphorus; potassium, tilth, wetness.	65	51	28	2.4	Tilth maintenance, drainage improvement.
Ch	Cooper silty clay loam, 0 to 1 percent slopes.	53	Phosphorus	68	53	30	3.2	Tilth maintenance, drainage improvement.
Ha	Hamburg silt loam, 30 to 60 percent slopes.	(7)	Very steep slopes	(7)	(7)	(7)	[8] 40	Grazing restriction, permanent vegetation.
Hd	Haynie silt loam, 0 to 1 percent slopes.	35	Phosphorus; some flooding.	65	48	28	2.8	Flood prevention.
Hb	Haynie fine sandy loam, 0 to 1 percent slopes.	30	Phosphorus; some flooding.	55	36	20	2.2	Flood prevention, wind-erosion control.
Hc	Haynie loamy fine sand, 0 to 2 percent slopes.	30	Phosphorus; moisture deficiency.	48	30	16	1.8	Flood prevention, wind-erosion control.
Ia	Ida silt loam, 1 to 7 percent slopes.	20	Phosphorus; erosion, moisture deficiency.	54	35	------	2.2	Contouring, terraces; CCOM rotation.
Ib	Ida silt loam, 7 to 14 percent slopes.	16	Same	51	32	------	2.2	Contouring, terraces; CCOM rotation.
Ic	Ida silt loam, 14 to 22 percent slopes.	13	Same	38	24	------	1.8	Contouring, terraces;[6] COMM rotation.
Id	Ida silt loam, 22 to 30 percent slopes.	(7)	Same	(7)	(7)	(7)	[8] 60	Permanent vegetation.
Ie	Ida silt loam, 30 to 50 percent slopes.	(7)	Same	(7)	(7)	(7)	[8] 50	Permanent vegetation, grazing restriction.
Ka	Kennebec silt loam, 0 to 1 percent slopes.	53	Flooding	68	53	30	3.2	Flood prevention, artificial drainage.
Kb	Kennebec silt loam, calcareous variant, 0 to 1 percent slopes.	40	Phosphorus, potassium; flooding.	66	52	28	2.8	Flood prevention, artificial drainage.
La	Luton clay, 0 to 1 percent slopes.	38	Phosphorus, wetness	45	30	22	1.6	Tilth maintenance, drainage improvement.

TABLE 5.—*Estimated average acre yields of principal crops to be expected for the various soils under two levels of management*—Continued

Map symbol	Soil	Estimated average yield of corn per acre under present practices	Fertilizer elements other than nitrogen [1] most likely to be deficient, and other factors that limit yields	Estimated average yields per acre under improved management [2]				Major practices needed, besides fertility programs [3]
				Corn	Oats	Soybeans	Hay [4]	
		Bu.		*Bu.*	*Bu.*	*Bu.*	*Tons*	
Mg	Monona silt loam, 1 to 7 percent slopes, eroded.	41	Same	62	42	25	2.4	Contouring, terraces, CCOM rotation.
Mh	Monona silt loam, 7 to 14 percent slopes.	39	Same	60	42	------	2.2	Contouring, terraces, CCOM rotation.
Mk	Monona silt loam, 7 to 14 percent slopes, eroded.	36	Same	54	36	------	2.2	Contouring, terraces, CCOM rotation.
Mm	Monona silt loam, 14 to 22 percent slopes.	31	Same	50	32	------	2.0	Contouring, terraces;[6] COMM rotation.
Mn	Monona silt loam, 14 to 22 percent slopes, eroded.	24	Same	44	30	------	1.8	Contouring, terraces;[6] COMM rotation.
Mo	Monona silt loam, 22 to 30 percent slopes.	(7)	Same	(7)	(7)	(7)	[8] 80	Permanent vegetation.
Mp	Monona silt loam, 22 to 30 percent slopes, eroded.	(7)	Same	(7)	(7)	(7)	[8] 80	Permanent vegetation.
Mr	Monona silt loam, 30 to 40 percent slopes.	(7)	Same	(7)	(7)	(7)	[8] 60	Permanent vegetation, grazing restriction.
Na	Napa clay, 0 to 1 percent slopes.	10	Tilth, wetness	10	15	5	.5	Drainage improvement.
Nb	Napier silt loam, 4 to 10 percent slopes.	54	Gully erosion	70	54	30	3.2	Contouring where sloping, grassed waterways where needed; CCOM rotation.
Oa	Onawa silty clay, 0 to 1 percent slopes.	40	Phosphorus; tilth, wetness.	54	34	24	2.2	Flood prevention, tilth maintenance.
Ob	Onawa silty clay loam, 0 to 1 percent slopes.	50	Phosphorus	65	50	28	3.0	Flood prevention, tilth maintenance.
Sb	Salix silt loam, 0 to 1 percent slopes.	55	Phosphorus	72	55	30	3.2	CCOM rotation.
Sa	Salix silty clay loam, 0 to 1 percent slopes.	54	Phosphorus	70	54	30	3.2	CCOM rotation.
Sc	Sarpy fine sandy loam, 0 to 4 percent slopes.	20	Phosphorus; wind erosion, moisture deficiency.	40	26	12	1.5	Wind erosion control; COMM rotation.
Sd	Sarpy loamy fine sand, 0 to 4 percent slopes.	(7)	Same	(7)	(7)	(7)	[8] 50	Permanent vegetation.
Se	Shelby loam, 8 to 14 percent slopes.	25	Phosphorus, erosion, moisture deficiency.	45	32	------	1.8	Contouring, terraces; CCOM rotation.
Sg	Shelby loam, 14 to 35 percent slopes.	(7)	Same	(7)	(7)	(7)	[8] 60	Permanent vegetation.
Sh	Steinauer loam, 8 to 35 per-	(7)	Same	(7)	(7)	(7)	[8] 60	Permanent vegetation.

Soil Characteristics and Management That Affect Yields

The yields that are produced on a soil are determined by its characteristics and the management applied. In Monona County the characteristics of the soils differ to the extent that yields are much higher on some soils than on others. On some soils such as the Sarpy, yields are low because the soils are droughty; on soils such as the Luton, yields are low because the soils are often wet.

The management practices applied—listing and planting on the contour; using terraces, grassed waterways, and

Soil porosity and permeability

Wet soils contain little air. The soil is made up principally of water and soil particles. Most of the soils in the county, if completely saturated, would be comprised of about one-half solids (or mineral materials) and about one-half water. The water is held in the spaces, or pores, between the solids. These pores are of different sizes in different soils. If the pores are small, as they are in the lower part of the Luton profiles, water moves through the soil slowly and drainage is not improved to any extent by tiling. In the lower part of the Monona profiles, the

TABLE 6.—*Effect of tillage and cropping practices in reducing losses of soil and water on areas of Ida silt loam that*

organic matter generally have a much more desirable structure than do soils of similar texture that contain

Eight general capability classes are recognized. In classes I, II, and III are soils that are suitable for annual or periodic cultivation. Class I soils are those that have the widest range of use. They are level, productive, well drained, and easy to work. The soils do not require tile drainage for good crop yields. They do not erode readily, even if cultivated continuously, and will remain productive

Ma McPaul silt loam, 0 to 2 percent slopes.
Mc Modale silt loam, 0 to 1 percent slopes.
Ob Onawa silty clay loam, 0 to 1 percent slopes.
Sa Salix silty clay loam, 0 to 1 percent slopes.
Sb Salix silt loam, 0 to 1 percent slopes.

Class II. Soils that can be cultivated with only moderate risks of erosion or that have other moderate limitations.

IVe. Soils subject to erosion—
Mainly sheet erosion with some gully erosion—
Cb Castana silt loam, 14 to 22 percent slopes.
Ic Ida silt loam, 14 to 22 percent slopes.
Mm Monona silt loam, 14 to 22 percent slopes.
Mn Monona silt loam, 14 to 22 percent slopes, eroded.
Se Shelby loam, 8 to 14 percent slopes.
Sk Steinauer-Castana complex, 8 to 30 percent slopes.
IVw. Poorly drained black alkali soils that have poor tilth—
Na Napa clay, 0 to 1 percent slopes.
IVs. Soils limited mainly by features other than erosion and wetness—
Droughty soils—
Sd Sarpy loamy fine sand, 0 to 4 percent slopes.

Class V. Soils unsuited to cultivation because of excess water. Few limitations for grazing or forestry.
Vw. Soils subject to frequent flooding—
Mb Mixed alluvial land.

Class VI. Soils unsuited to cultivation, except for the minimum required to establish pasture, forage, or trees, because of erosion or other limitations.
VIe. Soils subject to erosion—
Cc Castana silt loam, 22 to 30 percent slopes.
Id Ida silt loam, 22 to 30 percent slopes.
Mo Monona silt loam, 22 to 30 percent slopes.
Mp Monona silt loam, 22 to 30 percent slopes, eroded.
Sg Shelby loam, 14 to 35 percent slopes.
Sh Steinauer loam, 8 to 35 percent slopes.

Class VII. Soils unsuited to cultivation and unless properly managed subject to serious limitations or soil damage when used for pasture or as woodland.
VIIe. Soils subject to erosion—
Hg Hamburg silt loam, 30 to 60 percent slopes.

and Monona soils. It is of Wisconsin age, according to Ruhe and Scholtes (*6*).[3] It is as much as 80 to 100 feet thick in some places in the county. Where it is calcareous, it is fairly high in silt and contains almost no sand-sized particles.

According to Shimek (*7*), the Wisconsin loess overlies Loveland material in Monona County. Kay and Graham (*4*) believed the Loveland material to be loess of immediate post-Illinoian age. The Loveland material has not been a major soil-forming material in this county. It was, however, the parent material of areas of Malvern soils, which are not mapped separately in this county but are included in areas of Shelby soils. According to Kay and Graham (*4*), Kansan glacial till underlies Loveland loess in Monona County. The Shelby and Steinauer soils have formed in this till. The Adair soils have also formed in this till but in an earlier geologic time than the Shelby and Steinauer soils (*6*).

Alluvium was the parent material of many of the soils of the county. The alluvium in this county varies more in texture and color than either the loess or the glacial till. It apparently differs in age, as will be explained under the heading, Time.

The soils derived from glacial till occupy only a small acreage. Where the glacial till is exposed, it is calcareous clay loam that contains some pebbles and a few boulders. Although the mineral content of the unleached glacial till or the Wisconsin loess in this county has not been determined, samples of loess taken in other parts of Iowa contain many different minerals (*4*).

Vegetation

After the soil material was deposited—loess, alluvium, or glacial till—bacteria, fungi, and other simple forms of life invaded it. Later, prairie grasses, the main vegetation in this county, became established. Each year the

Soils formed under forest have thinner, darker surface layers than soils formed under prairie vegetation. None of the soils in this county, however, show distinctly the characteristics normal for soils that have formed under forest. An estimated 90 percent of the county was covered by prairie grasses at the time the county was settled, and about 10 percent, by trees. The early settlers destroyed the original prairie grasses by cultivating and grazing the marginal lands. Some of the fields were later abandoned, and trees invaded the areas. As a result there are probably more trees in the county at the present time than when the county was first settled (*5*).

Relief and natural drainage

Many of the differences among soils are related to differences in relief. As a rule the steeper the slope, the Therefore, the steeper slopes and those exposed more directly to the winds tend to be less leached.

Time

Time is a factor in soil development. If the parent material has been in place for only a short time, the climate and vegetation have not had an opportunity to act on the soils, and the soils are said to be young. The Albaton, Haynie, McPaul, Modale, Onawa, and Sarpy soils are young. They are Alluvial soils forming from recently deposited sediments. The sediments were deposited within the last few centuries, some even within the last few years. The profiles of these soils have not had time to develop.

The Blencoe, Colo, Cooper, Kennebec, Luton, Napier, Salix, and Zook soils, on the other hand, are forming from

Alluvial Profiles

Regosol Profiles

Major Profile III: (Brunizem) In this kind of profile, the surface layer is dark colored and is 12 to

TABLE 7.—*Great soil groups, families, and series*

The Monona family is made up of the Monona, Salix, and Shelby series. The soils of the Monona and Salix series are similar in texture and consistence. The soils of the Shelby series are somewhat finer textured and are not so permeable as the soils of the Monona and Salix series.

The Napier family is made up of the Napier, Castana, and Kennebec series. Though classified as Brunizems, the soils of this family grade toward the Alluvial soils. Of this family, the Kennebec soils are somewhat grayer in color than the other soils, which would indicate that they are occasionally saturated by high water.

The Blencoe family is comprised of the Blencoe and Cooper series. The soils of these two series grade toward the Humic Gley (Wiesenboden) soils. They have somewhat grayer colors in their lower layers than the soils of either the Monona or Napier families.

HUMIC GLEY (WIESENBODEN)

tion, mostly in humid and subhumid climates that vary greatly in thermal efficiency. A large proportion of the Humic Gley soils range from medium acid to mildly alkaline in reaction. Few are strongly acid (*10*).

Three families—the Luton, Colo, and Napa—are in the Humic Gley (Wiesenboden) great soil group. The Luton family consists of the Luton and Zook series. The Colo family has in it only the Colo series. The Colo family has been separated from the Luton family on the basis of the texture of the soils and because the Luton soils have grayer colors in the lower layers.

The Napa series, a minor one in the county, could be classed as solonetzic, but its lower subsoil is like the soils of the Luton family, so it has been listed as belonging to the Humic Gley, or Wiesenboden, great soil group.

The calcareous variants of the Zook, Colo, and Kennebec series have not been included with the respective series in table 7.

TABLE 8.—*Physical and chemical properties of six soils*—Continued

Soil and profile number	pH	Exchangeable cations per 100 gm.					Total N	Organic matter	Sand	Silt	Clay
		Ca	Mg	K	Na	H+					
Luton silty clay (P–149):											
Depth in inches:		*Meq.*	*Meq.*	*Meq.*	*Meq.*	*Meq.*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
0 to 7	6.7	26.2	6.9	2.4	.00	1.9	0.25	------	5.1	52.3	41.7
7 to 15	6.9	22.4	6.4	2.9	.02	1.5	.16	------	------	------	------
15 to 21	6.6	21.2	7.5	3.4	.03	1.6	.12	------	8.5	47.0	44.5
21 to 29	6.8	------	------	------	------	------	.09	------	------	------	------
29 to 37	6.8	21.2	7.6	2.9	.10	1.0	.06	------	------	------	------
37 to 43	6.8	------	------	------	------	------	.05	------	------	------	------
43 to 49	6.9	11.1	3.5	1.6	.01	.8	.03	------	36.3	47.8	15.9
Monona silt loam (P–145): [3] Site NE¼SE¼NE¼, sec. 23, T. 82 N., R. 42 W.											
Depth in inches:											
0 to 3	------	21.3	9.0	1.05	------	1.2	------	------	------	------	27.8
6 to 9	------	14.0	5.9	.81	------	2.8	------	------	------	------	30.4
12 to 15	------	12.9	5.8	.36	------	2.9	------	------	------	------	26.8
18 to 21	------	11.8	5.7	.23	------	2.3	------	------	------	------	22.6
30 to 34	------	11.1	5.1	.18	------	1.0	------	------	------	------	22.2
54 to 60	------	12.7	5.4	------	------	------	------	------	------	------	18.8
88 to 110	------	------	------	------	------	------	------	------	------	------	16.7

Sand. A soil separate that ranges in diameter from 2.0 mm. to 0.05 mm. As a textural class, sand is any soil material that contains 85 percent or more sand, and the percentage of silt plus 1½ times the percentage of clay does not exceed 15.

Silt. A soil separate that ranges in diameter from 0.05 mm. to 0.002 mm. As a textural class silt is any soil material that contains 80 percent or more silt and less than 12 percent clay.

Soil. The natural medium for the growth of land plants. It is a natural body of organic and mineral materials in which plants grow.

Topsoil. Presumably fertile soil material used to topdress roadbanks, gardens, and lawns.

Soil Test Data and Engineering Soil Classifications

To be able to make the best use of the soil maps and the soil survey reports, the engineer should know the physical properties of the soil materials and the in-place condition of the soil. After testing soil materials and observing the behavior of soils when used in engineering structures and foundations, the engineer can develop design recommendations for the soil units delineated on the map.

Soil test data

Soil samples from the principal soil type of each of 10 extensive soil series were tested in accordance with standard procedures (*2*) to help evaluate the soils for engineering purposes. The test data are given in table 9. These test data are considered to be normal for the specific sampling depths in the respective soils. However, considerable variation in texture and plasticity should be anticipated in each of the soils developed from alluvium.

The engineering soil classifications in table 9 are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by using combined sieve and hydrometer methods. The percentages of clay obtained by the hydrometer method should not be used by soil scientists in naming soil texture classes.

The liquid limit and plastic limit tests measure the effect of water on the consistence of the soil material. As the moisture content of a clayey soil increases from a dry density when it is at approximately the optimum moisture content.

Engineering classification systems

Most highway engineers classify soil materials in accordance with the system approved by the American Association of State Highway Officials (*2*). In this system soil materials are classified in seven principal groups. The groups range from A–1, consisting of gravelly soils of high bearing capacity, to A–7, which is made up of clay soils having low strength when wet. Within each group, the relative engineering value of the soil material is indicated by a group index number. The group index numbers range from 0 for the best materials to 20 for the poorest. The group index number is shown in parentheses, following the soil group symbol, in the next to last column in table 9. The principal characteristics according to which soils are classified in this system are shown in table 10.

Some engineers prefer to use the Unified soil classification system (*12*). In this system, soil materials are identified as coarse grained (8 classes), fine grained (6 classes), or highly organic. An approximate classification can be made in the field. The principal characteristics of the 15 classes of soil are given in table 11. The classification of the tested soils according to the Unified system is given in the last column of table 9.

Soil Engineering Data and Recommendations

Some of the engineering information can be obtained from the soils map. It will often be necessary, however, to refer to other parts of the report, particularly to these sections: General Nature of the Area; Descriptions of Soils; and Productivity, Management, and Capability.

The soil engineering data in table 12 are based on the soil test data in table 9, on information given in the rest of the report, and on experience with the same kinds of soils in other counties.

The Shelby and Steinauer soils are located in some areas where roads are being constructed to traverse the

taken from 10 soil profiles, Monona County, Iowa

Mechanical analysis [2]										Liquid limit	Plasticity index	Classification	
Percentage passing sieve [3]						Percentage smaller than—[3]						A. A. S. H. O.[4]	Unified [5]
⅜ in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
------	------	------	------	100	99	98	96	80	63	78	46	A-7-5(20)	CH
------	------	------	------	100	89	85	65	19	14	30	8	A-4(8)	ML-CL
------	------	------	------	100	99	93	68	22	18	34	10	A-4(8)	ML-CL

TABLE 11.—*Characteristics of soil groups*

Major divisions	Group symbol	Soil description	Value as foundation material [2]	Value as base course directly under bitu-
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

in Unified soil classification system [1]

Value for embankments	Compaction: Characteristics and recommended equipment	Approximate range in A.A.S.H.O. maximum dry density [3]	Field (in-place) CBR	Subgrade modulus k	Drainage characteristics	Comparable groups in A.A.S.H.O. classification
		Lb./cu. ft.		*Lb./sq.in./in.*		
Very stable; use in pervious shells of dikes and dams.	Good; use crawler-type tractor, pneumatic-tire roller, or steel-wheel roller.	125–135	60–80	300+	Excellent	A–1.
Reasonably stable; use in pervious shells of dikes and dams.	Same	115–125	25–60	300+	Excellent	A–1.
Reasonably stable; not particularly suited to shells but may be used for impervious cores or blankets.	Good, but needs close control of moisture; use pneumatic-tire or sheepsfoot roller.	120–135	20–80	200–300+	Fair to practically impervious.	A–1 or A–2.
Fairly stable; may be used for impervious core.	Fair, use pneumatic-tire or sheepsfoot roller.	115–130	20–40	200–300	Poor to practically impervious.	A–2.
Very stable; may be used in pervious sections; slope protection required.	Good; use crawler-type tractor or pneumatic-tire roller.	110–130	20–40	200–300	Excellent	A–1.
Reasonably stable; may be used in dike section having flat slopes.	Same	100–120	10–25	200–300	Excellent	A–1 or A–3.
Fairly stable; not particularly suited to shells but may be used for impervious cores or dikes.	Good, but needs close control of moisture; use pneumatic-tire or sheepsfoot roller.	110–125	10–40	200–300	Fair to practically impervious.	A–1, A–2, or A–4.
Fairly stable; use as impervious core for flood-control structures.	Fair; use pneumatic-tire or sheepsfoot roller.	105–125	10–20	200–300	Poor to practically impervious.	A–2, A–4, or A–6.
Poor stability; may be used for embankments if properly controlled.	Good to poor; close control of moisture is essential; use pneumatic-tire or sheepsfoot roller.	95–120	5–15	100–200	Fair to poor	A–4, A–5, or A–6.
Stable; use in impervious cores and blankets.	Fair to good; use pneumatic-tire or sheepsfoot roller.	95–120	5–15	100–200	Practically impervious.	A–4, A–6, or A–7.
Not suitable for embankments	Fair to poor; use sheeps-	80–100	4–8	100–200	Poor	A–4, A–5,

TABLE 12.—*Engineering characteristics of soils*

GLACIAL TILL

Soil series	Brief description of soil profile and ground condition	Dominant slope	Engineering soil classification	Depth to seasonally high water	Suitability as source of topsoil 1

TABLE 12.—*Engineering characteristics of soils*—Continued

ALLUVIUM—continued

Soil series	Brief description of soil profile and ground condition	Dominant slope	Engineering soil classification		Depth to seasonally high water table	Suitability as source of topsoil [1]
			A. A. S. H. O.	Unified		
		Percent			*Feet*	
Napier	Moderately well drained to imperfectly drained silt loam.	1–5	A–4, A–6, or A–7	ML or CL	[3] 2–4	Good to depth of 3 feet.
Onawa	1½ to 3½ feet of imperfectly to poorly drained silty clay loam or silty clay over imperfectly drained silt loam.	0–2	A–6 or A–7 over A–4 or A–6.	CL, MH, or CH over ML or CL.	0–4	Fair.
Salix	Moderately well drained silt loam; in places silty clay loam to a depth of 3½ to 4 feet.	0–2	A–4, A–6, or A–7	ML, CL, or CH	2–5	Good to depth of 2 feet.
Sarpy	½ to 2 feet of well-drained fine sandy loam or loamy fine sand over fine sand.[4]	0–2	A–2 or A–4 over A–2.	SM	[3] 3–5	Poor.
Zook	Very poorly drained silty clay; high organic-matter content to a depth of about 3 feet.	0–1	A–7	MH, CH, or OH	0–3	Fair to depth of 1–1½ feet.

[1] Except where the depth is shown, rating is for the surface of A-horizon material only; the term suitability refers to fitness for use on embankments, on cut slopes, and in ditches to promote the growth of vegetation.

[2] Usually occurs in slight depressions.

[3] Depth to seasonally high water table may be greater than 5 feet in many areas.

[4] Some of sand deposits have been reworked into low dunes by wind; dune material is A–3 (SP).

The soil map and profile descriptions, as well as the engineering data and recommendations given in this section, should be used in planning detailed surveys of soils at construction sites. By using the information in the soil survey report, the soils engineer can concentrate on the most important soil units. Then, a minimum number of soil samples will be obtained for laboratory testing, and an adequate soil investigation can be made at minimum cost.

Literature Cited

(1) AANDAHL, ANDREW R.
1948. THE CHARACTERIZATION OF SLOPE POSITIONS AND THEIR INFLUENCE ON THE TOTAL NITROGEN CONTENT OF A FEW VIRGIN SOILS OF WESTERN IOWA. Soil Sci. Soc. Amer. Proc. 13: 449–454.

(2) AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS.
1955. STANDARD SPECIFICATIONS FOR HIGHWAY MATERIALS AND METHODS OF SAMPLING AND TESTING: CLASSIFICATION OF SOILS AND SOIL-AGGREGATE MIXTURES FOR HIGHWAY CONSTRUCTION PURPOSES, DESIGNATION M 145–49.

(3) HUTTON, CURTIS, E.
1950. STUDIES OF THE CHEMICAL AND PHYSICAL CHARACTERISTICS OF A CHRONO-LITHO-SEQUENCE OF LOESS-DERIVED PRAIRIE SOILS OF SOUTHWESTERN IOWA. Soil Sci. Soc. Amer. Proc. 15: 318–324.

(4) KAY, G. F., and GRAHAM, JACK B.
1941. THE ILLINOIAN AND POST-ILLINOIAN PLEISTOCENE GEOLOGY OF IOWA. Iowa Geol. Survey Ann. Rpt., 1940–41, 38: 1–262, illus.

(5) LOOMIS, W. E., and MCCOMB, A. L.
1944. RECENT ADVANCES OF THE FOREST IN IOWA. Iowa Acad. Sci. Proc. 51: 217–224.

(6) RUHE, R. V., and SCHOLTES, W. H.
1956. AGES AND DEVELOPMENT OF SOIL LANDSCAPES IN RELATION TO CLIMATIC AND VEGETATIONAL CHANGES IN IOWA. Soil Sci. Soc. Amer. Proc. 20: 264–273.

(7) SHIMEK, B.
1910. GEOLOGY OF HARRISON AND MONONA COUNTIES. Iowa Geol. Survey Ann. Rpt., 1909, 20: 273–485.

(8) SIMONSON, R. W., RIECKEN, F. F., and SMITH, GUY D.
1952. UNDERSTANDING IOWA SOILS. Dubuque, Iowa.

(9) SMITH, GUY D., ALLAWAY, W. H. and RIECKEN, F. F.
1950. PRAIRIE SOILS OF THE UPPER MISSISSIPPI VALLEY. Advances in Agron. 2: 157–205.

(10) THORP, JAMES, and SMITH, GUY D.
1949. HIGHER CATEGORIES OF SOIL CLASSIFICATION: ORDER, SUBORDER, AND GREAT SOIL GROUPS. Soil Sci. 67: 117–126.

(11) TIMMONS, J. S., CHAIRMAN.
1950. TEAMWORK TOWARD BETTER LAND USE AND SOIL CONSERVATION IN WESTERN IOWA. Iowa Expt. Sta. Spec. Rpt. 4, 27 pp., illus.

(12) WATERWAYS EXPERIMENT STATION.
1953. UNIFIED SOIL CLASSIFICATION SYSTEM. Tech. Memo. No. 3–357, vol. 1.

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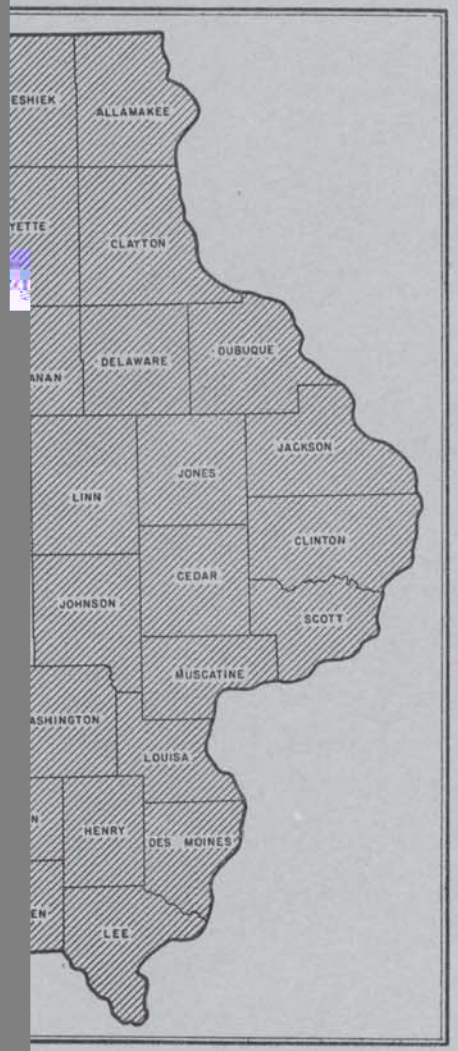
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