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Soil Survey

Midland County Michigan

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UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Plant Industry, Soils, and Agricultural Engineering
In cooperation with the
MICHIGAN AGRICULTURAL EXPERIMENT STATION

HOW TO USE THE SOIL SURVEY REPORT

SOIL SURVEYS provide a foundation for all land use programs. This report and the accompanying map present information both general and specific about the soils, the crops, and the agriculture of the area surveyed. The individual reader may be interested in the whole report or only in some particular part. Ordinarily he will be able to obtain the information he needs without reading the whole. Prepared for both general and detailed use, the report is designed to meet the needs of a wide variety of readers of three general groups: (1) Those interested in the area as a whole; (2) farmers and others interested in specific parts of it; and (3) students and teachers of soil science and related agricultural subjects. Attempt has been made to meet the needs of all three groups by making the report comprehensive for purposes of reference.

Readers interested in the area as a whole include those concerned with general land use planning—the placement and development of highways, power lines, urban sites, industries, community cooperatives, resettlement projects, and areas for forest and wildlife management and for recreation. The following sections are intended for such users: (1) General Nature of the Area, in which location and extent, physiography, relief and drainage, climate, water supply, vegetation, organization and population, industries, transportation and markets, and cultural development and improvement are discussed; (2) Agriculture, in which a brief history and the present status of the agriculture are described; (3) Land Use and Soil Management, in which the present uses of the soils are described and suggestions made for improvement.

Readers interested chiefly in specific areas—as some particular locality, farm, or field—include farmers, agricultural technicians interested in planning operations in communities or on individual farms, real estate agents, land appraisers, prospective purchasers and tenants, and farm loan agencies. These readers should (1) locate on the map the tract with which they are concerned; (2) identify the soils on the tract by locating in the legend on the margin of the map the symbols and colors that represent them; and (3) locate in the table of contents in the section on Soils the page where each type is described in detail and information given as to its suitability for use and its relations to crops and agriculture. They will also find useful information in the section on Land Use and Soil Management.

Students and teachers of soil science and allied subjects—including crop production, forestry, animal husbandry, economics, rural sociology, geography, and geology—will find their special interest in the section on Morphology and Genesis of Soils. They will also find useful information in the section on Soils, in which are presented the general scheme of classification of the soils of the area and a detailed discussion of each type. For those not already familiar with the classification and mapping of soils, these subjects are discussed under Soil Survey Methods and Definitions. Teachers of other subjects will find the sections on General Nature of the Area, Agriculture, Land Use and Soil Management, and the first part of the section on Soils of particular value in determining the relations between their special subjects and the soils of the area.

This publication on the soil survey of Midland County, Mich., is a cooperative contribution from the—

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SOIL SURVEY OF MIDLAND COUNTY, MICHIGAN

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

CONTENTS

MIDLAND COUNTY lies in the east-central part of the Lower Peninsula of Michigan. Midland, the county seat and only city, is surrounded by rural homes of many industrial workers. Lumbering, salt and oil wells, and clay mines are the principal industries.

[1] The field work for this survey was done while the Division was a part of the Bureau of Chemistry and Soils.

Agriculture at first was confined to growing crops for home consumption, but as transportation facilities improved and markets were created, farmers began to raise more livestock and to sell their crops for cash. Farming is highly diversified. Livestock farming is widespread and consists largely of dairy cattle and poultry production and growing most of the necessary feed crops, as corn for grain and silage, oats, barley, wheat, alfalfa, red clover and sweetclover, timothy, quackgrass, and tame and permanent pastures. To provide a basis for the best uses of the land a cooperative soil survey was begun in 1938 by the United States Department of Agriculture and the Michigan Agricultural Experiment Station. The report here presented may be briefly summarized as follows.

SUMMARY

The land surface of Midland County consists of nearly level lakebed plains dipping slightly to the southeast. Stream dissection is immature and incomplete, and the few streams flow in narrow valleys 10 to 60 feet below the level of the plain. Natural drainage is deficient on about 90 percent of the county areas, but most of the better agricultural soils have been artificially drained.

The soils are subdivided into three groups according to the texture of the parent material, and these groups are further subdivided on the basis of natural drainage. The soils developed from heavy-textured materials are the well-drained Tuscola, imperfectly drained Selkirk, and poorly drained Toledo, Brookston, and Bergland. The soils developed from light- to medium-textured materials are the well-drained Arenac, imperfectly drained Ogemaw, Macomb, and Kawkawlin, and poorly drained Colwood and Munuscong. The soils developed from deep sands are the well-drained Oshtemo, Rubicon, and Weare, imperfectly drained Saugatuck, and poorly drained Newton and Granby. In addition to these, Genesee and Griffin soils are mapped in the river flood plains, and Carlisle muck, Kerston muck, and Muck and peat in the bogs and swamps.

Many soils require drainage to some extent before they can be used for cultivated crops. Some of the deep sandy soils, however, are deficient in moisture supply, and where there is a cheap source of water, irrigation might be practical for crops of high acre value. Tillage requirements vary according to the texture of the soil; organic matter in the form of barnyard and green manure is beneficial for all soils; soil blowing on the very sandy mineral soils and unusually dry well-decomposed mucks is highly injurious; and fertilizers are generally used to increase crop production.

Estimated yields of the principal crops on each soil in the county under average management practices are given, and the soils are rated according to their productivity for the more important crops and listed in the order of general productivity under common practices of management, the ratings being given for two general levels of management—the common and the better practices.

The morphology and genesis of the soils are discussed from a soil scientist's point of view, particularly in connection with soil classification. The three broad groups, or orders, into which the soils are classified (zonal, intrazonal, and azonal) are divided into subgroups,

or great soil groups (Podzol, Gray-Brown Podzolic, Planosols, Ground-Water Podzol, Half Bog, Bog, and Alluvial soils), on the basis of additional common characteristics. These groups are subdivided into soil series, and the series in turn into types, which are the principal units of mapping.

GENERAL NATURE OF THE AREA

LOCATION AND EXTENT

Midland County is rectangular in shape and occupies an area of 520 square miles, or 332,800 acres, in the east-central part of the Lower Peninsula of Michigan (fig. 1). Midland, the county seat, is 20 miles northwest of Saginaw, 65 miles north of Lansing, 85 miles northeast of Grand Rapids, and 105 miles northwest of Detroit.

FIGURE 1.—Location of Midland County in Michigan.

PHYSIOGRAPHY, RELIEF, AND DRAINAGE

Situated in the eastern lake section of the Central Lowland physiographic province of the United States, the land surface consists of nearly level lake-bed plains dipping slightly to the southeast. The geologic materials include wave-washed till, water-laid moraines, and lacustrine sediments deposited during or following the Late Wisconsin glacial period.[2] The basal deposits are mainly clay and bouldery

[2] LEVERETT, F. SURFACE GEOLOGY AND AGRICULTURAL CONDITIONS OF MICHIGAN. Mich. Geol. and Biol. Survey Pub. 25, Geol. Ser. 21, 223 pp., illus. 1917.

clayey till; these are covered by deposits of sand varying from 2 to 30 feet thick over much of the country.

The original constructional surface has been only slightly modified by stream dissection. There are relatively few small tributary streams, and therefore broad unbroken plains occur between the stream valleys. The valley floors of the largest streams are usually less than half a mile wide and are entrenched to a depth of 10 to 60 feet. The plains are marked at intervals by winding ridges of sand 10 to 20 feet high, which are bars and beach ridges defining former lake stages. The sand ridges are seldom continuous or straight but in general are oriented in a northeast-southwest direction, as between North Bradley and Coleman, but in many places they are merely mounds or hummocks, seemingly without order. A few steep slopes border the outer valley edges of the larger streams, and there are a few small areas of rolling land. Generally the surface is flat and relatively featureless.

Elevations range from approximately 620 feet above sea level in the southeastern corner, where the Tittabawassee River flows from the area, to about 750 feet in the northwestern part. Other elevations are 624 feet at Laporte, 640 feet at Sanford, and 702 feet at Pleasant Valley.[3]

The county is drained largely by the Tittabawassee River, which enters from the north, and its tributaries, the Pine and Chippewa Rivers, which enter from the southwest and west, respectively, and empty into the Tittabawassee River west of Midland. Natural drainage is deficient on about 90 percent of the area, but most of the better agricultural soils have been artificially drained.

CLIMATE

The climate, modified somewhat by the Great Lakes, is continental. Lake Michigan has some influence because the prevailing winds blow from the west and southwest. The average January temperature is about 5 degrees warmer than in south-central Wisconsin, and the average July temperature is slightly cooler. In winter there is much cold cloudy weather. Snow usually covers the ground for 3 or 4 months, and the soils are frozen most of each winter. In spring and fall the weather is damp and chilly. Soils warm slowly in spring, and ice and snow remain in the swamps and timberlands after they have disappeared from the cleared land. The summers are generally mild, but hot weather may be experienced for a few days.

The average annual temperature at Midland is 47.3° F., and the average winter and summer temperatures are 23.8° and 69.4°, respectively. Extremes as low as −30° and as high as 104° have been recorded, but these are rare.

The average length of the growing season at Midland is 144 days, from May 10 to October 1. In most years the last killing frost in spring and the first in fall will be within 10 days of these average dates. In the southern part of the county the growing season is about 10 days longer than in the northern part.

The annual precipitation is seldom less than 20 or more than 35 inches. The mean annual precipitation of 25.71 inches is well distributed throughout the year. About a third of the rain falls in the

[3] Data on elevations from U. S. Geological Survey maps.

three main crop-growing months—May, June, and July—and about a half in the average growing or frost-free season. Precipitation is slightly less than 2 inches a month during the 6 coldest months, November through April, but it averages 2½ to 3 inches during the 6 warmest months, May through October, and is seldom less than 1¼ inches. The average rainfall in May, the wettest month, is 3.15 inches. Crops, pastures, and forests are apparently well watered in most years. In 1910, the driest year on record at Midland, there was about 1 inch of precipitation in the months of June and July. It is uncommon for 2 successive months to have less than 1 inch precipitation, but there may be isolated months or periods of 30 to 45 days during any year when there is little rain.

The main form of precipitation is rain, half of it falling at night. Rains during the day are often accompanied by violent storms and are likely to be heavier than those at night. Heavy, short downpours (thunderstorms) are common in summer, but cloudbursts are uncommon. Smooth relief retards rapid runoff, thus preventing flash floods and minimizing erosion. Heavy rains are uncommon when the ground is frozen late in the fall, in winter, or early in spring.

Some loss of moisture through runoff during spring thaws occurs on the loam and clay loam soils, but the sandy loams and loamy sand soils absorb most of the water from rain and melting snow. Some areas of cropland, both on the nearly level upland and in the stream bottoms, may be flooded in spring or immediately following heavy rains, but these periods of inundation are usually short. Floods caused by precipitation in remote areas do not occur here, as the streams are relatively short.

Snow also is an important form of precipitation, the annual snowfall averaging 40.8 inches. About 90 percent falls during 4 months, December through March, and is well distributed through these months. Deep snows do not ordinarily accumulate until the ground is frozen, so they do not appreciably lessen frost penetration but definitely protect the soil from great variations in temperature.

Prevailing winds are from the southwest or west, and winds of high velocity are uncommon. Wind velocity increases late in the morning, reaching a maximum at 2 or 3 p. m., particularly in summer, then decreases rapidly and is relatively gentle by sundown. Rainstorms are usually preceded by strong southwest winds, but little wind accompanies long, gentle rains. Snowstorms often come from the northwest and west. Tornadoes, or twisters, are uncommon but when they do occur they cause considerable damage to small areas. Strong windstorms sometimes severely damage small areas of crops. Few acres are seriously damaged by soil blowing, although many plowed fields and barren or overgrazed areas on exposed sandy ridges are subject to some blowing. Hailstorms, covering an area ½ to 2 miles wide, occur on the average about twice each year, usually when only two or three crops are susceptible to severe injury. Glaze, or sleet, storms are relatively common in spring and late in the fall, but resultant damage in the agricultural sense is confined largely to trees and shrubs.

Climatic data as recorded by the United States Weather Bureau station at Midland are given in table 1. These data are probably representative of the entire county, as there is little variation due to relief.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Midland, Midland County, Mich.*

[Elevation, 604 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year	Total for the wettest year	Average snowfall
	°F	°F	°F	*Inches*	*Inches*	*Inches*	*Inches*
December	26 3	60	−16	1 51	1 95	3 03	8 8
January	23 4	60	−24	1 55	1 35	1 49	10 1
February	21 6	65	−30	1 27	.99	66	9. 8
Winter	23 8	65	−30	4 33	4 29	5 18	28 7
March	32 6	75	−20	1 91	01	4 15	7 7
April	45 7	91	5	1 98	1 02	1 23	1 9
May	58 0	95	23	3 15	4 56	5 71	.1
Spring	45 4	95	−20	7 04	5 59	11 09	9 7
June	67 0	100	24	2 25	25	5 35	0
July	71 8	103	38	2 87	.80	2 77	0
August	69 4	104	32	2. 50	1 30	1 21	0
Summer	69 4	104	24	7 62	2 35	9 33	0
September	63 0	98	26	2 58	.51	5 12	[1]
October	50 7	89	18	2 31	1 95	3 58	2
November	38 4	73	4	1 83	1 85	2 62	2 2
Fall	50. 7	98	4	6 72	4 31	11 32	2. 4
Year	47. 3	[2] 104	[3] −30	25. 71	[4] 16 54	[5] 36 92	40. 8

[1] Trace.
[2] August 1918
[3] February 1912
[4] In 1910.
[5] In 1942

WATER SUPPLY

The water supply for domestic and general farm use is obtained largely from wells—it is abundant, but that from the deeper wells is commonly slightly salty. Flowing wells are common only in the vicinity of North Bradley. Although surface water for livestock may be scarce in the pasture lands during summer, it is easily obtained from shallow wells.

VEGETATION

The native forest cover consisted of a dense growth of hardwoods and conifers. A definite correlation existed between the type of this cover and the character of the soils, although on some sites a variety of species, both hardwoods and conifers, were intimately associated. Pine trees were most abundant on dry or semiwet sand soils and hardwoods on the more clayey soils, both wet and dry, and on wet sandy soils. The stand on the moister medium-textured soils and on sandy loam soils consisted largely of white pines, with occasional deciduous species. Jack pine and red (Norway) pine stands occupied the driest sands. The principal deciduous species were elm, red maple, swamp white oak, white oak, black and white ash, and basswood, with some beech, hard maple (sugar maple), hickory, butternut, sycamore, and cottonwood. In a few places hemlock was common. A few of the wettest or marshy areas have a vegetative cover of reeds, cattails, other coarse sedges and grasses, willows, spiraea, and alder.

The organic soils—mucks and peats—have the following four natural vegetative types: (1) Marsh, (2) bush or shrub, (3) conifer and tamarack, and (4) deciduous tree. Open swamps and marshes are wettest and have a cover of sedges, reeds, and cattails. Dry peaty swamps have a growth of blueberry, leatherleaf, bracken fern, and sweetfern; whereas wet peaty swamps support a growth of tamarack, redcedar, and spruce. Swamps of well-decomposed muck, which usually is underlain by clay substrata at 3 to 6 feet, support a growth of elm, swamp white oak, and black ash. The natural vegetation of the wet peat and muck swamps has been altered greatly by lumbering operations and by frequent burning or brush fires.

The vegetative cover is now markedly different from the original stands, of which only a few patches remain. The present cover (1937–38), roughly estimated at the time of the soil survey, is shown in figure 2.

About 40 percent of the land is cleared, and a few areas of this are stony or are along winding river bottoms and used mainly for pasture. The present cover on the moist sandy soils is dominantly aspen, elm, oak, birch, and alder, and on the dry sandy ridges oak, aspen, and pin cherry. The understory consists of weeds, as goldenrod, grasses, sedges, bracken fern, and sweetfern. In many places the ground cover in stump lands and less shaded second-growth areas is Kentucky bluegrass and Canada bluegrass. Alsike clover, timothy, and bluegrass grow wild on the clayey and more moist sandy soils of the old cut-over forest land. Wintergreen, blueberry, moss, and bracken fern constitute the ground cover on the moist acid sands, and sumac and sweetfern on the dry sand plains and ridges.

ORGANIZATION AND POPULATION

The first permanent white settlement in what is now Midland County was made in eastern Ingersoll Township in 1836. The county was organized in 1850, and as then constituted, included much of what is now Gratiot, Bay, Saginaw, Isabella, Roscommon, Gladwin, and Clare Counties, which were organized as settlement progressed.

The early settlers were of French and English origin and came from the eastern part of the United States and from Canada. Later settlements were made by emigrants from northern Europe and by pioneers from the Eastern and Southern States. The population steadily increased, from 65 inhabitants in 1850 to 27,094 in 1940 (U. S. census). Of the rural population in 1940 (16,765), 9,922 were classed as rural-farm. Midland, the county seat and only city, has a population of 10,329. It is flanked on all sides by rural homes of industrially employed workers, and its growth, together with the rural residents who work in its industries, accounts for the increase in population of the county in recent years. Coleman, North Bradley, Sanford, Averill, Smiths Crossing, located along the Pere Marquette Railway, and Edenville are small towns and villages.

INDUSTRIES

Lumbering was the first big industry in Midland County. Logs were said to form a "jam" or "bridge" from Bay City to Edenville dur-

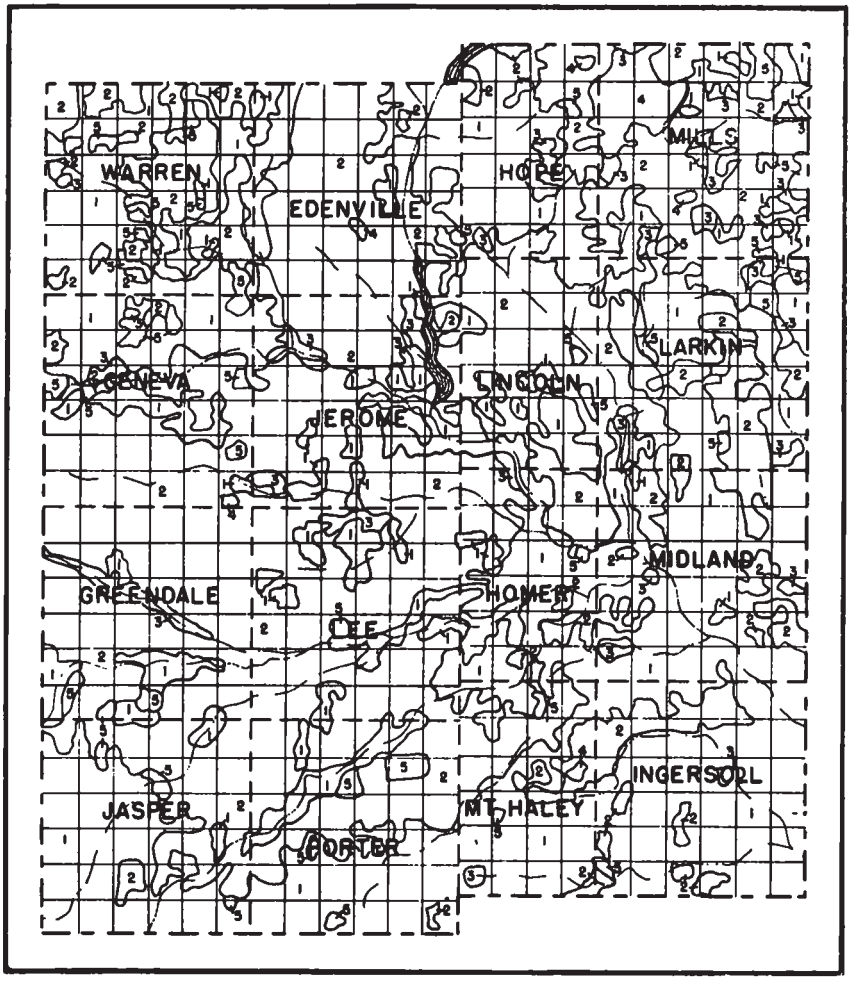


FIGURE 2.—Present land cover in Midland County, Mich.: 1, Cleared land—hay, crop, pasture, and urban; 2, brushland—old cut-over forest land covered with a scanty growth of aspen, alder, willow, spiraea, and a few oak, pine, and elm; 3, hardwood land—mainly second growth of elm, maple, oak, and ash; 4, swampland—grasses and sedges, with alder, tamarack, spruce, and redcedar; 5, pine-stump land—mainly pasture with some brush and scattered trees.

ing parts of the year. Some of the timber was made into shingles, hoops, laths, and boards in the local lumber mills as early as 1838. Pine and mixed hardwood stands were largely cut by 1884, but many of the lumber workers remained to engage in farming. The first mineral or salt well was completed in 1878 or 1879, and bromine and salt industries were established. At present about 250 brine wells in the vicinity of Midland supply part of the raw material for a large chemical industry. One of the industrial sources of income is from oil wells, which began production in Greendale Township in 1928. The

early production, however, has not been maintained, since only a few new producing wells have been discovered. One open-pit clay mine is a source of clay for portland cement.

TRANSPORTATION AND MARKETS

The Tittabawassee River was a means of transportation to traders, Indians, fishermen, and trappers prior to the first permanent white settlements. The early settlers transported their wheat and other commodities down the river by "pole boat." A steamer gave regular service between Midland and Bay City from 1837 until the Pere Marquette Railway was completed as far as Midland in 1867; this railroad was completed to Coleman in 1870.

All communities are well situated with respect to good roads and have railroad connections with western, southern, and eastern Michigan. Nearby Saginaw and Bay City are the lake ports. Beets, beans, potatoes, wheat, and part of the corn, barley, and oat crops are transported by truck and by railroad. Livestock is sold largely to local buyers or nearby livestock markets. Milk is generally sold in bulk, but some cream is marketed.

CULTURAL DEVELOPMENT AND IMPROVEMENT

The rural districts are well supplied with good roads, schools, churches, and telephones, and recently rural electric power lines have been extended, making electricity available to many farms.

AGRICULTURE

The agriculture of the early settlers consisted mainly of growing potatoes, wheat, corn, and garden crops for home consumption. As transportation facilities improved, however, and markets were created, farmers began to raise more livestock and to sell their crops for cash. Since 1900 the farm acreage and population have been quite stable, despite the fact that farmers have moved to better soil areas and that during the last 20 or 30 years many factory and oilfield workers have established rural homes in the vicinity of the city of Midland and have undertaken the practice of agriculture in a small way (pl. 1, *A*). Many of the homes, however, are on soils that are poor for gardens. The homes tend to be too crowded along the main roads, and sufficient land is not always available.

CROPS

A gradual change in crops has accompanied the shifts in population and land use in the county. While the farms were being established during the period 1880–1900, hay, corn, wheat, oats, potatoes, and garden crops were most important.

About 77 percent of the 2,113 farms in the county in 1940 grew hay in 1939 (U. S. census). The hay acreage increased steadily to a maximum of 27,725 acres in 1919 but has decreased slightly since that date. Alfalfa has increased in the last 40 years from 2 to 12,698 acres. In general, alfalfa and red clover hay have increased at the expense of timothy-and-clover mixtures.

Corn, an important crop from the time the county was first settled, increased consistently in acreage from 1,564 acres in 1879 to 15,254 in 1919. It declined sharply in 1929 but increased again to 17,455 acres in 1939. About 75 percent of the farms grow corn, using about four-fifths of it for grain and the rest for silage and forage. The introduction of hybrid varieties in recent years has increased average crop yields 5 to 15 percent. Oats are grown on about 53 percent of the farms and are used mostly for feed. Their acreage increased steadily from 1879 to 1919 but has declined about one-third in the last two decades. At the beginning of the twentieth century, field beans occupied 1,298 acres, and in the next 20 years the acreage increased tenfold but has remained fairly constant in the last two decades. Beans of the pea and navy bean varieties are grown on approximately one-third of the farms and are sold to local elevators. The acreage planted to barley has varied with the fluctuating demand for malting grain by the brewing industry. Wheat acreage reached its peak in 1899 when 7,138 acres were grown, after which it declined, owing partly to the development of the Great Plains wheatlands and partly to increased production of field beans, sugar beets, and corn. Most of the wheat is of the soft, or winter wheat, type. Though some is fed to poultry, it is usually sold to elevators.

Hay, wheat, and rye acreages have decreased with the increase of cash crops such as sugar beets, which were grown by 329 farms in 1939. Sugar beets are well adapted to the dark-colored heavy-textured soils which comprise 10 to 15 percent of the total area of the county. They were produced on 599 acres in 1899, 2,045 in 1919, and 3,683 in 1939. The beets are thinned, hoed, and harvested by transient Mexican laborers and hauled by truck to beet-sugar factories in nearby cities.

Since 1900, potatoes have been grown for local sale as well as home consumption. Almost three-fifths of the farms reported growing potatoes in 1939, but the average acreage a farm was small. Some Irish Cobbler seed is shipped to Ohio and Indiana.

Minor crops are rye, buckwheat, and chicory. Truck crops are sold locally or consumed at home. Orchards have never played an important role in the agriculture, chiefly because of the nearly level relief and poorly drained nature of the soils. Apples are the principal tree fruit, and 14,860 apple trees of bearing age were reported in 1940. Wild blackberries and blueberries, abundant in many areas, are picked for local use. In 1939 there were 60 acres in raspberries and blackberries, 53 in strawberries, and 22 in wild blueberries. A few farmers receive some income from berries and garden crops sold in Midland and other nearby cities.

One-third of the area of all the cropland is in rotation or permanent pasture consisting of bluegrass, quackgrass, alsike, sweetclover, and timothy. Woodland pasture acreage is almost double that of plowable and other pasture.

The trend of agriculture is indicated in table 2, which gives the acreages of the principal crops reported by the United States census for the years 1879 to 1939, inclusive.

TABLE 2.—*Acreages of the principal crops in Midland County, Mich., in stated years*

Crop	1879	1889	1899	1909	1919	1929	1939
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn, total	1,564	2,152	8,869	9,050	15,254	9,751	17,455
Harvested for grain	1,564	2,152	8,869	9,050	11,173	4,241	15,498
Cut for silage or fodder, hogged, or grazed					4,081	5,510	1,957
Oats threshed	1,349	6,408	8,053	10,460	16,325	10,410	10,816
Oats cut and fed unthreshed						938	887
Wheat	2,882	3,432	7,138	1,990	1,578	1,965	1,793
Barley	21	101	147	345	4,355	1,950	4,866
Rye	71	182	684	1,089	1,771	333	346
Buckwheat	185	446	994	365	322	504	286
Hay, total	4,588	12,380	14,954	18,696	27,725	25,803	24,584
Alfalfa			2	8	171	2,331	12,698
Clover or timothy, alone or mixed				17,573	25,792	17,601	8,400
Clover alone			1,898	484	630	2,939	[1] 605
Small-grain hay			502	172	630	352	929
Annual legumes for hay					25	88	233
Other tame hay			12,478	301	344	2,381	1,522
Wild hay			74	158	133	111	197
Field beans			1,298	9,091	14,355	14,815	12,764
Sugar beets			599	1,261	2,045	1,119	3,683
Potatoes	510	1,167	1,939	2,056	1,888	1,105	1,173
Market vegetables					143	220	66

[1] Sweetclover.

LIVESTOCK AND LIVESTOCK PRODUCTS

Livestock and livestock products are important sources of food and income on most farms in this county.

Dairying is one of the most important agricultural enterprises. Most dairy farms are located on intermediately productive soils despite the fact that dairying is usually practiced in conjunction with other types of farming. On April 1, 1940, there were 15,851 cattle over 3 months old on farms, mostly dairy breeds such as Holstein-Friesian, Guernsey, and Jersey. Only a few beef and dual-purpose cattle are raised. About 80 percent of the farms have 1 or more cows, and about 65 percent sell fluid milk or cream.

A total of 307 farms reported 8,681 sheep over 6 months old on April 1, 1940. Shropshire and Hampshire are the common breeds. Both wool and mutton are sold, usually to buyers from neighboring cities. The majority of sheep farms are on intermediate to poor-grade agricultural land.

Some poultry is raised on practically all farms, and poultry and poultry products were sold by many farms in 1939. Hogs and pigs are used for local and home consumption. A total of 7,073 over 4 months old on April 1, 1940, were reported on 1,112 farms.

An increase in the number of tractors has brought about a decline in the number of horses and mules. About three-fourths of the farms reported horses in 1940, largely mixed Percheron and Belgian stock, but the total number has dropped in the last 20 years from 6,772 head to 3,862.

The values of certain crops and livestock products in 1929 and 1939, as reported by the Federal census, are shown in table 3.

TABLE 3.—*Value of certain agricultural products, by classes, in Midland County, Mich., in 1929 and 1939*

Crops	1929	1939	Livestock products	1929	1939
All cereals	$336,645	$577,671	Whole milk, cream, and butter sold	$604,808	$443,895
Corn for grain	110,903	320,566	Whole milk	383,615	250,784
Wheat threshed	43,059	33,711	Cream [1]	209,036	189,810
Other cereals	182,683	223,394	Butter	12,157	3,301
Other grains and seeds	632,642	374,808	Livestock sold or slaughtered	(2)	366,549
Hay and forage	316,376	289,321	Cattle and calves	(2)	198,159
Vegetables for sale and home use (excluding potatoes and sweetpotatoes)	64,274	59,319	Hogs and pigs	(2)	141,633
For sale	7,182	3,665	Sheep and lambs	(2)	26,757
For home use	57,092	55,654	Poultry raised and eggs produced	313,323	216,067
Potatoes and sweetpotatoes	106,213	74,557	Wool shorn	16,586	14,176
Fruits and nuts	32,930	30,470	Honey produced	12,832	11,410
Horticultural specialties sold	15,800	6,074			
All other crops	61,731	194,091			
Forest products sold	18,398	2,244			

[1] Both sweet cream and sour cream (butterfat).
[2] Not available

TYPES OF FARMS

Farm enterprises are highly diversified in this county, as indicated in the following tabulation, which shows the classification of farms by the Federal census according to their major source of income in 1939:

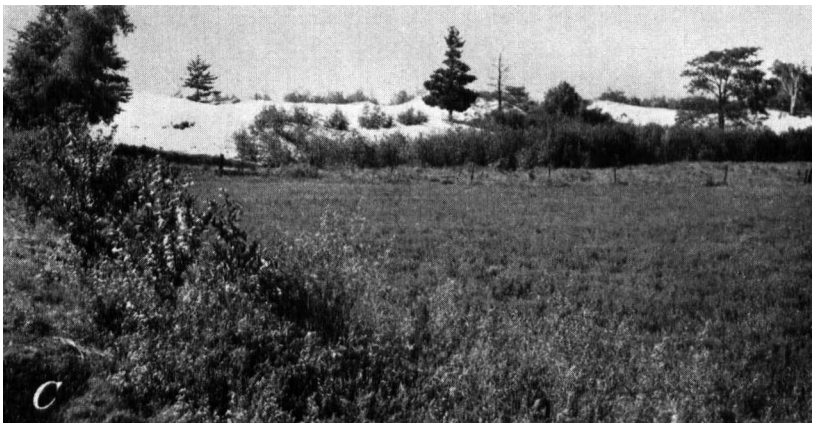
	Number
Farms with major source of income from:	
Farm products used by farm households	718
Field crops	536
Dairy products	433
Livestock	219
Poultry and poultry products	91
Other livestock products	24
Fruits and nuts	14
Vegetables harvested for sale	4
Horticultural specialties	4

Livestock farming is widespread and consists largely of dairy cattle and poultry production and growing most of the necessary feed crops, as corn for grain and silage, oats, barley, wheat, alfalfa, red clover and sweetclover, timothy, quackgrass, and tame and permanent pastures, the latter frequently consisting of bluegrass. About 40 percent of the farms are classed as livestock farms.

General farms, comprising about 25 percent of the total, produce the same crops and livestock as the livestock farms and, in addition, certain cash or specialty crops, as dry beans, sugar beets, and potatoes.

A large number of small farms (35 percent) are operated on a part-time basis by industrial workers who derive most of their income from activities away from the farm. They produce vegetables, fruits, and other horticultural specialties, together with some poultry and dairy products, mostly for home consumption.

In general, the livestock farming enterprises are found on relatively large farm units located on soils of moderate to fair natural fertility; the general farms are intermediate-sized units located generally on soils of high to moderate natural fertility; and part-time farms are of relatively small size and usually located on soils of fair to low natural fertility. These part-time farms are concentrated principally in close proximity to the city of Midland, but some are well distributed throughout the county.



A, Rural home of an industrial employee. A large garden, a few fruit trees, and perhaps a milk cow provide part of the family living; *B*, an abandoned farm on Newton loamy sand in the southwestern part of Jerome Township; *C*, alfalfa on Brookston loam in depressional area in foreground; blowout area in the background in Weare sand.

LAND USE

Farming in this county is highly diversified. About 55 percent of the total area of the county was in its 2,113 farms in 1940, about three-fourths of which were owner-operated. The average size of farms is 87 acres, but the trend in size of commercial farms is toward larger units. The number of farms, as well as the rural population and proportion of the county in farmland, has remained fairly constant since about 1900. If the farms increase in number, they will probably be of the part-time type, varying in size as the nonagricultural occupations of the operators vary. Although the general trend is toward larger units, the increase in the number of small part-time farms has offset any increase in the average size of farms.

Statistics on population, farms, and farm tenure, as reported by the Federal census for the census years 1880–1940, are shown in table 4.

TABLE 4.—*Population, number of farms, proportion of land in farms, and value and tenure of farms in Midland County, Mich., in stated years*

Year	Population		Farms		Proportion of county in farms	Average value of all property per farm	Farms operated by—		
	Urban	Rural	Number	Average size			Owners	Tenants	Managers
	Number	*Number*		*Acres*	*Percent*	*Dollars*	*Percent*	*Percent*	*Percent*
1880	----------	6,893	855	78.0	19.8	1,510	95 8	4 2	----------
1890	----------	10,057	1,456	69 0	29 6	1,828	88.6	11.4	----------
1900	----------	14,439	2,153	69 1	44 0	1,704	86 8	12.1	1.1
1910	2,527	11,478	2,246	78 6	52.2	3,299	86 2	13.4	.4
1920	5,483	11,754	2,163	93 8	59.9	6,555	82.0	17.8	.2
1930	8,038	11,112	1,784	93 8	49 4	6,126	86.0	13.4	.6
1940	10,329	16,765	2,113	87.0	55.2	5,021	84.5	15.3	.2

FARM TENURE

Most farms are operated by owners. In 1940 owners and part owners operated 84.5 percent of the farms, tenants 15.3 percent, and managers 0.2 percent. On those operated by tenants on a share basis, the owner often furnishes part of the equipment, feed, labor, and livestock. About 30 percent of the rented land is farmed on a cash-rent basis.

FARM INVESTMENTS AND EXPENDITURES

The average investment in all farm property per farm in 1940 was $5,021, of which land and buildings represented 75.6 percent; implements and machinery 11.6 percent; and domestic animals, poultry, and bees 12.8 percent. In the same year land, including buildings, was valued at $3,798 a farm, or $43.66 an acre.

Farmers on 816 farms (38.6 percent) spent a total of $36,650, or an average of $44.91 a farm, on commercial fertilizers in 1939. Most fertilizers bought are of medium analysis, as 4–8–6 and 2–12–8,[4] although certain crops, as potatoes, if grown on soils of high to medium organic content, require 2–12–12 or other mixtures high in phosphorus and potassium. Some farmers apply superphosphate with barnyard manure. Lime is usually purchased from the beet-sugar factories

[4] Percentages, respectively, of nitrogen, phosphoric acid, and potash.

at a very low cost per ton. In 1939, 16 farms reported a total expenditure of $227 for 148 tons of liming materials.

Feed is another item of expense on many farms. Practically all the roughage and much of the grain used by livestock is raised on the farm, but ready-mixed feed, particularly concentrates, was purchased in 1939 at a cost of $76,932 for use on 45.7 percent of the farms, an average of $79.72 a farm.

Outside labor was employed by 959 farms in 1919, but in recent years the available farm labor supply has been reduced and the opportunity for factory work has increased to such an extent that only 847 farms had outside help in 1939, for which a total of $150,980, or an average of $178.25 a farm, was paid. Most of the hired labor on farms is seasonal in character, although a few farms hire labor by the year. The sugar-beet industry, which requires much hand labor, imports many seasonal Mexican laborers. On other types of farms the introduction of smaller types of power-driven harvesting machinery and tractors has reduced the amount of outside labor required. The number of tractors increased from 395 in 1929 to 674 in 1940.

SOIL SURVEY METHODS AND DEFINITIONS

In making a soil survey the soils are examined, classified, and mapped in the field and their characteristics recorded, particularly in regard to the growth of various crops, grasses, and trees.

The soils and the underlying formations are examined systematically in many locations. Test pits are dug, borings made, and highway or railroad cuts and other exposures studied. Each exposes a series of distinct soil layers, or horizons, termed collectively the soil profile. Each horizon, as well as the underlying parent material, is studied in detail, and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The chemical reaction of the soil and its content of lime and salts are determined by simple tests.[5] Other features taken into consideration are the drainage, both internal and external, the relief, or lay of the land, and the interrelations of soil and vegetation.

The soils are classified according to their characteristics, both internal and external, with special emphasis upon the features that influence the adaptation of the land to the production of crop plants, grasses, and trees. On the basis of these characteristics the soils are grouped into classification units, the principal three of which are (1) series, (2) type, and (3) phase. In some places two or more of these principal units may be in such intimate or mixed pattern that they cannot be clearly shown separately on a small-scale map but must be mapped as (4) a complex. Some areas that have no true soil—as Gravel pits—are termed (5) miscellaneous land types.

The series is a group of soils having the same genetic horizons, similar in their important characteristics and arrangement in the profile

[5] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality; higher values, alkalinity; and lower values, acidity. Indicator solutions are used to determine the chemical reaction. The presence of lime is detected by the use of a dilute solution of hydrochloric acid.

and having similar parent material. Thus, the series comprises soils having essentially the same color, structure, natural drainage, and other important internal characteristics and the same range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The series are given geographic names taken from localities near which they were first identified. Bergland, Colwood, Genesee, and Kawkawlin are names of important soil series in Midland County.

Within a soil series are one or more types, defined according to the texture of the upper part of the soil. Thus, the class name of this texture—sand, loamy sand, sandy loam, silt loam, clay loam, silty clay loam, or clay—is added to the series designation to give a complete name to the soil type. Bergland loam and Bergland silty clay loam are soil types within the Bergland series. Except for the texture of the surface soil, these types have approximately the same internal and external characteristics.

A soil phase is a variation within the type, differing from it in some feature, generally external, that may be of special practical significance. For example, within the normal range of relief of a soil type some areas may be adapted to the use of machinery and the growth of cultivated crops and others may not. Differences in relief, stoniness, and degree of erosion may be shown as phases. Even though no important differences may be apparent that affect the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. In such instances the more sloping parts of the soil type may be segregated on the map as a sloping or a hilly phase. Similarly, some soils having differences in stoniness may be mapped as phases, even though these differences are not reflected in the growth of native plants.

Some soil types possess a narrow range of characteristics and hence are not divided into phases, but in those types that are divided, one of the phases is generally of more common occurrence than the others. Such a phase is considered to be the normal phase of the type and bears no phase designation. Selkirk silt loam, for example, is divided into two phases: (1) Selkirk silt loam (the normal phase) and (2) Selkirk silt loam, sloping phase.

The soil type, or where the type is subdivided, the soil phase, is the principal unit of mapping in soil surveys. Because these units are more uniform than broader groups or classes of soils, more definite statements about their use and management can be made. They are the units to which agronomic data are definitely related.

Examples of soil complexes are found in Ogemaw-Selkirk complex and Saugatuck-Newton sands, in which the soils are so intimately associated that they cannot be separated on a map of the scale used.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, complexes, and land types in relation to roads, houses, streams, lakes, section and township lines, and other cultural and natural features of the landscape.

SOILS

The soils of Midland County vary greatly in chemical and physical composition, natural fertility, adaptation to crops, grasses, and trees,

and in response to management. These variations are reflected in the morphological characteristics, which are used as the basis for separating the mapping units. Thirty-eight mapping units, consisting of 31 soil types, 2 additional phases, 2 complexes, and 3 miscellaneous land types, are identified and shown on the soil map.

Most of the soils are swampy or poorly drained in their natural state, owing to the nearly level relief and the almost universal presence of a clay layer within 10 feet or less of the surface, which causes a relatively high suspended water table. Over the larger part of the county the soils are developed from sandy material that was deposited on this clay layer. Potential agricultural value of the land depends largely on the depth at which clay occurs. The best soils for general farming are those in which clay occurs at or within one or two feet of the surface, but most of these, however, cannot be farmed until artificial drainage has been provided. The soils having sandy loam and loamy sand surface layers are generally lower in plant-nutrient content, less retentive of moisture, and therefore generally less productive of the common farm crops than are the more clayey soils.

SOIL SERIES AND THEIR RELATIONS

The soil series are combined into three groups for the purpose of simplified description—(1) soils of the level to gently undulating lake-bed plains, (2) soils of the river flood plains, and (3) soils of the bogs and swamps. Some of these groups are divided into smaller subgroups to bring out differences in parent material and drainage.

The soils of the level to gently undulating lake-bed plains are divided into three subgroups—(1) calcareous glacial till and lacustrine deposits (heavy-textured materials), (2) light- to medium-textured calcareous coarsely sorted till materials underlain by bouldery till and fine lacustrine deposits, and (3) soils developed from deep well-sorted sandy materials. All occupy nearly level relief, but the grouping reflects the productivity, ease of tillage and fertility maintenance, use, and management, as well as texture.

The soils developed from heavy-textured materials have loam or heavier textured plow soils, those from light- to medium-textured materials usually have sandy loam to loamy sand surface soils, and those from deep sands have sand to loamy sand surface soils. Under natural conditions the drainage of almost all the soils in these groups is slow to imperfect because of low surface gradients and groundwater tables that are relatively high, being at or near the surface in many places; but some of these soils have relatively deep groundwater tables and are relatively well drained. The resulting variations in the natural soil moisture brought about by these drainage conditions gives rise to markedly different soil profiles, and on the basis of these, the soil groups are subdivided into poorly drained, intermediately drained, and well-drained soils. Before large areas of the poorly and intermediately drained soils could be cultivated, it was necessary to establish systems of artificial drainage.

The classification of the soil series in groups and subgroups, together with some morphological characteristics, is shown in table 5.

TABLE 5.—*Key to soil series of Midland County, Mich.*

Soil series	Parent material	Drainage	Surface soil			Subsoil			Substratum		
			Color	Texture [1]	Reaction	Color	Texture [1]	Reaction	Color	Texture	Reaction
SOILS OF THE LEVEL TO GENTLY UNDULATING LAKE-BED PLAINS											
Tuscola	Calcareous glacial till and lacustrine deposits (heavy-textured material).	Good	Grayish brown	Fine	Acid	Brown or brownish yellow.	Fine	Acid	Yellowish gray	Fine (silt)	Calcareous.
Selkirk		Imperfect	Light brownish gray	do	do	Mottled	do	do	Pinkish gray	do	Do.
Toledo		Poor	Very dark gray	do	Neutral	Gray and yellow	do	Neutral	Gray	do	Do.
Brookston		do	do	Medium to fine	do	Mottled bluish gray	do	do	Grayish yellow	do	Do.
Bergland		do	do	do	Slightly acid	Mottled gray	do	Nearly neutral	Pinkish or reddish gray.	Very fine	Neutral to calcareous.
Arenac	Light- to medium-textured calcareous coarsely sorted till materials underlain by bouldery till and fine lacustrine deposits.	Good	Brownish gray	Coarse	Medium acid	Brown	Coarse	Strongly acid	Grayish yellow	Fine	Calcareous.
Ogemaw		Imperfect	do	do	do	Mottled brown and yellow.	do	do	Gray or pinkish gray	do	Do.
Macomb		do	do	Medium	Neutral	Brownish yellow	do	Neutral	Mottled gray	do	Do.
Kawkawlin		do	do	do	Slightly acid	Mottled grayish brown.	Fine	Slightly acid	Pinkish gray	do	Do.
Colwood		Poor to imperfect	Dark gray	do	Neutral	do	Very fine sand and silt.	Neutral	Yellowish gray	Interbedded very fine sand and silt.	Do.
Munuscong		Poor	do	Coarse	do	Gray	Coarse	do	Pinkish gray or gray	Fine	Do.
Oshtemo	Soils developed from deep well-sorted sandy materials.	Good	Light grayish brown	do	Acid	Yellowish brown	do	Acid	Yellowish gray	Coarse	Do.
Rubicon		Excessive	Light gray	do	do	Brown or yellowish brown.	do	do	Grayish yellow	do	Acid.
Weare		do	do	do	do	do	do	do	do	do	Do.
Saugatuck		Imperfect	do	do	do	Dark brown or reddish brown.	do	do	Gray and yellow	do	Do.
Newton		Poor	Very dark gray	do	do	Gray	do	do	do	do	Neutral.
Granby		do	do	do	Slightly acid	Gray streaked with brownish yellow.	do	Neutral	do	do	Neutral to calcareous.
SOILS OF THE RIVER FLOOD PLAINS											
Genesee	General stream alluvium.	Good	Brown	Coarse to fine	Neutral	Light brown	Medium	Neutral	Grayish yellow	Medium to coarse	Neutral.
Griffin		Poor	Dark grayish brown	Fine to coarse	do	Mottled brownish gray and rust brown.	Fine	Neutral to alkaline.	Yellowish gray	Fine	Neutral to alkaline.
SOILS OF THE BOGS AND SWAMPS											
Carlisle	Organic matter	Waterlogged	Black	Mucky	Neutral to calcareous.	Brown	Muck	Neutral to calcareous.	Gray	Clay (below 2-5 feet)	Calcareous.
Kerston [2]		do	do	do	Neutral	Black	Muck and clay	Neutral	do	Sand or clay	Neutral.
Muck and peat		do	do	do	Acid	Black or brown	Variable	Acid	do	Sand	Acid.

[1] Very fine-silty clay and clay; fine-silt loam and silty clay loam; medium-loam, fine sandy loam, and sandy loam; coarse-loamy sand and sand.
[2] Contains admixtures of mineral alluvium.

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The soils developed from heavy-textured materials are the well-drained Tuscola, the imperfectly drained Selkirk, and the poorly drained Toledo, Brookston, and Bergland. The Tuscola, Selkirk, Toledo, and Bergland soils are developed from lacustrine sediments from calcareous glacial till, and the Brookston from glacial till that in many places was reworked by lake action. The Tuscola soil has a grayish-brown silty surface soil that in most places has a high content of very fine sand and silt. The subsoil is brownish-yellow silty clay loam with lenses or strata of silt and very fine sand, and the substratum consists of calcareous yellowish-gray stratified silt and very fine sand with some layers of clay. Selkirk soils have light brownish-gray silty surface soils, mottled gray, yellowish-brown, and reddish-brown clay subsoils, and pinkish-gray calcareous clay substrata. Toledo and Brookston soils have very dark-gray clayey surface soils and mottled gray and yellow subsoils. The calcareous substratum of the Toledo is gray stone-free silty clay, and that of the Brookston mottled bluish-gray clay containing gravel and stones. Bergland soils have very dark-gray clayey surface soils, mottled gray and grayish-brown subsoils, and pinkish- or reddish-gray calcareous clay substrata that contain some stones but are generally stone-free.

The soils developed from light- to medium-textured materials are the well-drained Arenac, the imperfectly drained Ogemaw, Macomb, and Kawkawlin, and the poorly drained Colwood and Munuscong. Arenac, Ogemaw, Colwood, and Munuscong soils have developed from lacustrine or outwash deposits, which, in the case of the Arenac, have been subject to some wind sorting in places. Macomb and Kawkawlin are developed from glacial till that in most places has been somewhat modified by the action of waves. Arenac soils have brownish-gray sandy surface soils, brown upper subsoils, grayish-yellow or mottled yellowish-brown and gray lower subsoils, and, at an average depth of about 4 feet, calcareous clay substrata. Ogemaw soils are nearly similar to the Arenac but have poorer drainage, the subsoils are mottled, and the clay substrata usually lie at a depth of 1 to 3 feet. Macomb and Kawkawlin soils have dark brownish-gray surface layers and mottled brownish-yellow and gray subsoils. In most places these layers are sandier in the Macomb than in the Kawkawlin soils. The calcareous substrata are mottled gray in the Macomb and pinkish gray in the Kawkawlin. Colwood and Munuscong soils have dark-gray surface soils and gray subsoils and substrata. Colwood soils are developed in interbedded wind- and wave-sorted lacustrine sands, silts, and clays, but Munuscong soils are developed in sandy outwash deposits underlain at a depth of about 1 or 3 feet by clay till.

The soils developed from deep sands are the well-drained Oshtemo, Rubicon, and Weare, the imperfectly drained Saugatuck, and the poorly drained Granby and Newton. All have developed from outwash materials, with a high percentage of quartz, that were deposited in water, and in most places calcareous till substrata occur at a depth of 5 to 10 feet. The Oshtemo soil occupies long, narrow, low ridges in the vicinity of Coleman, which mark former lake shores. It has a light grayish-brown surface soil, yellowish-brown subsoil, and yellowish-gray substratum containing a small quantity of gravel. Rubicon occurs on the well-drained sand plains; Weare on the higher lying dry winding beach ridges and bars; and Saugatuck, Newton,

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and Granby in depressions or broad flats that have a suspended or high water table. The surface layers of the Rubicon and Weare soils are light gray, the subsoils light brown, and the substrata grayish yellow. Saugatuck soils have nearly white surface soils, dark-brown and usually cemented subsoils, and mottled gray and yellow substrata. Granby and Newton soils have dark-gray surface layers, gray subsoils, and gray and yellow substrata. Granby soils are slightly acid to neutral in reaction, and the Newton soil is acid. As contrasted with Granby soils the Newton soil is developed mostly from nearly pure sand, but in some places the parent material contains small quantities of gravel.

The Genesee and Griffin soils are developed from alluvial deposits on the river flood plains. The Genesee are well drained, brown, and friable throughout, whereas the Griffin are poorly drained, grayish brown in the upper part, and mottled with brownish gray and rust brown in the lower.

The soils of the bogs and swamps are developed from accumulations of plant remains in former shallow ponds or very wet depressions. The surface layers are nearly black, the lower layers of organic matter are brown, and the mineral substrata are light gray. In most places these soils have been burned beyond recognition as to the original character of the vegetation and the nature of the surface soil, and they are mapped as Muck and peat. Two types and one burned phase, sufficiently important to separate from the complex group of organic soils, are mapped as Carlisle muck and its burned phase and Kerston muck. Because of severe burning, nonagricultural value, or small areal extent, most areas of the various mucks and peats are mapped as a complex.

DESCRIPTIONS OF SOIL UNITS

In the following pages the soil types, phases, and land types are described in detail and their agricultural relations discussed. Their location and distribution are shown on the accompanying map, and their acreage and proportionate extent are given in table 6.

TABLE 6.—*Acreage and proportionate extent of the soils mapped in Midland County, Mich.*

Soils	Acres	Percent	Soils	Acres	Percent
Arenac loamy sand	6,464	1 9	Macomb sandy loam	8,448	2 5
Arenac sandy loam	6,144	1 8	Muck and peat	1,984	6
Bergland loam	9,536	2 9	Munuscong loamy sand	25,984	7 8
Bergland silty clay loam	2,496	8	Munuscong sandy loam	16,000	4 8
Brookston loam	20,864	6 3	Newton loamy sand	40,896	12 3
Brookston silty clay loam	1,728	5	Ogemaw loamy sand	20,352	6 1
Carlisle muck	256	1	Ogemaw sandy loam	9,984	3 0
Burned phase	448	1	Ogemaw-Selkirk complex	3,264	1 0
Colwood fine sandy loam	5,440	1 6	Oshtemo loamy sand	384	1
Colwood very fine sandy loam	2,304	.7	Rubicon sand	13,056	3 9
Genesee sandy loam	2,240	7	Saugatuck sand	21,312	6 4
Genesee silt loam	2,496	8	Saugatuck-Newton sands	50,368	15 1
Granby loamy sand	8,064	2 4	Selkirk silt loam	5,376	1 6
Granby sandy loam	896	3	Sloping phase	896	.3
Gravel pits	64	(1)	Toledo silty clay loam	4,032	1 2
Griffin loam	3,648	1 1	Tuscola silt loam	512	2
Griffin sandy loam	5,568	1 7	Wasteland	256	1
Kawkawlin loam	7,424	2 2	Weare sand	14,592	4 4
Kawkawlin sandy loam	8,512	2 5			
Kerston muck	512	2	Total	332,800	100 0

[1] Less than 0 1 percent

Arenac sandy loam.—This moderately well drained soil occurs in small widely distributed areas throughout the county. It occupies a total of 6,144 acres, usually on low, narrow, winding ridges in areas consisting largely of poorly drained soils. Lying 2 to 5 feet above the lake plain, these ridges represent bars or beaches of glacial lakes that contain a high proportion of fine and very fine sands and may have strata or lenses of clay and silt occurring usually at depths below 2 feet. In a few places the soil material is largely sand, containing some pebbles; in other places, as in Hope Township, the soil occurs on an undulating, or "sag and swell," type of relief, the individual areas occupying low knolls, or "swells, in association with Colwood fine sandy loam in the swales or sags." The native forest was dominantly white and red pines but probably contained some hard maple, oak, and beech trees.

In cultivated fields the surface soil, to a depth of 7 or 8 inches, is brownish-gray sandy loam or loamy fine sand, in some places underlain by a 2- or 3-inch subsurface layer of nearly white loamy sand or loamy fine sand. The subsoil, to a depth of 15 or 20 inches, is brown to yellowish-brown sandy loam, weakly cemented in some places. The deeper subsoil is brownish-yellow loamy sand or loamy fine sand to a depth of about 36 inches, underlain by a layer of grayish-yellow loamy sand or loamy fine sand faintly mottled with gray and rust brown. The substratum of clay or interbedded clay, silt, and fine sand, deposited when this area was covered with water, or cobbly clayey glacial till is reached in most places at a depth of about 4 feet. Generally this clay floor is nearly level and the thickness of the sandy covering constant over a soil area, but in some places the surface of the clay is uneven and not parallel to the surface of the soil. The reaction is medium to strongly acid in the surface and upper subsoil layers and neutral to slightly acid in the deepest sandy layer; the clay substratum is calcareous. The deep sandy part of the soil is slightly coherent, but no definite cemented or other definite structure has developed. The clay substratum is relatively impervious and highly retentive of water.

This is not fertile soil, and crops suffer from lack of moisture during prolonged periods of drought. Owing largely to its wide distribution in small areas surrounded by more productive soils, however, about 60 percent of the total area is cleared, half of which is in tilled crops and the rest in pasture. As a high percentage of the area in tilled crops occurs as narrow bands in fields composed largely of some other soil, the cropping practices are determined by the requirements of the more extensive soil. It is, however, common practice in these fields to apply lime and make heavier applications of manure and fertilizer on the sandy ridges than on the adjoining soils. Where the soil occurs in bodies large enough to dominate a field, it is likely to be used for pasture, or a long rotation principally of grasses and legumes with some small grains and few intertilled crops is practiced. Some areas are used for potatoes, small fruits, and truck crops for local consumption. As this soil warms early and responds to fertilization, much of it is used for home gardens. Average yields of the staple general farm crops are low.

Practically all the water falling on this soil is absorbed. Where fields are plowed in fall and left bare all winter, erosion by wind may

cause some damage. This is easily prevented by growing cover crops whenever the soil would otherwise be bare or by allowing grass and weeds to grow.

Arenac loamy sand.—Although similar to Arenac sandy loam, this soil differs in that it has more sand in the surface and subsoil layers and a somewhat thicker covering of sand over the clay floor. The total area mapped is 6,464 acres. About 50 percent of it is cleared, half of which is cultivated.

The soil is not well suited to crops, as the moisture-holding capacity is low, and, unless rainfall is adequate and well distributed throughout the growing season, yields are very low or perhaps fail completely. It is moderately well suited to spring pasture, as it dries early and can be pastured at this time of year when poorly drained soils, with which it is usually associated, are soft. It does not furnish much grazing late in summer. Areas near dwellings are used as gardens because they warm early and respond to management. The water-holding capacity and general productivity can be greatly increased by practices that add organic matter to the soil and light lime applications to correct acidity. Where cover crops are grown or heavy applications of manure made, potatoes, small fruits, and truck crops are grown successfully for local consumption. Although erosion is not a hazard in most places, this soil should not be left bare for long periods as severe damage from blowing may result.

Bergland loam.—This dark-colored poorly drained soil developed on broad level flats and in swales or depressions on pinkish- or reddish-gray clay till or lake-laid clay in the northern part of the county in association with Arenac, Ogemaw, Macomb, and Kawkawlin soils. The total area mapped is 9,536 acres.

The 6- or 8-inch surface layer of very dark-gray or somewhat black loam is underlain to a depth of about 12 inches by a dark-gray heavy loam or clay loam subsurface layer. These layers contain practically all the organic matter in this soil, and, as the color indicates, the content is relatively high. The subsoil, to a depth of about 30 inches, is bluish-gray silty clay loam, mottled with rust brown and brownish yellow. The substratum is pinkish- or reddish-gray clay till or lake-laid clay, which contains some stones and small pebbles in some places but is generally relatively free of stone fragments. The upper layers are very slightly acid, but the lower part of the subsoil as well as the substratum is neutral to alkaline in reaction.

Practically all the soil is cleared and used for crops. About 10 percent of it is in permanent pasture or woodland, most of which is isolated from other productive soils or is very difficult to drain. Hay, rotation pasture, and corn (generally cut for silage) are the principal crops, but some beans, sugar beets, and oats are grown. The cropland requires drainage, and ordinarily drainage lines spaced at intervals of 3 to 5 rods are sufficient. Where drainage is adequate and complete fertilizers are used, good yields are obtained.

Bergland silty clay loam.—Covering a total area of 2,496 acres, this soil is similar to Bergland loam except that the surface layers are finer textured, ranging from clay loam to silty clay loam, and the pinkish-gray clay substratum lies at an average depth of 24 inches.

Agricultural practices on this soil are much the same as on the loam, but, owing to the higher clay content in the surface layer, it is somewhat more difficult to manage. Many farmers plow this soil in fall, as the alternate freezing and thawing during winter improve the tilth. Drainage of the cropland is required, and ordinarily drainage lines at intervals of 3 to 4 rods are sufficient. Where drainage is adequate, complete fertilizers are used, and green manures and deep-rooted legumes, which improve tilth as well as fertility, are grown, and good yields are obtained.

Brookston loam.—When adequately drained this dark-colored poorly drained soil is one of the best agricultural soils in this area. It is developed on gray calcareous fine-textured glacial till and is one of the more extensive soils in the county, occupying 20,864 acres. Broad nearly level areas are associated with smaller areas of Kawkawlin and Macomb soils in the southern part. The native vegetation consisted largely of red maple, elm, ash, basswood, swamp white oak, and hickory trees with some sedges and marsh grasses in the wetter spots.

The 6- to 8-inch surface layer is dark-gray nearly black loam, and the subsurface layer, to a depth of about 12 inches, is moderately dark-gray heavy loam or silty clay loam. The subsoil, to a depth of about 3 feet, is gray or bluish-gray silty clay loam, mottled with rust brown and grayish yellow. The underlying substratum is grayish-yellow calcareous fine-textured glacial till. The surface and subsoil are neutral in reaction, and free lime is abundant in the substratum.

About 10 percent of the soil is still in forest, 70 percent in cultivation, and the rest in permanent pasture or wild hay meadow. As the soil is poorly drained, adequate artificial drainage is necessary before the common farm crops can be grown; therefore most fields are adequately drained with tile. Corn, sugar beets, dry beans, oats, barley, wheat, and hay are grown extensively. A common rotation consists of corn, beets or dry beans; oats, barley or wheat; and alfalfa, clover or mixed clover and timothy. In some years alfalfa and winter wheat are injured by heaving, but generally yields of all crops are high. Much of the land is fall-plowed, as this aids in improving the tilth and permits earlier sowing in spring. Little lime and manure are used, but commercial fertilizers are applied to root and grain crops. Green-manure and cover crops are not extensively grown as there is little danger from erosion even on bare land, and the organic matter supply can be maintained by turning under a sod every few years. Tilth can be maintained by the use of legumes in the rotation.

Included with this soil are small areas where the surface layer is sandy and others where it is a clay or clay loam. In some places, particularly near the center of the county, parts of individual areas may have a pinkish-gray substratum similar to that of the Bergland soils. In the southeastern part a relatively hard cemented layer, which contains more yellow than the typical yellowish-gray till and in some places is brownish yellow, occurs in the substratum of some areas at a depth of 3 to 6 feet. The hardness of this layer is not due to a higher content of clay but rather to the fact that it is cemented or has been compacted by being overridden by ice during the glacial period. This hard layer does not appear to affect yields or the use

of land that is adequately drained, but it adds to the difficulty of drainage as it is very difficult to excavate. In most places lateral drains are above it, but main ditches and canals extend into it. A few boulders and cobbles are on and in the soil, but in only a few places has it been necessary to remove stones to cultivate the land.

Brookston silty clay loam.—This dark-colored poorly drained soil, occupying a total of 1,728 acres in the same general areas as Brookston loam, is similar to that soil except that the texture is finer, particularly in the surface layer, and the organic-matter content of this layer may be slightly higher. The native vegetation included the same species, but a larger part of this soil was covered with sedges and other marsh vegetation.

About 90 percent of this soil is cleared, 75 percent of which is cultivated. The management practices, use limitations, and yields are nearly the same as on Brookston loam, but drainage tiles need to be spaced at closer intervals than on that type. Corn, sugar beets, and red clover are the most important crops, as winterkilling of wheat and alfalfa is more common and small grains are more liable to lodge. Fall plowing is a common practice, as it tends to improve tilth, and erosion is not a problem. As the soil is relatively fertile and easily kept in a high state of productivity when adequately drained, only moderate quantities of manure and commercial fertilizer are applied.

Carlisle muck.—Decayed remains of former vegetation almost entirely compose this nearly black organic soil. It occupies slight depressions on smooth plains on a total of only 256 acres, mostly in the southern part of Mills Township. Artificial drainage might be difficult to establish. The native forest consisted largely of elm, soft maple, black ash, and willow trees. All areas are still forested, and the cut-over composition is similar to that of the native forests.

The 10- or 12-inch surface soil is nearly black muck, beneath which is dark-brown less well decomposed muck that rests on calcareous clay at a depth of 2 to 5 feet. In some parts of the State bodies of this type of muck have been drained and have produced high yields of mint, onions, celery, and other special crops, but in this county drainage difficulties and cold climate probably limit the use of this soil to woodland.

Carlisle muck, burned phase.—In most places this soil is wild unused land that represents areas of the normal phase from which a large part of the organic material has burned off. It occurs in the northeastern part of the county, occupying a total of 448 acres. The native vegetation consisted of elm, soft maple, black ash, and willow trees. Since burning, however, aspen, alder, willow, grasses, and weeds have sprouted, and pasture is abundant in some areas during the dry months.

The surface consists of gray or reddish-brown ashes, more or less mixed with organic matter, underlain by brown organic matter and clay floor. The thickness of the various layers and the depth to the clay floor vary somewhat according to the severity of burning. In many places burning was very uneven, and the microrelief of the surface may be very irregular.

Drainage, spottiness of the soil, uneven relief, and cold climate limit the use of this soil to pasture land.

Colwood very fine sandy loam.—Owing to the complex pattern of this soil most areas contain less than 40 acres and new fields are composed entirely of it. This type is developed on interbedded lake-laid sand, silt, and clay as nearly level or very gently undulating land in association with Colwood fine sandy loam, Arenac sandy loam, and Toledo silty clay loam. It covers a total area of 2,304 acres and is a common soil in the southeastern part of the county, particularly in the eastern part of Ingersoll Township. The native vegetation consisted principally of elm, soft maple, and ash trees.

The surface soil, to a depth of 6 or 8 inches, is dark-gray or dark grayish-brown very fine sandy loam to light silt loam, relatively high in organic-matter content. The subsurface layer, to a depth of about 18 inches, is gray or brownish-gray very fine sandy loam or light silt loam, faintly mottled with grayish yellow and containing spots and streaks of rust brown. The subsoil, to a depth of 30 or 36 inches, is mottled gray, grayish-yellow, and brownish-gray silt loam or silty clay loam. The substratum is gray and yellowish-gray silt, clay, and sand. The sandy layers are the yellowest, and some lenses of clay are pinkish gray. Thin layers of clay, silt, or sand may occur in any part of the soil, and some small areas having a sandy surface soil are included on the map. Most of these sandy spots occupy slight rises or low knolls. The reaction of the surface and subsurface layers is slightly acid to neutral, but the subsoil in most places is slightly calcareous.

Practically all of this soil is now cleared and used for crops. Artificial drainage must be provided before most areas can be cultivated successfully. The drainage system requires careful planning because of the variable texture of the subsoil, and also, in places, because of the undulating relief. This soil is cold late in spring, and some farmers plow in fall so that early seeded crops may be planted at the proper time. Alfalfa, corn, beans, and small grain return good yields. Stable manure and commercial fertilizer are used on intertilled crops, and some green-manure crops are grown. Complete fertilizers respond well, and yields of common crops are good.

Mapped with this soil in the shallow depressions are small spots of Toledo silty clay loam too small to show separately on a small-scale map.

Colwood fine sandy loam.—Developed on lake-laid sand, silt, and clay this moderately dark-colored poorly to imperfectly drained soil is similar to Colwood very fine sandy loam in color but has a higher content of medium and fine sands in the surface and subsoil layers. It occurs on gently undulating to nearly level relief in association with Toledo silty clay loam, Colwood very fine sandy loam, Tuscola silt loam, and, in places, Arenac and Newton loamy sands in an intricate or highly detailed pattern. It is a common soil in the eastern part of the county, particularly in Hope and Ingersoll Townships. The total area mapped is 5,440 acres, but most individual areas are small, containing less than 40 acres.

Only about 50 percent of this soil is cultivated. It is much less fertile and more droughty than the very fine sandy loam. Generally, drainage is not needed on this soil except for small wet spots as found in eastern Hope Township. Light applications of lime and complete fertilizers are needed. Early summer crops do best. When associated

with Arenac and Newton loamy sands or other relatively unproductive soils, much of the soil is undrained and is used only for forest or permanent pasture. Where associated with Tuscola and other relatively productive soils, most of this soil is drained and used for cultivated crops.

Cropping practices are about the same as on Colwood very fine sandy loam, but it is necessary to return more organic matter in the form of stable manure, green manures, and crop residues to this soil than to the finer textured heavier soils. Fall plowing is not practiced extensively, as some soil is lost from the more sandy areas by blowing when the soil is bare.

Mapped with this soil are many areas in Hope Township where a layer of sand 1 or 2 feet thick was deposited on fine-textured deposits. The soil in some of these included areas is probably little different from Munuscong sandy loam.

Genesee silt loam.—Most areas of this well-drained alluvial soil, which includes many imperfectly drained areas, are long, narrow strips paralleling the streams. A total area of 2,496 acres is mapped on the nearly level flood plains of the larger streams in association with Griffin and Kerston soils. Some areas are flooded annually, while others occupy relatively high bottoms and are seldom inundated. Harmful deposits of sand are made on some fields during severe floods, but dams protect areas lying downstream by storing water during wet periods so that many former frequently flooded areas are seldom flooded now. The native forest consisted largely of elm, soft maple, ash, sycamore, basswood, oak, and butternut trees.

The 6- or 8-inch surface soil is dark-brown or dark grayish-brown friable silt loam or light loam. The subsoil, to a depth of about 24 inches, is brown or light-brown friable silt loam that may have strata or lenses of sand. The substratum is grayish-yellow stratified sand and silt, and layers or lenses of gravel occur in places. Streaks or spots of rust-stained material appear below a depth of 20 or 25 inches in some areas. The reaction is neutral to slightly alkaline in all layers.

About 40 percent of the soil is cleared for cultivation or pasture; the rest is in frequently flooded bottoms, in bands too narrow to be made into fields, or in places where the associated upland soils are sandy and relatively unproductive. It is one of the most productive soils in the county, and crops are rarely ruined by flooding. Corn, beets, beans, small grains, and grasses return high yields. Alfalfa and clover are grown on areas that do not flood regularly. Small grain may lodge, and such perennial crops as clovers, alfalfa, and grasses are subject to heaving on the more moist areas. Productivity is maintained by the use of commercial fertilizers in a 4- or 5-year rotation that includes 1 or 2 years of grass or clover.

Genesee sandy loam.—Natural levees are formed in long, narrow areas by this alluvial soil. The relief is gently undulating or billowy, and drainage is good. The soil is similar to Genesee silt loam, except that the several layers are light brown and sandier and the substratum in many places is sand or loamy sand. Most of the total area of 2,240 acres is in pasture or forest, as it is not so productive as the silt loam, and few areas are large enough to be made into a field. Culti-

vated areas usually form part of a field of Genesee silt loam and are managed in the same way.

Granby loamy sand.—A total area of 8,064 acres of this soil is mapped, principally in the northern part of the county, especially in the Edenville and Mills Townships. Individual areas are large, some containing more than 1,000 acres. This dark-colored poorly drained soil is developed in nearly level deposits of sand and resembles Newton loamy sand in color, but the subsoil and substratum layers are neutral to alkaline, whereas the Newton soil is strongly acid to a depth greater than 3 feet and contains a higher percentage of quartz-bearing sand. The native vegetation was largely elm, soft maple, basswood, aspen, and alder trees, sedges, and grasses.

The 4- to 10-inch very dark-gray loamy sand surface soil is mucky in some places, particularly in the upper part, and is medium to slightly acid. The subsoil, to a depth of about 24 inches, is gray sand or loamy sand with some streaks or spots of brownish yellow, and the substratum is mottled gray, grayish-yellow, and yellowish-brown sand or slightly clayey sand. Both subsoil and substratum are neutral or mildly alkaline, and the substratum contains carbonates of lime and magnesium in most places. Discontinuous layers or lenses of silt and clay occur in a few places in the subsoil and substratum, and a till clay floor lies at a depth of 3 to 6 feet. The subsoil and substratum contain coarse sand and gravel in places, particularly in the southeastern part of Edenville Township. The areas in Mills Township are somewhat more poorly drained than others and generally have a thin mucky layer 3 to 5 inches thick on the surface. The native vegetation here was largely sedges and rushes, and these plants make up a large part of the present ground cover.

About 25 percent of the soil, mostly in Edenville Township, has been cleared, 20 to 30 percent of which is cultivated. Adequate artificial drainage by means of open ditches or tile is not difficult to establish where outlets are available, but as the productivity is low most cleared areas are used as pasture. Corn, small grain, and timothy are grown on some areas, but yields generally are only fair to poor.

Mapped with this soil are small bodies of muck, Saugatuck, Weare, Ogemaw, and Newton soils that are too intricately associated to map separately.

Granby sandy loam.—This dark-colored poorly drained soil, developed in nearly level sandy deposits in the southwestern part of the county on a total of 896 acres, resembles Munuscong sandy loam in color characteristics but differs in that the clay floor is generally deeper than 3 feet. Individual areas are large, but the associated Arenac, Munuscong, Macomb, and Saugatuck soils may occur as components of the soil complex. Native forests consisted largely of elm, soft maple, swamp white oak, ash, and basswood trees.

The 6- to 12-inch very dark-gray sandy loam surface soil is mucky in some places. The subsoil, to a depth of about 20 inches, is gray sandy loam, streaked or spotted with brownish yellow. The substratum of mottled gray, grayish-yellow, and yellowish-brown sandy loam or loamy sand with streaks or lenses of clay rests on a clay

floor at an average depth of about 5 feet. The surface layer is medium to slightly acid, but the rest of the soil is neutral to mildly alkaline. Calcium carbonate is present at a depth of 3 to 4 feet in most places. The sands commonly have some minerals other than quartz.

Practically all of this soil is now cleared, drained, and cultivated. Adequate artificial drainage is relatively easy to establish where outlets are available. Tile systems have been installed in most places, but a few fields are drained by open ditches. Corn, small grains, beans, and hay are commonly grown, and yields are fair but not high.

Gravel pits.—This land type consists of pits or excavations where gravel, and in some instances sand, has been removed for road building, industrial uses, railroad ballast, and other purposes. The areas total 64 acres, the larger ones being 30 feet or more deep with permanent water standing within a few feet of the surface. They occur principally in former areas of and areas associated with Genesee, Saugatuck, Newton, and Oshtemo soils. The quality of the gravel and sand is variable, as is the mineralogical composition. Gravel obtained from pits in areas of Oshtemo and Genesee soils contains a high proportion of limestone materials, whereas that from areas associated with Saugatuck and Newton soils contains a high proportion of quartz material.

Griffin loam.—This poorly drained alluvial soil, occurring in long, narrow bodies in the level or nearly level flood plains, covers a total area of 3,648 acres. Some areas that are undulating or billowy and made up of small areas of well and poorly drained soils are mapped with this soil. The native forest consisted largely of soft maple, elm, and basswood trees.

The surface soil, to a depth of about 8 inches, is dark-gray to dark grayish-brown loam. The subsoil, to a depth of about 24 inches, is brownish-gray sandy loam or loam, streaked or mottled with rust brown. The substratum is stratified yellowish-gray sand or mottled yellowish-brown sand, silt, and clay. The soil is neutral to mildly alkaline in all layers, and, in some places, free lime is present in the substratum.

As most areas are subject to frequent overflow, less than 25 percent of the soil is cultivated. This soil has good fertility, and when drained, good yields are obtained. Corn, beans, small grains, and hay are the most common crops and return high yields when not damaged by floods. Much of the uncultivated soil is cleared or partly cleared and used as permanent pasture. These better areas furnish grazing in summer when upland pastures are dry.

Griffin sandy loam.—This poorly to imperfectly drained alluvial soil is similar to Griffin loam, but the surface layer contains more sand. In some places, commonly certain natural levee areas, the surface layer is sand or loamy sand. A total area of 5,568 acres is mapped; most of it is in forest or pasture. This land is flooded about once every 2 to 5 years and crop production is hazardous. Fields of this type are irregular in shape, and the areas are bordered or mingled with swales occupied by poorly drained Kerston soils.

Kawkawlin loam.—This imperfectly drained soil, developed on pinkish-gray glacial till, covers a total area of 7,424 acres. It occurs on nearly level to gently undulating relief in association with Kawkawlin

and Ogemaw sandy loams and Brookston loam, chiefly along the eastern edge of the county in a relatively simple pattern. Native forests consisted largely of white pine, red maple, beech, elm, ash, and hickory trees.

The surface soil, to a depth of about 6 inches, is gray to dark-gray loam having a high content of fine sand, and the subsurface layer, to a depth of about 9 inches, is gray sandy loam mottled and streaked with rust brown. The subsoil, to a depth of 24 or 30 inches, is grayish-brown, mottled with gray and brownish yellow sandy clay loam, breaking into ⅛- to ¼-inch angular somewhat blocky aggregates. Some pinkish-gray mottling is present in this layer, particularly in the lower part. The substratum is pinkish-gray calcareous sandy glacial till containing some pebbles and cobbles and a few boulders. A few cobbles and boulders on and in the soil of most areas do not seriously hinder cultivation. The surface and upper subsoil layers are medium acid, but the lower part of the subsoil is neutral.

The relief is characterized by small depressions making up about 2 to 5 percent of this soil area. In some of these dark-colored areas Bergland soils have developed. Tile drainage is beneficial, as percolation and runoff are slow, and drainage of the depressions is particularly important because water stands in them after heavy rains.

About 85 percent of the soil is cleared and used for crops or pasture. The most important crops are corn, beans, and alfalfa, but sugar beets and oats also are grown. A common rotation consists of corn, beans, oats, and alfalfa or mixed hay for 2 or 3 years. Moderate applications of lime are made when alfalfa is grown, and stable manure and commercial fertilizer, particularly superphosphate, are applied to corn and grain crops. Green-manure crops are grown by some farmers, but usually the soil is plowed in fall. Control of erosion is not a problem under ordinary cropping practices; however, if the supply of organic matter in the surface soil were depleted by long rotations containing several intertilled crops, some blowing would result.

Kawkawlin sandy loam.—This imperfectly drained soil, developed on pinkish-gray glacial drift, is similar to Kawkawlin loam, but the surface and, in some places, the subsoil layers have a high content of medium and coarse sand. In many places this sandy material was deposited on the glacial till while the area was covered with water. Much of the total area of 8,512 acres occurs on gently undulating relief, characterized by small shallow depressions, in association with Kawkawlin loam and Ogemaw and Munuscong sandy loams along the eastern edge of the county.

The profile of this soil is similar in color and reaction to that of Kawkawlin loam but contains fewer pebbles and cobbles. A few stony areas do occur, however, on the ridge between North Bradley and Coleman. Some areas have a moderate hardpan similar to that of the Ogemaw soils.

About 75 percent of the soil is cleared and practically all used for crops. Management practices are the same as on Kawkawlin loam, but yields are generally slightly lower. Green-manure crops, complete fertilizers, and a large part of the rotation used for hay and pasture crops are good practices. Some lime is needed, and tile drainage is required in swale areas.

Kerston muck.—A total of 512 acres of this land type occurs in narrow strips along slow moving streams, the largest area being in the southwestern part of the county along the branches of Carroll Creek. The native vegetation consisted largely of rushes and sedges with some cedar, tamarack, willow, white oak, elm, and maple trees.

Ordinarily this poorly drained muck does not have well-differentiated soil layers but consists of a black mixture of organic matter, sand, and clay, which rests on gray sand or clay. In some places organic matter, accumulated in place from decaying plants, and mineral material, deposited during floods, occur in bands of varying thickness. The position of most areas of this muck, relative to the ground-water level and drainage outlet, makes drainage very difficult. Many areas have been cleared of trees and brush and are used for pasture or wild hay meadow, but much of the land is idle or is used for pasture without improvements.

Macomb sandy loam.—This imperfectly drained soil, developed where a cobbly or sandy deposit rests on or is mixed with clayey glacial till, is widely distributed over a total area of 8,448 acres but is best and most extensively developed in Mount Haley Township. It generally occupies slight rises in areas of Brookston soils but occurs also in association with Bergland and Munuscong soils. The soil pattern is relatively simple, many areas being more than 80 rods wide. The native forest consisted largely of soft maple, elm, and ash, with some white pine trees.

The 6- or 8-inch surface soil is dark-gray or grayish-brown sandy loam. The subsoil, to a depth of about 15 inches, is brownish-yellow sandy loam and, to a depth of about 25 inches, mottled gray, grayish-yellow, and yellowish-brown sandy clay loam. The substratum is mottled gray and grayish-yellow calcareous clayey glacial till.

Mapped with this soil are areas where the surface texture is loam and others where it is loamy sand. The till substratum lies at a shallower depth in loam areas and at a greater depth in the loamy sand areas. Areas associated with Munuscong and Bergland soils are underlain by pinkish-gray deposits, some of which are stratified silt and clay. Other areas resemble Ogemaw soils, except that they have some pebbles and cobbles on and in the soil and lack the distinct gray or white subsurface layer. The surface and upper subsoil layers are slightly acid to neutral, the deeper subsoil neutral, and the substratum calcareous. Some pebbles and cobbles and occasional boulders are on and in the soil of most areas but are sufficiently numerous in only a few places to interfere with cultivation. Stones have been removed from some areas to make the soil easier to cultivate.

Most of this soil is cleared and about two-thirds of it cultivated, but the more stony areas are left in forest or used as pasture. Corn, beans, potatoes, sugar beets, oats, barley, wheat, alfalfa, and mixed clover and timothy hay are important crops, and yields are good. Most farmers use barnyard and green manures and apply fertilizer when seeding crops. The soil is easily worked and warms relatively early in spring. Erosion caused by runoff is negligible, and little damage results when the soil is plowed in fall. It is advisable, however, largely to maintain a high level of productivity and to sow cover crops when a clean-tilled crop is harvested. Some drainage is needed, lines at intervals of 4 to 5 rods usually being adequate.

Muck and peat.—Different kinds of organic materials that are underlain by acid sands make up these soils. Accumulations in most bogs are less than 4 feet thick, and the soils differ in accordance with the type of vegetation from which the organic residues were derived and with the degree of decomposition. The most common conditions are (1) moderately well-decomposed remains of sedges, rushes, and shrubs (Houghton muck); (2) relatively undecomposed remains of those plants (Greenwood peat); and (3) slightly decomposed remains of willow, tamarack, and white cedar (Rifle peat). These soils are widely distributed over a total area of 1,984 acres, in most places occurring in roughly circular areas containing 5 to 20 acres. Such areas usually are bordered by deep soils including dry sands. In general, each individual bog consists entirely of one type of muck or peat, burned more or less severely. In some there is a narrow band of shallow well-decomposed material around the edge. When burning has not been too severe, the present vegetation consists largely of the original species, in addition to much alder and willow. Severely burned areas are covered by a dense growth of annual weeds, with some alder, aspen, and rushes.

Crops cannot be raised on these soils until artificial drainage is established. Drainage systems are difficult to establish, however, because the soils occupy depressions having no available outlets. As these soils have low fertility and are underlain by acid sands, and the danger of frost even in summer is great, only a few areas are cultivated. Some areas are used as pasture and furnish grazing late in summer when upland pastures may be dry. Blueberries and such special crops as strawberries, celery, and lettuce may be grown on areas where frost hazard is not too great. Even in favorable farming areas productivity is low on these mucks and peats (Houghton, Greenwood, Rifle) as compared to Carlisle or Edwards mucks.

Munuscong sandy loam.—A dark-colored poorly drained soil that is developed in sandy outwash deposits underlain by clay till. It is widely distributed in all parts of the county on nearly level land, occupying a total area of 16,000 acres. Relatively large bodies occur in association with Munuscong loamy sand, Ogemaw, Arenac, and in some places Saugatuck, Newton, Brookston, or Bergland soils. Except in the few places where this soil is associated with Brookston or Bergland soils, it lies 1 or 2 feet lower than the associated sandier soils. The native vegetation consisted largely of elm, swamp white oak, red maple, and ash trees. These, together with aspen, willow, and alder, constitute the present growth in cut-over areas.

The 8- or 10-inch surface soil is dark-gray or blackish sandy loam. In some places the virgin soil has a 2- to 3-inch layer of black muck on the surface. The subsoil, to a depth of 12 to 24 inches, is gray sandy loam or loamy sand that in some places is mottled with yellowish brown in the lower part. The substratum is pinkish-gray or gray calcareous clayey till or lacustrine silts and clays. The thickness of the sandy cover is generally 12 to 18 inches but varies from 6 to as much as 36 inches. In a few places the microrelief of the clay floor is uneven and the thickness of the sandy covering varies from 1 to 3 feet within a short distance. Varying quantities of fine sand, very fine sand, and silt occur in the surface and subsoil layers, and in some places the surface texture is loam. The finer textured soils generally

occupy areas where the depth to clay is shallow. There are no stones or pebbles in the sandy layers, except where small areas of the Macomb soil are included within an area of this soil. The sandy layers are slightly acid to neutral, and the clayey substratum is calcareous.

Unless drained artificially this type is not suitable for cultivation. Drainage systems are easily established and usually successful—tile are laid 5 to 10 rods apart. About three-fourths of the soil is cleared, two-thirds of which is used for crops and pasture. Corn, oats, beans, and hay are the principal crops, and some wheat, barley, potatoes, and sugar beets are grown. Rotations usually consist of corn, small grain or beans, and mixed clover and timothy hay, with many fields being used for pasture an additional 2 to 3 years. Many farmers apply barnyard manure and commercial fertilizer to the row crops and phosphate to the hay and pasture fields. Yields are relatively good under good management practices, but they may be low if the soil is heavily cropped or if the drainage system is not adequate.

Munuscong loamy sand.—This dark-colored poorly drained soil is developed in sandy deposits underlain by clayey substratum. It is similar to Munuscong sandy loam, except that the surface soil contains a high percentage of medium and coarse sand, and in most places the depth to the clay floor is greater than 24 inches. Some areas have mucky surface to a depth of 6 inches or more. A total area of 25,984 acres is widely distributed over the county in association with Munuscong sandy loam, Ogemaw, Arenac, and in some places Saugatuck, Newton, Brookston, and Bergland soils.

This soil is less productive than the sandy loam, and about 50 percent of it is in woodland pasture. A large part of the cleared land is in pasture. The principal crops are corn, beans, and potatoes. Management practices are the same as on the sandy loam, but yields are somewhat lower. Larger farm units, provided with tile or open-ditch drainage and used for a larger proportion of harvested and special crops than of pasture, could be developed on this soil type.

Newton loamy sand.—This dark-colored poorly drained acid soil, developed in sandy material, covers a total area of 40,896 acres, in large bodies on level or nearly level land in association with Saugatuck, Rubicon, and Weare soils, which occupy the higher lying or undulating areas. It resembles Granby loamy sand but differs from it in being more acid in reaction and higher in quartz sand. As mapped, however, there are many places where this distinction does not hold, and consequently there is no observable difference between the two. The native forest consisted largely of elm, ash, red maple, and aspen with scattered white pine trees. Cut-over areas usually support a dense growth of alder, willow, and aspen brush.

In many places, the 6- or 10-inch very dark-gray nearly black loamy sand surface soil consists of a mixture of organic matter and nearly pure sand. Many of the sand grains are white, and the soil looks like a mixture of salt and pepper. The subsoil, to a depth of about 20 inches, is gray or brownish-gray loamy sand, streaked in some places with yellowish brown, and to a depth of about 30 inches is mottled gray and brownish-yellow sand or loamy sand. In most places clay layers occur at depths greater than 5 feet. The reaction in the upper 2 or 3 feet is medium to slightly acid and below that depth slightly acid to neutral.

Most of this soil is in forest or brush, and much is used for woodland pasture. Only about one-fourth is cleared and used mostly as hay or pasture land. Many attempts have been made to develop this land, but most have failed and the farms have been abandoned (pl. 1, *B*). Quackgrass, the principal constituent in most hay and pasture fields, is associated with timothy, bluegrass, redtop, and other grasses. Open ditches provide drainage in most of the cultivated areas, but only a few fields were tiled. Light applications of lime and commercial fertilizer, in addition to barnyard manure and cover crops, are necessary to obtain fair yields of the common crops. Areas of this soil on farms composed largely of better soils are useful for pasture and woodland, and, in some other counties, particularly in southern Michigan, the land is drained, fertilized, and used for such special crops as blueberries, strawberries, cucumbers, and garden crops.

Ogemaw sandy loam.—A total of 9,984 acres of this soil is widely distributed over the county in association with many soils, especially those developed in sands underlain by clay and those developed from fine-textured materials. The nearly level or slightly undulating land closely resembles Arenac sandy loam. Depth to the clay substratum commonly varies from about 18 to 30 inches. This imperfectly drained soil is most commonly associated with Arenac and Munuscong sandy loams, which are better drained and more poorly drained, respectively. This association occupies slightly undulating or billowy relief, with Arenac on tops of ridges or knolls and Munuscong in depressions or flats. In general the soil pattern is simple and the areas large, but in the southern part of the county many small areas occupy low narrow sandy ridges or small knolls in large areas of Brookston soils. The native vegetation consisted largely of a good growth of white pine, with some Norway pine and a few oak and hard maple trees.

In cultivated fields the surface soil is light brownish-gray sandy loam to a depth of about 6 inches, and the subsurface layer, to a depth of about 10 inches, is light-gray loamy sand or sandy loam. In forested areas a 2- or 3-inch layer of leaves, twigs, and partly decomposed organic matter is on the surface, and the surface soil, to a depth of about 1 inch, is dark-gray sandy loam. This layer is mixed by cultivation with a few inches of the light-gray subsurface layer to form the light grayish-brown surface soil commonly seen in fields. To a depth of about 15 inches the subsoil is brown or yellowish-brown cemented sandy loam. The strength of cementation is not constant but varies from slightly or weakly cemented soft sandy loam to hard rocklike fragments. The depth to and thickness of this layer vary widely within short distances, and in some places it lies so near the surface that fragments are turned up in plowing. The deeper subsoil, to a depth of 20 or 30 inches, is mottled gray and brownish-yellow loamy sand. The substratum is gray or pinkish-gray calcareous clay, which may be either stone-free or pebbly and stony. The surface and subsoil layers are medium to strongly acid, but the substratum is alkaline. Very few pebbles or cobbles are on or in the soil except where associated with the Macomb soil. The content of fine material varies somewhat—in places the texture of the surface soil is fine or very fine sandy loam, and lenses of fine material occur in a few places in the lower layers.

This soil is relatively productive and responsive to management, and its use depends largely on the soils with which it is associated. Where

the associated soils are finer textured and more productive, much of this soil is left in forest or used for pasture; on the other hand, where the associated soils are deep sands, this may be the more productive soil in the farm unit and may be used for cultivated crops. To a certain extent the productivity varies with the depth of the sandy layers, the most productive areas being those where the clay layers are closer to the surface. Artificial drainage is needed on some areas and is usually provided by both open ditches and tile. Some areas, particularly those adjoining areas of lower lying soils in which tile systems are installed, need no additional drainage.

About two-thirds of the area is cleared, more than half of which is used for crops. Corn, oats, barley, beans, and hay are the most common crops grown. Alfalfa is grown in some places after lime has been applied at the rate of about 2 tons an acre. Frequent applications of manure and fertilizer, together with green-manure crops, are used to build up and maintain productivity. Potatoes, small fruits, and truck crops may be successfully grown in a few areas. Water penetrates this sandy soil rapidly, and there is little or no erosion damage from water. As erosion by wind, however, may cause damage, the ground should not remain bare for any long period.

In many nearly level places small areas of Arenac and Munuscong sandy loams were included with this soil in mapping.

Ogemaw loamy sand.—In many places this soil occupies the transitional zone between the fine-textured soils and the deep sands. It is similar to Ogemaw sandy loam except that the surface and subsoil layers are thicker, and, in most places, the sandy deposit is between 2 and 4 feet thick. In many places the subsoil is very weakly cemented or incoherent. The total area of 20,352 acres occurs in association with Ogemaw sandy loam and numerous other soils.

This type is somewhat less productive than Ogemaw sandy loam, but with good management, including green-manure crops and legumes, fair yields may be maintained. Less than half the area is cultivated, but a considerable acreage is in permanent pasture. Special crops, as truck crops, early spring crops, and others, might be grown successfully on limited areas.

More care must be exercised to prevent wind damage on this soil than on the sandy loam, but where the organic-matter content is maintained and the ground kept covered during winter, little damage occurs. Applications of green manure and barnyard manure, careful use of lime and fertilizer, and growing early maturing crops are good practices. It is doubtful that common farming systems would be successful on this soil type.

Ogemaw-Selkirk complex.—Areas of this complex include small bodies of Ogemaw sandy loam and Selkirk silt loam, with some Ogemaw loamy sand and Bergland loam, associated in a pattern too intricate to delineate the separate components on a small-scale map. These soil types are characteristically developed in areas of the complex, and, as they are described elsewhere in this report, the descriptions are not repeated. The land is very gently undulating to billowy, and differences in relief do not exceed 10 feet. Ogemaw soils occupy the low sandy ridges or knolls and Selkirk soils the nearly level places. Most areas of the complex are small, less than 20 acres in extent, and include

several bodies of Ogemaw and Selkirk soils. The total area of 3,264 acres is mostly in the northern part of the county and in the vicinity of Midland in association with Toledo, Selkirk, and Bergland soils.

The use and management of areas of this soil complex are governed partly by the proportion of the various soil types in the area. About 85 percent is cleared, and most of it cultivated. Corn, oats, beans, beets, hay, and pasture are the principal crops grown. Areas composed predominantly of Ogemaw soils or Selkirk silt loam are used and managed in the same manner as those respective soils. More manure, lime, and fertilizer are applied to the Ogemaw areas, and drains are placed in the Selkirk areas. Fall plowing is recommended for the Selkirk soils but, if practiced on areas of this complex, may result in some damage from wind erosion on the included areas of Ogemaw soils; also, it precludes the growing of cover crops that, turned under as green manure, aid in maintaining the organic supply of these light-colored soils.

Oshtemo loamy sand.—This light-colored well-drained soil occurs on low, sandy, gravelly ridges and is associated with Macomb and Ogemaw soils in the vicinity of Coleman. The total extent is 384 acres. The soil pattern is relatively simple; the individual areas are less than one-fourth mile wide, but some are more than a mile long. White pine trees constituted the greater part of the native forest.

The surface layer, to a depth of about 6 inches, is light grayish-brown loamy sand, and the subsurface layer, to a depth of 12 or 15 inches, grayish-yellow loamy sand. The subsoil, to a depth of 24 or 30 inches, is yellowish-brown sticky sandy loam, in many places containing lenses of sandy clay loam, and to a depth of about 40 inches, is brownish-yellow loamy sand. The substratum is yellowish-gray loose sandy slightly calcareous stratified sands with some gravel. The surface and subsoil layers are strongly to medium acid in reaction. A few pebbles and cobbles are on and in the soil.

Practically all the soil is cleared and some of it cultivated. The natural fertility is relatively low, but the soil is easy to work and, with good management, gives fair returns of the common farm crops. Corn, oats, and hay are the crops commonly grown. Lime, commercial fertilizer, and barnyard manure are applied to cultivated fields. Wind erosion may be severe if the sandy ridges are left bare for long periods. Cover crops, turned under for green manure, protect the soil from blowing and help maintain a good supply of organic matter.

Rubicon sand.—This light-colored well-drained soil, occupying level or nearly level sand plains or low knolls or ridges in association with Newton, Saugatuck, and Weare soils, is developed in sandy glacial outwash. A total area of 13,056 acres is widely distributed over the county, large areas occurring in the west-central part in the vicinity of and along the Chippewa River. The soil pattern is relatively simple. Original forests consisted largely of Norway, white, and jack pines, with some oak trees.

In forested areas there is a 2- or 3-inch layer of leaf litter and partly decomposed leaves and twigs on the surface. Beneath this is a very thin layer of nearly black well-decomposed organic matter mixed with sand less than ¼ to 1 inch thick. The subsurface layer, to a depth of

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5 or 7 inches, is very light-gray or white sand. In most places the organic matter formerly on the surface has been mixed with the underlying white layer by lumbering operations, pasturing, or cultivation, resulting in a brownish-gray sand surface soil. To a depth of 10 or 12 inches the subsoil is brown or yellowish-brown loamy sand that is slightly cemented, particularly in the upper part. The degree of cementation varies; in some places this layer is hard and rocklike and in others loose and incoherent. The deeper subsoil, to a depth of 2 or 3 feet, grades from brownish-yellow to yellow sand. The substratum is grayish-yellow loose sand. The soil is very strongly to strongly acid, the lower part of the surface soil and upper part of the subsoil being most acid. Clay lies at a depth of 4 to 10 feet, but in most places this soil is developed in sandy deposits 20 feet thick or more. A few pebbles are on and in the soil in a few places, and thin lenses of sandy clay may occur in the subsoil.

As many attempts to cultivate this very droughty soil have ended in failure, practically none of it is farmed. Some areas are used for pasture, but much of the land not in second-growth forest or brush is used for home sites by people who derive their living from industry or business in the city of Midland. It can be used successfully for gardens when heavy applications of manure and fertilizer are made and irrigation is practiced. The first 2 or 3 years it is cultivated fair yields of corn, oats, and potatoes may be obtained, but the fertility is soon exhausted and the land abandoned. Bluegrass and quackgrass are the most common grasses in pastures. Aspen and scrub oak brush, sweetfern and bracken fern, and wintergreen occupy most areas that were formerly cultivated or severely burned, but some stands of red, white, and jack pines occur on this soil. Water penetrates the soil rapidly, and little or no wind erosion has occurred.

Saugatuck sand.—This light-colored imperfectly drained soil, developed in sandy deposits, resembles Ogemaw soils but has clay at a depth of more than 3 feet. The total area of 21,312 acres is widely distributed over the county in association with Newton, Rubicon, and Weare soils and in a few places with Ogemaw and Munuscong soils. Most areas are smaller than those of the associated soils. The most common occurrence is on a very low, nearly level elevation 2 to 4 feet above the associated Newton loamy sand, but many areas occupy shallow depressions in areas of Rubicon and Weare sands or the transitional area between areas of Newton and Rubicon or Weare soils. Native forest consisted principally of white pine, with some elm, aspen, swamp white oak, ash, and soft maple trees.

In forested areas a 2- to 6-inch layer of organic matter is on the surface. Beneath this the 2- or 3-inch mineral surface soil is a gray or dark-gray loamy sand or a mixture of sand and finely divided organic matter that looks like salt and pepper. The subsurface layer, to a depth of 12 or 15 inches, is light-gray sand, nearly white when dry. In cultivated areas the surface soil is gray or dark-gray loamy sand with pieces of red or brown hardpan scattered over the surface. To a depth of 18 inches the subsoil is dark-brown or reddish-brown sandy loam. In some places this layer is hard and rocklike, particularly when dry, but in others it is only very weakly cemented and rocklike fragments occur only intermittently. The deeper subsoil, to a depth of 24 or 30 inches, is yellowish-brown sand or loamy sand,

mottled with gray and rust brown. The substratum is mottled gray and yellow waterlogged sand. A clay layer occurs in some places at a depth of 3 or 4 feet, but in most places it lies at a greater depth. The reaction is strongly to very strongly acid in all layers.

The soil varies somewhat in different parts of the county. In the eastern part considerable fine sand is in the soil material, and the texture of the surface and subsoil layers is fine sand or loamy fine sand in many places. In the northwestern part much coarse sand and some gravel are in the soil material, and the texture of the surface and subsoil layers is coarse sandy loam or gravelly sandy loam in many places.

Most of this soil is in forest or brush, and much of it is used as wild pasture. Aspen, bracken fern, and wintergreen comprise the common vegetation. A few areas are cleared and farmed by people who have incomes from other sources. Many areas that were once cleared have been abandoned and are now used as pasture. In other parts of the State this soil is used successfully for the production of hybrid varieties of blueberries. Some artificial drainage and heavy applications of fertilizer would be necessary in order to produce fair to good yields of the common farm crops, but returns from these expenditures would probably not justify the cost. Forestry is probably the best use for this soil, but where it is part of a farm composed largely of more productive soils, it is used for pasture.

Saugatuck-Newton sands.—Areas of this complex consist of small bodies of Saugatuck and Newton sands associated in a pattern too intricate to delineate separately on a small-scale map. The relief is very gently undulating or hummocky—Saugatuck sand occupies the low ridges or knolls and Newton sand the depressions. The total area of 50,368 acres is about equally divided between the two soils. This is the most extensive soil unit mapped in the county. Both soils are characteristically developed in areas of the complex, and, as they have been described separately, the descriptions are not repeated.

About 80 percent of the complex is forested, and most of the cleared area is used as pasture or is abandoned and growing up in aspen and alder brush. Some areas are farmed or used for gardens or home sites by people who derive their major income from some other source.

Selkirk silt loam.—A total extent of 5,376 acres of this light-colored imperfectly drained clay soil is mapped. The relief is nearly level to gently undulating. Native forest consisted principally of hard maple, beech, elm, and ash trees.

The surface soil, to a depth of about 6 inches, is light brownish-gray silt loam. To a depth of 10 or 12 inches the subsoil is grayish brown, mottled with gray and yellowish-brown, silty clay loam, breaking into ¼-inch relatively hard angular block-shaped aggregates. The deeper subsoil, to a depth of about 20 inches, is reddish-brown clay or silty clay, mottled or streaked with gray silt, breaking into ½- to 1-inch angular blocks between which the gray silty material has penetrated. The material in this layer is hard and is slowly penetrated by water and roots. The substratum is pale reddish- or pinkish-gray clay containing pockets or layers of silt and very fine sand. The surface and subsoil layers are medium to slightly acid, and the substratum is calcareous.

In some places this soil is relatively well drained, and the reddish color is not present in the upper 2 or 3 feet; but where it grades into Toledo or Brookston silty clay loams it approaches a poorly drained gray subsoil condition. In some places the surface layer is dark gray or grayish brown, and the soil resembles Kawkawlin soils.

About 90 percent of the soil is cleared and much of it cultivated. Corn, beets, beans, and hay, principally alfalfa, are the principal crops, and some small grains are grown. Yields are good to high, particularly where the organic content of the surface soil is maintained by the use of barnyard manure, and green-manure crops and commercial fertilizers are used. Tile drainage is installed on many areas because natural drainage is not sufficient to remove water and allow the soil to warm early in spring. The soil can be plowed in fall, as water runs off very slowly and the firm texture, together with good moisture-holding capacity, prevents excessive blowing. Fall plowing allows the soil to become dry and workable earlier in spring.

Selkirk silt loam, sloping phase.—Occupying short steep slopes or bluffs bordering stream valleys, this soil covers a total area of 896 acres. Individual areas are narrow, averaging about 150 feet, but many are a mile or more long. The difference in elevation from base to tops of slopes is 20 to 50 feet or more. In most places the gradient is between 10 and 20 percent, but slopes as steep as 40 percent are encountered. These slopes were originally forested with white cedar, elm, basswood, aspen, white birch, ash, and hemlock trees.

This sloping phase represents a soil condition or a complex of soils rather than a definite morphological unit. In most places the soil is similar to the normal silt loam, but in some places the surface is dark colored and mucky, and, in others, where the soil is developed from sandy deposits underlain by clay, it is sandy. The soil is partly wet because of numerous seepage springs.

Much of the land is cleared and included with Griffin or Genesee soils in pastures. Bluegrass and sedges are common in most pastures. Most of the slopes are too steep to cultivate, but a few areas are included with the adjoining upland soils in cropped fields. A few areas of sharply sloping upland in the vicinity of Hope Township are mapped with this soil phase.

Toledo silty clay loam.—This dark-colored poorly drained soil, developed from fine-textured lacustrine deposits, resembles Brookston soils in many characteristics, but its parent material is stone-free lacustrine deposits, whereas that of Brookston soils is glacial till or boulder clay. It occupies a total of 4,032 acres on nearly level to very gently undulating or billowy relief in association with Selkirk, Colwood, and Arenac soils. In general the soil pattern is simple, with large areas of this soil and smaller areas of the other soils, but in places the pattern is a complex association of this soil in small shallow depressions with Arenac and Selkirk on the low narrow divides between the numerous depressions. Most of the soil was originally forested with ash, elm, hickory, soft maple, swamp white oak, and basswood trees.

To a depth of about 6 inches the surface layer is a very dark-gray, nearly black, silty clay loam or silt loam. The subsurface layer, to a depth of about 12 inches, is gray or dark-gray silty clay loam. The

subsoil, to a depth of 21 or 24 inches, is gray or mottled gray, yellowish-brown, and grayish-yellow clay loam or silty clay loam. The substratum is gray or mixed gray and pinkish-gray silty clay or interbedded clay, silt, and fine sand that is calcareous at a depth of about 30 inches. The soil is neutral in the surface and subsoil layers and mildly alkaline in the upper part of the substratum.

Artificial drainage is necessary before crops common to the area can be grown on this soil, and satisfactory tile drainage systems have been established in most places. The large, nearly level areas are easily drained where outlets are available. Some of the small depression areas are difficult to drain properly. Tile are placed ordinarily at intervals of 3 to 4 rods.

Practically all this soil is cultivated. Rotations on the large areas are largely sugar beets and corn, with short periods of small grains and legumes or grass. Those on the smaller areas are governed largely by the associated soils and include corn, beans, small grains, and legumes or grass for several years. Hay crops, particularly alfalfa, may be killed during winter, and a common practice on the larger areas is to seed two or three fields with red clover and timothy and alfalfa and to save the one having the best stand the following spring. The soil is naturally fertile, and yields are maintained at a high level with the use of manure, occasional green-manure crops, and moderate applications of fertilizer high in potassium and phosphorus. Fall plowing aids in improving tilth and permits earlier planting. Little or no erosion, by either wind or water, occurs on this soil.

Tuscola silt loam.—A total area of only 512 acres of this soil is mapped, and most individual areas are small. It occurs in association with Colwood and Toledo soils in Ingersoll and Hope Townships on gently undulating to billowy relief, this soil occupying the low well-drained knolls and ridges, and Colwood or Toledo soils the depressions. The native vegetation consisted largely of hard maple, oak, and beech trees, with a few white pine.

This well-drained soil is developed on interbedded silt, fine sand, and clay. The surface layer, to a depth of about 6 inches, is grayish-brown silt loam, and the subsurface layer, to a depth of about 12 inches, grayish-yellow silt loam. To a depth of 18 or 20 inches the subsoil is brown or brownish-yellow silty clay loam, having seams or lenses of very fine sand in many places. The substratum is brownish-yellow to yellowish-gray silt, fine sand, very fine sand, and clay that is calcareous below a depth of about 30 inches.

The soil is productive when properly managed, and practically all of it is cleared and cultivated. Corn, beans, small grains, and legume hay are the common crops. Owing to the small size of most individual areas, few fields are situated entirely on this soil, so, in many places, the management practices are governed largely by the associated poorly drained soils. The organic supply of the surface soil is maintained by heavy applications of barnyard manure and by green manures. Complete fertilizers are applied when most crops are planted, and many hayfields are top-dressed with barnyard manure. Alfalfa does especially well on this soil.

Artificial drainage is not required on this soil, but the associated soils usually require drainage for successful cultivation. The moisture-holding capacity is good, and there is little danger of sufficiently

lowering the water table to cause droughtiness when adjoining areas are drained. Little damage results from erosion.

Wasteland.—Several artificial ponds used for the storage of refuse from a chemical plant form this land. These areas occupy a total of 256 acres near Midland. The soil removed to form the pits is used as levees around the ponds or pits.

Weare sand.—Developed in deep sand, this excessively drained soil occupies undulating to rolling beach ridges or stabilized sand dunes. The ridges rise 5 to 25 feet above the surrounding plain and have short slopes of 5 to 20 percent. It covers a total area of 14,592 acres, widely distributed over the county in association with almost all soils but principally with Rubicon, Saugatuck, and Newton types. Individual areas are 100 to 400 feet wide and ¼ to 1 mile or more long. These ridges extend in various directions, but the general trend is northwest-southeast. The native forest consisted of red and white pine trees, with some oak.

In wooded areas a 1- to 3-inch layer of litter and partly decomposed organic matter is on the surface, and the surface layer of mineral soil, to a depth of about 6 inches, is gray sand. In places where organic matter has been mixed with this material the surface soil is relatively dark gray or has the appearance of a salt-and-pepper mixture. The subsoil, to a depth of about 24 inches, is yellowish-brown sand or loamy sand, the upper 3 or 4 inches of which is brown or dark brown and, in places, weakly cemented. The substratum is grayish-yellow loose sand. The reaction is acid.

This extremely droughty soil is seldom included in cultivated fields; any cultivated areas are parts of fields composed largely of other soils and are included solely to improve the shape of the field. They constitute a liability in most places, as the yields are low and great care must be exercised to prevent damage from wind action, not only to this soil but also to adjoining areas. Much of this soil is in aspen, sweetfern, and oaks and some in permanent pasture. With heavy applications of stable manure and light applications of complete fertilizers at frequent intervals, fair pastures can be maintained. Pastures are valuable early in spring, as the soil warms early and furnishes grazing when most of the others are too wet. Overgrazing must be prevented, for the soil blows readily unless a good cover is maintained. Bluegrass and quackgrass are the most common species in most pastures.

Mapped with this soil are areas where the subsoil layer is cemented into an almost continuous rocklike mass. If these areas were sufficiently extensive they would be mapped as Wallace soil. Small areas of moving sand also are included (pl. 1, *C*).

LAND USE AND SOIL MANAGEMENT

Some soils of Midland County are well suited to a wide variety of crops and can be used equally well for crops, pasture, or timber. Other soils have limited uses, but some can be much improved through good management practices. Some soils respond to certain crop rotations and some to certain fertilizer practices; others are suited only to special crops. The general uses and management requirements of the soils in this county are given in table 7.

TABLE 7.—*General uses and management practices recommended for the soils of Midland County, Mich*

Management group and soil type	Land use	Rotation	Commercial fertilizer [1]	Lime [2]	Manure	Water control [3]	Remarks
Wet fine- or medium-textured soils.							
Bergland loam Bergland silty clay loam Brookston loam Brookston silty clay loam Toledo silty clay loam	Corn, sugar beets, field beans, oats, barley, rye, wheat, alfalfa, clovers.	Corn, 1 year; sugar beets or field beans, 1 year; small grain, 1 year, red clover, 1 year or alfalfa, 1 or 2 years, seeded in small grain.	Liberal applications of complete fertilizer, containing P_2O_5 and K_2O in a 2-1 ratio.	*Tons* 0-1	Green-manure crops and applications of barnyard manure.	Artificial drainage always required, drainage lines 3-5 rods apart	Nearly all cleared and used for rotation crops, finer textured soils (silty clay loams) more difficult to manage; small grains and hay crops sometimes lodge, frost-heave, or winterkill on finer textured soils, fall plowing recommended; yields generally high.
Medium-textured soils with intermediate to good drainage (on gentle slopes):							
Kawkawlin loam Ogemaw-Selkirk complex Selkirk silt loam Tuscola silt loam	Corn, field beans, oats, barley, rye, wheat, alfalfa, clovers, sugar beets.	Corn or field beans, 1 year, followed by winter cover and green-manure crop of small grain, small grain, 2 years; red clover, 1 year or alfalfa, 1 or 2 years, seeded in small grains.	----do----------	1-2	Green-manure crops regularly; barnyard manure on corn or beans.	Artificial drainage usually required; drainage lines 4-5 rods apart.	Nearly all cleared and used for rotation crops; continuous use for tilled crops not recommended, fall plowing not generally recommended; yields moderately high.
Wet dark-colored sandy loams over clay							
Colwood fine sandy loam. Colwood very fine sandy loam. Munuscong sandy loam	Corn, field beans, potatoes, oats, barley, rye, wheat, alfalfa, clovers, timothy.	Corn, field beans, or potatoes, 1 year; small grain, 1 year; alfalfa, 1 or 2 years or clover, 1 year, or clover and timothy, 1 year, alfalfa preferred.	Liberal applications of complete fertilizer, containing equal quantities of P_2O_5 and K_2O.	0-1	Green-manure and cover crops regularly; barnyard manure for cultivated crops.	Artificial drainage always required, drainage lines 4-5 rods apart.	Large area cleared and used for rotation crops Colwood soils in intricate association with other soils presenting difficult management problems, especially of drainage; individual bodies of Munuscong sandy loam relatively large and widely distributed; careful management required for all types in the group, continuous use for tilled crops not recommended, yields moderate to moderately high under good management

See footnotes at end of table.

TABLE 7.—*General uses and management practices recommended for the soils of Midland County, Mich.*—Continued

Management group and soil type	Land use	Rotation	Commercial fertilizer [1]	Lime [2]	Manure	Water control [3]	Remarks
Wet dark-colored deep sandy loams:				*Tons*			
Granby sandy loam Munuscong loamy sand	do	Corn, or field beans or potatoes, 1 year; followed by winter cover and green-manure crop of small grain; small grain, 1 year; alfalfa, 1 or 2 years or clover, 1 year or clover and timothy, 1 year, alfalfa preferred.	Liberal applications of complete fertilizer, containing equal quantities of P_2O_5 and K_2O; manganese needed for oats and field beans	0	Green-manure and cover crops regularly; frequent applications of barnyard manure in moderate quantities.	do	Large area cleared and used for rotation crops; occurs in large bodies; continuous use for tilled crops not recommended; yields moderate under good management
Imperfectly drained light-colored sandy loams over clay:							
Kawkawlin sandy loam Macomb sandy loam	Corn, field beans, sugar beets, potatoes, oats, barley, rye, wheat, alfalfa, clovers, timothy.	Corn, or field beans or sugar beets or potatoes, 1 year, followed, where possible, by winter cover and green-manure crop of small grain; small grain, 1 year, alfalfa, 1 or 2 years, or clover, 1 year, or clover and timothy, 1 year, alfalfa preferred.	Liberal applications of complete fertilizer; containing equal quantities of P_2O_5 and K_2O.	0–2	Green-manure and cover crops regularly; barnyard manure for the cultivated crops	do	Large area cleared and used for rotation crops, soils easily worked, warm early in spring, continuous use for tilled crops not recommended, yields moderate to high under good management, a few cobbly or stony areas best suited to forest or permanent pasture
Imperfectly drained light-colored loamy sands and sandy loams over clay.							
Ogemaw loamy sand Ogemaw sandy loam	Strawberries, brambles, potatoes, cucumbers, string beans, or other truck crops.	Strawberries, 2 years, or brambles, 3 to 5 years, potatoes, cucumbers, string beans, or other truck crops, 1 year. (Winter cover and green-manure crop of small grain between small fruit and truck crops).	Liberal applications of complete fertilizer, high in nitrogen, with equal quantities of P_2O_5 and K_2O.	(4)	Green-manure and cover crops regularly, barnyard manure, as much as is available.	Artificial drainage usually required, drainage lines 4–5 rods apart	Large area cleared and used for rotation crops, for small fruits, spots with a high water table during wet periods must be avoided; straw mulch recommended for small fruits.

	Corn, field beans, oats, barley, rye, wheat, alfalfa, clovers, timothy.	Corn, field beans or potatoes, 1 year, followed by winter cover and green-manure crop of small grain, alfalfa, seeded alone, 3 years.	Liberal applications of complete fertilizer, containing equal quantities of P_2O_5 and K_2O.	2-5	----do----	----do----	Continuous use for tilled crops not recommended; wind erosion a hazard on the loamy sand type; both types generally responsive to good management, yields variable from place to place.
Medium-textured soils with intermediate to good drainage (on steep slopes):							
Selkirk silt loam, sloping phase.	Permanent meadow and pasture, bluegrass and clover.	None----	Occasional applications of P_2O_5 and K_2O in a 2-1 ratio.	0-1	Use manure in cropped areas.	Occasional artificial drainage required for local seepage areas but not always necessary.	Mostly cleared and used for permanent meadow and pasture.
Well-drained soils of the flood plains							
Genesee sandy loam----	Permanent meadow and pasture (bluegrass, clover and alfalfa where drainage permits).	----do----	Occasional applications of P_2O_5 and K_2O in a 1-1 ratio	(4)	----do----	Artificial drainage usually not required.	Moderate area cleared and largely in permanent meadow and pasture.
Genesee silt loam----	Corn, sugar beets, field beans, oats, barley, rye, wheat, alfalfa, clovers, timothy	Corn, 1 year, sugar beets or field beans, 1 year, fall-seeded small grain, 1 year; clover, or clover and timothy (seeded in small grain), 1 year, alfalfa, 2-3 years when drainage permits	Light to moderate applications of complete fertilizer high in P_2O_5 and K.	(4)	----do----	Artificial drainage usually not required except in swales.	Small percentage of cleared area used for crops; small grains and hay crops may lodge, frost-heave, or winterkill; subject to occasional flooding; yields generally high.
Wet loams and sandy loams of the flood plains							
Griffin loam----	Permanent meadow and pasture (bluegrass).	None----	Seldom advisable----	(4)	Usually none----	Artificial drainage required but often difficult, due to lack of outlet; drainage lines 4-5 rods apart, where feasible, flood protection desirable.	Small amount cleared and used for permanent hay and pasture crops; not recommended for crops except where adequate drainage and flood protection feasible; under these conditions recommendations for Genesee soils apply.
Griffin sandy loam----							
	Forest----	----do----	None----	0	None----	None----	Mostly forested; systematic forestry as recommended by the State Extension Forester or Conservation Department

See footnotes at end of table.

TABLE 7.—*General uses and management practices recommended for the soils of Midland County, Mich.*—Continued

Management group and soil type	Land use	Rotation	Commercial fertilizer [1]	Lime [2]	Manure	Water control [3]	Remarks
Organic soils Mucks and peat.				*Tons*			
Carlisle muck	Forest	None	None	0	None	None	All forested, systematic farm forestry as recommended by the State Extension Forester or Conservation Department
	Mint, onions, celery, lettuce, sugar beets, other special crops	Special rotations as recommended by the State Agricultural Experiment Station	P_2O_5 and K_2O, also sulfur, copper sulfate, and sodium chloride for special crops and soil conditions as recommended by the State Agricultural Experiment Station	0	do	Artificial drainage always required but often difficult, due to lack of outlet, drainage lines 3–5 rods apart, overdrainage should be avoided Open ditches most feasible.	Not utilized for crops in this county owing to drainage difficulties, isolation from other suitable agricultural soil areas, and frost hazard.
Carlisle muck, burned phase	Forest	None	None	0	do	None	All burned-over and second-growth forest, systematic farm forestry as recommended by the State Extension Forester or Conservation Department.
	(5)	(5)	(5)	(5)	(5)	(5)	Not utilized for crops in this county, owing to drainage difficulties, small-sized isolated bodies, and frost hazard.
Kerston muck Muck and peat	Forest and permanent pasture.	None	None	0	None	None	All forested; systematic farm forestry as recommended by the State Extension Forester or Conservation Department.
	(6)	(6)	(6)	0	do	(6)	Not utilized for crops in this county owing to drainage difficulties, small isolated bodies, frost, and flood hazards

Dry and moderately dry light-colored sandy soils:							
Arenac loamy sand, Arenac sandy loam, Oshtemo loamy sand, Rubicon sand, Weare sand	Forest and possibly permanent pasture and special crops.	None	None	0	do	None	Large area forested, systematic farm forestry as recommended by the State Extension Forester or Conservation Department. Rubicon and Weare sands subject to severe wind erosion where bare of vegetation; no rotation, fertilizer, or other recommendations made for these two soils
	Permanent pasture (bluegrass, quackgrass, white clover)	do	Frequent light applications of P_2O_5 and K_2O in a 1–1 ratio.	3–4	Use manure in cropped areas.	do	Moderate area cleared and largely used for permanent pasture.
	Gardens, truck crops (potatoes, cucumbers, string beans, tomatoes, and others), small fruits (strawberries, brambles, and others).	Garden or truck crops, 1 year; strawberries, 2 years; or brambles, 3 to 5 years. (Winter cover and green-manure crops of legumes or legume and small grain whenever feasible).	Large quantities of complete fertilizers high in P_2O_5 and K_2O.	3–4	Green-manure crops whenever possible, frequent moderate applications of barnyard manure.	Where water supply available, auxiliary irrigation desirable.	Small proportion used for special crops, continuous use for tilled crops not recommended; fall plowing not recommended, wind erosion a hazard, straw mulch recommended for strawberries and brambles; yields generally low.
Wet dark-colored loamy sands:							
Granby loamy sand, Newton loamy sand	Forest	None	None	0	None	None	Large area forested, systematic farm forestry as recommended by the State Extension Forester or Conservation Department.
	Permanent meadow and pasture (bluegrass, quackgrass, and white clover).	do	Frequent light applications of P_2O_5 and K_2O in 1–1 ratio.	1–3	Use manure in cropped areas.	Artificial drainage always required, drainage lines 4 rods apart	Small area cleared and largely in permanent meadow and pasture.
	Corn, potatoes, beans, truck and garden crops (in home gardens where better soil not available, not well suited to commercial production).	Corn, potatoes, or field beans, followed by winter cover crop of legume or legume and small grain, 1 year, truck or garden crops, 1 year.	Large quantities of complete fertilizers high in P_2O_5 and K_2O.	1–3	Frequent green-manure crops; frequent applications of barnyard manure in moderate quantities.	do	Very small area used for crops, usually in subsistence farms operated by industrial workers. Tilled crops not generally recommended, except where better soils not available; fall plowing not recommended, wind erosion a hazard, yields generally low.

See footnotes at end of table

TABLE 7.—*General uses and management practices recommended for the soils of Midland County, Mich.*—Continued

Management group and soil type	Land use	Rotation	Commercial fertilizer [1]	Lime [2]	Manure	Water control [3]	Remarks
Light and dark-colored deep sands with imperfect to poor drainage:				*Tons*			
	Forest	None	None	0	None	None	Large area in second-growth forest. Use of the greater part of the land for forestry as recommended by the State College and the State Department of Conservation.
Saugatuck-Newton sands.							
Saugatuck sand	Permanent pasture (bluegrass, quackgrass, white clover)	do	Frequent light applications of P_2O_5 and K_2O in 1–1 ratio.	2–4	Use manure in cropped areas.	Artificial drainage usually necessary; drainage lines 4 rods apart.	Small area cleared and partly in permanent pasture.
	Small fruits, flowers, truck and garden crops (in home gardens where better soil not available, not well suited to commercial production).	Small fruits or flowers, 1 to 5 years; truck or garden crops followed by winter cover crop of legume or legume and small grain, 1 year.	Large quantities of complete fertilizers high in N and P_2O_5, light frequent applications.	[7] 2–4	Frequent green-manure crops, frequent moderate applications of barnyard manure.	do	Very small proportion used for crops on subsistence farms operated by industrial workers Straw mulch recommended for small fruits. Yields generally low

[1] More specific information regarding the analyses of fertilizers which should be used on different soils for different crops may be obtained from the State Agricultural Experiment Station.
[2] Expressed in terms of ground limestone and need for successful production of alfalfa, sweetclover, and other legumes. Frequency of application as indicated by soil test.
[3] Engineering advice should be obtained for specific fields where drainage is contemplated.
[4] Usually none.
[5] See Wet fine- or medium-textured soils.
[6] See Carlisle muck.
[7] Not required for strawberries, brambles, or potatoes.

GENERAL MANAGEMENT PRACTICES

DRAINAGE

Many soils of the county require drainage in some degree before they can be utilized for production of cultivated crops. In general, the soils having the larger content of organic matter and higher natural fertility are those needing drainage and are the ones on which drainage is most economical. Flat relief, high water table, or substrata, that are relatively impervious to or highly retentive of moisture, are the factors causing the poor drainage conditions. Probably 90 percent of the total area of the county consists of soils with deficient drainage (see table 7).

Adequate artificial drainage requires a suitable outlet and may then be effected by use of open ditches or tile. Tile is preferable, as it requires less maintenance and permits cultivation across the drainage lines. The distance between drainage lines and their depth below the surface are conditioned upon the soil character and the amount of fall to the outlet. The size of the ditch or tile required depends upon (1) the area of land to be drained by the line; (2) whether the line will carry only excess rain water on the area to be drained, or additional water from springs, seepage areas, or surface drainage from adjacent areas; (3) the length of the line; and (4) the fall, or grade, of the drain. Under ordinary conditions, with a fall of 3 inches per 100 feet, a 5-inch tile will drain 20 acres, a 6-inch tile 30 acres, and an 8-inch tile 70 acres. It is seldom feasible to use a tile less than 4 inches in diameter, and then only as a short lateral. In cases where the line must be unusually long, or where water from laterals is to be received, the size of the tile should be increased as the outlet is approached.

All drainage systems should be laid so that there is a gradual fall from the beginning of the line to the outlet. About 3 inches per 100 feet is a desirable average fall, but if carefully constructed, a fall of 2 inches per 100 feet may be satisfactory. If tile are laid with slight fall, the grade must be very accurately determined and uniform. In general the less fall that can be allowed, the larger the diameter of the tile required.

Excessive drainage of mucks and peats can be as unfavorable as insufficient drainage for crop production. In addition, serious hazards of destruction of the soil by burning or by wind erosion are developed. It is especially necessary, therefore, that the drainage lines be at the proper depth. Open ditches are generally more effective than tile in muck and peat soils. Where these organic soils are to be used for crops, dams may be necessary to control the water table.

The soils that require drainage are indicated in table 7. Because few farms or even fields include only one soil type and because the different types differ in relief and drainage requirements, the drainage problem may be complicated and engineering aid desirable for best results.

IRRIGATION

Some of the deep sandy soils are deficient in moisture supply because of their very low moisture-retaining capacity. Where there is a cheap source of water from springs, streams, lakes, or wells, irrigation might be practical for crops of high acre value, as small fruits,

berries, home gardens, truck crops, or flowers. Increasing the organic content of these soils is usually necessary for best results. A higher organic-matter content increases the water-holding capacity as well as the fertility of such soils.

TILLAGE

Tillage requirements vary with the kind of soil. Soils of relatively fine texture, as silty clay loam and silt loam, require the most power for plowing; those of intermediate texture, as loam, fine sandy loam, and sandy loam, require less power; and those of coarse texture, as loamy sand and sand, require the least.

The fine-textured soils are highly retentive of moisture and warm slowly in spring. Fall plowing is recommended on level areas of such soils, as there is little erosion hazard from wind or water. The freezing and thawing of the plowed soil during winter helps to improve the structure and allows earlier seeding of spring crops. For the same reasons fall plowing is also recommended for soils of intermediate texture with level relief. It is rarely advisable to fall-plow the sandy soils, as they are subject to severe wind blowing. It should be emphasized that fall plowing on any soil, regardless of texture, where the slope, or lay of the land, is such that washing of the soil would occur, is not recommended. The sandy soils and others subject to erosion by wind and water should be protected either by a cover crop or by leaving in grass during winter. Plowing across the slope and strip cropping help to control erosion on the lesser slopes. On slopes greater than 15 percent or on severely eroded slopes, permanent grass or trees are the best means of controlling erosion.

Rolling with an implement of the cultipacker type is beneficial in preparing good seedbeds. On the finer textured soils it serves to settle the furrow slices and crush the clods; on the coarser textured soils it firms the surface down to plow depth and improves moisture relations. This is particularly beneficial if seeding is to follow soon after the plowing and harrowing operations. Disking of fine-textured soils is usually necessary to break the large lumps after plowing and help firm the soil, or to loosen the surface soil if a considerable length of time has elapsed between plowing and planting.

ORGANIC MATTER

Additions of organic matter in the form of barnyard and green manure are beneficial for all the soils. Organic matter helps to maintain and improve the fertility and physical structure of the soils in addition to increasing their ability to retain both moisture and plant food. In general the need for more organic matter is greater in the very sandy soils than in soils of heavier texture. As organic matter decays very rapidly in sandy soils, frequent small additions are more effective than less frequent heavy additions. In a few cases, when special crops are grown, the organic content of soils may be increased profitably by using muck from adjoining areas. In general, however, farmers must depend on winter cover crops, catch crops of sweetclover or other clover, and the frequent growing of alfalfa, alfalfa and bromegrass, clover, or grass to supply organic matter to their soils. All manure should be carefully saved and applied to the land. The use

of fall and winter cover crops for green manure is recommended in most places. This practice tends to develop good soil tilth, as does fall plowing, and in addition adds organic matter. Winter rye and other cover and green-manure crops use some moisture and probably dry fields more quickly for spring planting.

SOIL BLOWING

Soil blowing on the very sandy mineral soils and unusually dry well-decomposed mucks is highly injurious. It lowers soil fertility because the finer, more fertile soil particles blow, and the cutting or bruising action of these particles frequently causes serious damage to young plants. Seeding legumes with a light planting of a rapidly growing small grain and seeding crops where possible late in spring or in summer after the season of high winds has passed are methods of avoiding damage from this cause. Soil blowing on dry muck soils may be reduced by planting trees (willows) around the fields. For certain crops, such as onions, rows of barley or rye seeded between the onions at intervals across the field are excellent protection. Strips of burlap or bags may be effective as windbreaks.

FERTILIZATION

Fertilizers are commonly used for increasing crop production on the soils of this county (see table 7). In general, complete fertilizers give best results on the mineral soils. Increased response to fertilization is obtained on the medium- and coarse-textured soils when there is sufficient moisture and adequate organic content. The response from commercial fertilizers is increased by additions of lime sufficient to almost neutralize soil acidity. Greatest response is obtained when the soils are slightly acid and the organic content, moisture supply of the soil, and the nutritive elements of the commercial fertilizer are properly balanced to meet the deficiencies of a particular soil and the requirements of a specific crop. When barnyard manure is used regularly and green-manure crops or leguminous sods are plowed under at frequent intervals, superphosphate and potash are usually the only plant nutrients required on the heavy-textured more productive soils. On the majority of soils, however, complete fertilizers are advisable for most crops.

The method of applying commercial fertilizer has a bearing on the results obtained. If applied directly in the row with beans it may damage germination and early growth, even when small quantities are used. Sugar beets are not so easily injured in this respect, but in dry seasons an application as small as 200 pounds an acre causes a reduction in stand. In practically all instances it is best to apply the fertilizer at the side of and below the seed rather than in contact with it. Experiments indicate that building up a high state of fertility in the soil before planting beans or corn is superior to direct application of fertilizer with the crops.

Proportions of potash ranging from 12 to 32 percent in a fertilizer are recommended for organic soils. This fertilizer should contain one-fourth to one-half as much phosphate as potash, depending on the crop, soil character, and previous fertilizer and crop histories.

Nitrogen should range from 0 to 3 percent, depending on the natural character of the muck and the crop requirements.

ESTIMATED YIELDS AND PRODUCTIVITY RATINGS

Crop yields depend not only on the soil type but the soil management practices followed and on such seasonal conditions as weather or insect occurrence. When, however, different soils are treated in about the same way over a period of years, they are likely to show differences in the average crop yields, or different soils show different responses to management, some soils giving a larger yield from a given system of management than others. The response that a soil shows to a particular system of management expressed in terms of yield per acre is a measure of the productivity of the soil. The estimated average acre yields of the principal crops on each soil in Midland County under average and good management practices are given in table 8.

The soils of the county are rated in table 9 according to their productivity for the more important crops and are listed in the order of their general productivity under common practices of management, the most productive first. Ratings are given for two general levels of management—the common and the better practices. In evaluating individual soil types, as mapped, the purity of the type is a modifying factor. The descriptions of the individual soils in the preceding pages should be consulted.

The rating compares the productivity of each of the soils for each crop to a standard of 100. This standard index represents a good expectable acre yield under average management in the better areas for commercial production of the crops in the United States. An index of 50 indicates that the soil is about half as productive for the specified crop as are soils with the standard index. Soils given better than average management including adequate amendments, as lime, commercial fertilizer, and irrigation, and unusually productive soils of comparatively small extent may have productivity indexes of more than 100 percent for some crops.

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of weathering and soil development acting on the parent material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point depend on (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and has existed since accumulation; (3) the plant and animal life in and on the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of development have acted on the material. The climate, and its influence on soil and plants, depends not only on temperature, rainfall, and humidity but also on the physical characteristics of the soil or soil material and on the relief, which, in turn, strongly influences drainage, aeration, runoff, erosion, and exposure to sun and wind.

TABLE 8.—*Estimated average yields per acre of the principal crops on each soil in Midland County, Mich.*

[In columns A, the yields obtained under average management practices, in columns B, those obtained under good managment practices]

Soil	Corn (grain)		Corn (silage)		Oats		Barley		Wheat		Beans		Beets		Potatoes		Alfalfa		Red and sweet-clover		Clover and timothy		Timothy and quack-grass		Pasture: Rotation		Pasture: Permanent
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
	Bu	*Bu*	*Tons*	*Tons*	*Bu*	*Bu.*	*Bu*	*Bu*	*Bu*	*Bu*	*Bu*	*Bu.*	*Tons*	*Tons*	*Bu*	*Bu*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Acres* [1]	*Acres* [1]	*Acres* [1]
Arenac sandy loam	20 0	30	4 5	6 5	20. 0	30	16	20	13 0	18 5	10 0	15 0	3 0	6. 0	100	140	1. 0	2 0	1 0	1. 2	1 0	1 3	1. 0	1 2	2 0	1 4	3 0
Arenac loamy sand	15 0	20	3. 0	4 0	15. 0	20	----	----	----	----	6 0	10. 0	----	----	70	110	----	1 4	5	.9	.7	1 0	.7	1 0	2 5	1 8	4. 0
Bergland loam	35 0	50	7. 0	9 5	40 0	50	35	45	20 0	25 0	17. 5	22 5	8 5	11 5	----	----	1 6	2 2	1 5	2 4	1 5	2 2	----	----	1 0	8	2 0
Bergland silty clay loam	35 0	50	8 0	10 0	40 0	50	35	45	20 0	25 0	17 5	22 5	9 5	13 0	----	----	1. 2	2 0	1 4	2 6	1 4	2 1	----	----	1 0	8	2 0
Brookston loam	40 0	50	7. 0	9 5	40 0	50	35	45	20 0	25 0	17 5	22 5	8 5	11. 5	----	----	1 6	2 2	1 5	2 4	1 4	2 2	----	----	1 0	8	2 0
Brookston silty clay loam	40. 0	50	7 0	10 0	40 0	50	35	45	20 0	25 0	17 5	22 5	9. 5	12 5	----	----	1 4	2 2	1 4	2. 6	1. 3	2 1	----	----	1 0	.8	2. 0
Carlisle muck [2] (none farmed)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	.9	1. 4	1 0	1 4	9	1 2	2 0	1 4	2 5
Burned phase [2]	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	8	1. 2	.9	1 3	.8	1 1	2. 0	1 4	3 0
Colwood very fine sandy loam	35 0	45	6 5	8 0	35 0	45	30	40	17 5	22 5	20 0	24. 0	8. 0	11. 0	----	----	1 8	2. 6	1 4	2 4	1 3	2 1	----	----	1. 2	1 0	2 0
Colwood fine sandy loam	25 0	35	5 0	7 0	25 0	35	20	25	12 5	17 5	11 5	15 0	6 0	8 0	120	160	1 4	2 0	1 1	1. 6	1 1	1 5	.9	1. 4	1 4	1 2	2 5
Genesee silt loam	35 0	50	7 0	9 5	30 0	40	25	35	17 5	22 5	17 5	21 0	8 0	11 0	----	----	1 8	2 6	1 6	2 5	1 5	2 2	----	----	1 0	8	1. 5
Genesee sandy loam	30 0	35	5 5	7 5	25 0	35	20	25	12 5	18 5	10 0	15 0	5 0	7. 0	120	150	1 2	1 8	1 0	1 5	1 0	1 4	9	1 5	1 5	1 3	2 5
Granby loamy sand	20. 0	25	4 0	6 5	15 0	20	15	20	10 0	13 5	9 0	14 0	----	----	80	120	1 2	1 8	1 0	1 4	.8	1 1	8	1 2	2 0	1 4	3 0
Granby sandy loam	20 0	35	5 0	6 5	20 0	30	20	25	11 0	15 0	10 0	16 0	3 5	5 5	100	160	1 5	2 0	1 1	1 4	1. 1	1 5	9	1 3	1 5	1 1	2. 5
Griffin loam	30. 0	40	6 0	8 5	25 0	30	20	30	12 5	17 5	15 0	20 0	7 0	10 0	----	----	1 5	2 0	1 2	2. 1	1 4	2 2	----	----	1. 2	1 0	1. 5
Griffin sandy loam	25. 0	35	5 0	6 5	20 0	30	15	25	9 0	12 5	11 5	15 0	5. 0	6 5	100	160	.8	1. 6	1 1	1 4	1 1	1 5	9	1 4	1. 9	1. 3	2 5
Kawkawlin loam	35 0	45	6 5	9 0	40 0	45	30	40	20 0	25 0	17 5	22 5	8. 0	11 0	----	----	2 0	2. 6	1 4	2 4	1 3	2 1	----	----	1. 0	8	2 0
Kawkawlin sandy loam	25 0	40	5 0	7 0	30 0	35	25	35	15 0	20 0	15 0	19 0	6 0	9 0	120	160	1 6	2 4	1 1	2 0	1 2	1 9	1 0	1. 8	1 2	1. 0	2 0
Kerston muck [2]	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	3 0
Macomb sandy loam	30 0	40	5 5	7 5	30 0	40	25	30	15 0	20 0	15 0	20 0	6 5	9 0	120	160	1 4	2 2	1 2	1 8	1 2	1 7	----	----	1. 3	1 1	2 0
Muck and peat [4]	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	3 0
Munuscong sandy loam	30 0	40	5 5	7 5	30 0	40	25	30	15 0	20 0	15 0	19 0	6 0	8 5	150	190	1 4	2 0	1 1	1 6	1 1	1 7	1 0	1 8	1 3	1 1	2 0
Munuscong loamy sand	20 0	35	4 0	6 5	20 0	30	20	25	10 0	15 0	10 0	15 0	4 0	6 5	110	170	1 0	1 8	1 1	1. 4	1 0	1 3	8	1 3	1 9	1 3	3 0
Newton loamy sand	15 0	25	4 0	5 0	15 0	20	----	----	----	----	7 5	11 0	----	----	70	120	----	1 6	.6	1. 0	.8	1 0	8	1 1	2 2	1 4	3 0
Ogemaw sandy loam	25 0	35	5 5	7 5	25 0	35	20	30	12 5	18 5	12 5	16 0	5 5	8 0	130	180	1 2	2 0	1. 1	1. 6	1 0	1 6	.8	1. 6	1 4	1 1	2 5
Ogemaw loamy sand	20. 0	30	4 0	6 5	20 0	30	15	20	11 0	15. 0	9 0	14 0	3 5	6 0	100	150	1 2	2 0	1. 0	1 3	9	1 2	8	1. 2	1 9	1 4	3 0
Ogemaw-Selkirk complex	30 0	45	6 0	8 0	30 0	35	25	35	15 0	20 0	15 0	20 0	6 5	9 5	130	160	1 4	2. 2	1 3	2 2	1 2	2 0	1. 0	1 8	1. 3	.9	2 5
Oshtemo loamy sand	20 0	25	4 0	6 0	20 0	25	15	20	12 5	15 0	9 0	14 0	----	----	80	140	1 4	2 0	.8	1. 2	9	1 2	8	1. 1	2 2	1 5	3. 0
Rubicon sand	10 0	15	3 0	3 5	----	----	----	----	----	----	----	----	----	----	50	80	----	----	----	----	----	----	4	7	----	----	5 0
Saugatuck sand	12 5	20	3 0	4 0	10 0	15	----	----	----	----	----	----	----	----	60	90	----	----	4	.8	6	.8	6	8	3 0	2 2	5 0
Saugatuck-Newton sands	15 0	20	3 5	4 5	12 5	15	----	----	----	----	7 5	10 0	----	----	70	100	----	1 4	5	.9	7	9	7	1. 0	3 0	2 0	4 0
Selkirk silt loam	35 0	45	6 5	9 0	35 0	45	30	40	20 0	25 0	15 0	21 0	8 0	10 0	----	----	2 0	2 8	1 4	2 3	1 4	2 3	----	----	1 0	.8	1. 5
Sloping phase [3]	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1 2	1 0	1 6	8	1 4	8	1 0	1. 9	1 3	4 0
Toledo silty clay loam	40 0	50	7 0	9 5	10 0	45	35	45	20 0	25 0	17 5	21 0	9. 5	13 0	----	----	1 4	2 2	1 4	2 6	1 3	2 1	----	----	1 2	.9	2 2
Tuscola silt loam	35 0	45	6. 5	9 0	35 0	45	30	40	20 0	25 0	17 5	22 5	7. 0	10 0	----	----	2 0	2 6	1 4	2. 4	1 3	2 1	----	----	1 1	9	2 0
Weare sand	7 5	10	1 8	3 0	----	----	----	----	----	----	----	----	----	----	40	60	----	----	----	----	----	----	.3	.6	----	----	6. 5

[1] Acres per cow for 6-months grazing season

[2] Similar to Munuscong loamy sand; frost danger is almost prohibitive of common crops.

[3] No crops.

[4] No crops; some wild berries.

[5] Of little agricultural value.

TABLE 9.—*Productivity ratings of soils in Midland County, Mich.*

[In columns A the indexes refer to yields obtained under the common management practices and include the use of some commercial fertilizer and lime; in columns B, to the higher yields obtained under the generally better practices that include the greater use of legumes, green and barnyard manures, commercial fertilizers, and improved plant varieties, absence of an index indicates that the crop is not commonly grown]

Soil type [1]	Crop productivity index [2] for—																									
	Corn [3]				Oats (100=50 bu.)		Barley (100=40 bu.)		Wheat (100=25 bu.)		Beans (100=25 bu.)		Beets (100=12 tons)		Potatoes (100=200 bu.)		Alfalfa (100=4 tons)		Red or sweet-clover (100=2 tons)		Clover and timothy (100=2 tons)		Timothy and quack-grass (100=2 tons)		Pasture [4] [5] (100=1 acre per cow per 6 months)		
	Grain (100=50 bu.)		Silage (100=12 tons)																						Rotation		Permanent
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
Brookston loam	80	100	60	80	85	100	90	110	80	110	70	90	70	95	----	----	40	55	75	120	70	110	----	----	100	125	50
Bergland loam	75	100	60	80	85	100	90	110	80	110	70	90	70	95	----	----	40	55	75	120	75	110	----	----	100	125	50
Brookston silty clay loam	80	100	60	85	85	100	85	110	75	105	70	90	75	105	----	----	35	55	70	115	65	105	----	----	100	125	50
Bergland silty clay loam	75	100	65	85	85	100	85	110	75	105	70	90	80	110	----	----	30	50	70	115	70	105	----	----	100	120	50
Toledo silty clay loam	80	100	60	80	80	95	85	110	75	100	70	85	80	110	----	----	35	55	70	115	65	105	----	----	85	110	45
Kawkawlin loam	70	95	55	75	80	95	80	100	80	110	70	90	65	90	----	----	50	65	70	120	65	105	----	----	100	135	50
Selkirk silt loam	70	95	55	75	75	90	75	100	80	115	65	85	65	85	----	----	50	70	70	115	70	115	----	----	100	125	65
Tuscola silt loam	70	95	55	75	75	90	75	100	75	110	70	90	60	85	----	----	50	65	70	115	65	105	----	----	90	115	50
Colwood very fine sandy loam	70	90	55	70	75	90	70	95	70	100	75	95	65	90	----	----	45	65	70	115	65	105	----	----	85	105	50
Genesee silt loam	75	100	60	80	60	80	65	90	70	90	70	85	65	90	----	----	45	65	80	125	75	110	----	----	100	130	65
Ogemaw-Selkirk complex	65	90	50	70	60	75	60	85	65	85	65	80	55	80	65	80	35	55	65	110	60	100	50	90	75	110	40
Griffin loam	65	80	50	65	55	65	55	70	55	70	65	80	60	85	----	----	35	50	60	105	70	110	----	----	85	110	65
Kawkawlin sandy loam	55	80	40	60	60	75	65	85	65	85	60	75	50	75	60	80	40	60	55	100	60	95	50	90	85	110	50
Macomb sandy loam	60	85	45	65	65	80	60	80	65	80	65	80	55	75	60	80	35	55	60	90	60	85	----	----	75	95	50
Munuscong sandy loam	60	85	45	65	60	80	60	80	55	80	60	75	50	70	75	95	35	50	55	80	55	85	50	90	75	95	50
Ogemaw sandy loam	50	75	45	65	55	75	55	75	50	75	50	65	45	65	65	90	30	50	55	80	50	80	40	80	70	90	40
Colwood fine sandy loam	55	70	40	60	55	70	50	65	50	70	45	60	50	65	60	80	35	50	55	80	55	75	45	70	70	85	40
Genesee sandy loam	60	75	45	65	55	70	50	65	55	75	40	60	40	60	60	75	30	45	50	75	50	70	45	75	65	80	40
Munuscong loamy sand	45	70	35	55	45	65	45	60	40	60	40	60	35	55	55	85	25	45	55	70	50	65	40	65	55	75	35
Griffin sandy loam	50	70	40	55	60	40	60	35	50	45	60	40	55	50	80	20	40	55	70	55	75	45	70	55	75	40	
Granby sandy loam	45	70	40	55	45	65	45	60	45	65	40	65	30	45	50	80	35	50	55	70	55	75	45	65	65	90	40
Ogemaw loamy sand	45	65	35	55	45	65	40	55	45	65	35	55	30	50	50	75	30	50	50	65	45	60	40	60	55	70	35
Arenac sandy loam	40	60	35	55	40	60	40	55	50	75	40	60	25	50	50	70	40	60	45	60	50	65	45	60	50	70	35
Oshtemo loamy sand	40	55	35	50	40	55	40	55	50	65	35	55	----	----	40	70	35	50	40	60	45	60	40	55	45	65	35
Selkirk silt loam, sloping phase [6]	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	30	50	80	40	70	40	70	50	75	25
Carlisle muck [7] (none farmed)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	45	65	50	70	45	60	50	70	40
Burned phase [7]	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	40	60	45	65	40	55	50	70	35

Granby loamy sand	40	55	35	55	30	45	35	50	40	55	35	55	----	----	40	60	30	45	50	70	40	55	40	60	50	70	35
Newton loamy sand	35	50	35	45	25	40	----	----	----	----	30	45	----	----	35	60	----	40	30	50	40	50	40	55	45	65	35
Arenac loamy sand	25	35	25	35	25	40	----	----	----	----	25	40	----	----	35	55	----	35	30	45	35	50	35	50	40	55	25
Saugatuck-Newton sands	30	45	30	40	25	35	----	----	----	----	30	40	----	----	35	50	----	35	25	45	35	45	35	50	35	50	25
Saugatuck sand	25	40	25	35	20	30	----	----	----	----	----	----	----	----	30	45	----	----	20	40	30	40	30	40	35	45	20
Kerston muck [8]	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	35
Muck and peat [9]	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	35
Rubicon sand	20	30	20	30	----	----	----	----	----	----	----	----	----	----	25	40	----	----	----	----	----	----	20	35	----	----	20
Weare sand	15	25	15	25	----	----	----	----	----	----	----	----	----	----	20	30	----	----	----	----	----	----	15	30	----	----	15

[1] The soils are listed in the approximate order of their general productivity under the common practices that include adequate artificial drainage, the most productive first

[2] The soils of Midland County are given indexes that indicate the estimated production of each crop in percentage of the standard of reference

[3] Practically all corn is cut as fodder, two-thirds is shredded or shucked for grain, one-third is for silage.

[4] Rotation pasture is drained, permanent pasture is usually influenced by ditches of adjacent cropland, but large isolated areas are often too wet for good pasture

[5] Permanent pasture is given a common management rating only, since very few farmers practice good management of permanent pasture, a few farmers, however, use barnyard manure

[6] Little agricultural value

[7] Similar to Munuscong loamy sand Frost danger is almost prohibitive of common crops.

[8] No crops, drainage impractical, frost danger prohibitive of common crops

[9] No crops, some wild berries.

The physical and mineralogical composition of the parent soil material varies widely over this county. The entire area was covered by glacial till, but much of this was subsequently reworked in glacial lakes and the original deposits assorted and leveled by the action of water and, later, by wind. Rivers flowing into the lakes contributed material washed from other areas. This alluvial material was assorted more or less thoroughly and the coarser part deposited in large, nearly level deltas near the mouths of the rivers. Thus the material varies from unassorted glacial till through gravelly and sandy delta alluvium to beds of lacustrine silt and clay. In many places there is a deposit of sand, 1 to 10 feet thick, over lacustrine clay or fine-textured glacial till.

As the climate is relatively uniform over the county, soil differences resulting from variations in temperature and rainfall are not noticeable. Slope and exposure play minor roles in soil development in this county, as the land surface is nearly flat. Local variations in elevation of as much as 10 feet in 100 feet linear distance are rare and occur only on stream valley bluffs and on the narrow sand ridges formed by wind or accumulated on the beaches of glacial lakes. The principal effects of slope and differences in elevation are reflected in soil drainage. In a nearly level area such as this, particularly one having fine-textured strata, it is to be expected that practically all the soils are poorly or imperfectly drained. In fact, practically all of the area, except the deep sandy soils, was originally wet or swampy.

Populations of plants and animals varied somewhat in this area but were largely correlated with differences in drainage and in texture of the parent material. Deciduous trees and shrubs grew where the soils were fine-textured and considerably moist, but pines occupied the dry sandy sites.

The effect of age of the land surface is difficult to evaluate, as there is little or no difference in geologic age of the various parts of the county. That this region is very young is indicated by the fact that stream valleys are narrow, widely spaced, and sharply trenched, and the interstream areas nearly flat.

Soils developed where the dynamic factors of soil development, climate, and living organisms reach their full expression uninhibited by insufficient time or by extreme texture or drainage are known as zonal soils. Where some local factors, as drainage or nature of parent material, determine the development of soil characteristics, the soils are known as intrazonal soils. Where such factors as extreme youth of the parent material or kind of parent material or relief have prevented the development of regional profile characteristics, the soils are known as azonal soils. These three broad groups, or orders, into which soils are classified are divided into subgroups, or great soil groups, on the basis of additional common characteristics, these into soil series, and the series in turn into types and phases. This general scheme of soil classification, based on the categorical grouping of the soils of Midland County, is given in table 10.

TABLE 10.—*Classification of the soils of Midland County, Mich.*

Great soil groups	Series	Soil type or phase
ZONAL SOILS		
Podzol soils	Rubicon	Rubicon sand.
	Weare	Weare sand
Gray-Brown Podzolic soils	Tuscola	Tuscola silt loam.
	Oshtemo	Oshtemo loamy sand
INTRAZONAL SOILS		
Planosols	Kawkawlin	Kawkawlin loam
		Kawkawlin sandy loam.
	Selkirk	Selkirk silt loam.
		Selkirk silt loam, sloping phase.
Ground-Water Podzol soils	Ogemaw	Ogemaw sandy loam.
		Ogemaw loamy sand
	Macomb	Macomb sandy loam.
	Arenac	Arenac sandy loam.
		Arenac loamy sand.
	Saugatuck	Saugatuck sand
Half Bog soils	Brookston	Brookston loam.
		Brookston silty clay loam.
	Bergland	Bergland loam
		Bergland silty clay loam.
	Toledo	Toledo silty clay loam.
	Munuscong	Munuscong sandy loam.
		Munuscong loamy sand.
	Colwood	Colwood very fine sandy loam.
		Colwood fine sandy loam.
	Granby	Granby sandy loam.
		Granby loamy sand.
	Newton	Newton loamy sand
Bog soils	Carlisle	Carlisle muck
		Carlisle muck, burned phase
	Kerston	Kerston muck.
AZONAL SOILS		
Alluvial soils	Genesee	Genesee sandy loam
		Genesee silt loam
	Griffin	Griffin sandy loam
		Griffin loam

Representatives of two zonal great soil groups—Podzol and Gray-Brown Podzolic—have developed in this county. Their differences are due to conditions of parent material and vegetation. The podzolization process, a soil-forming process dominated by solution and leaching of bases, is dominant in both groups but is more strongly expressed in the Podzol soils. Podzol soils normally develop in cold humid regions where conditions favor the accumulation of acid organic matter on the surface of well-drained soils. In midlatitudes, as in Midland County, they develop only in sands. Sands are more thoroughly leached by a given amount of water, because the sand particles present a smaller surface area for a given volume of soil than do finer textured materials. In this county they occur only on sandy soils where the original vegetation was principally pine. A striking characteristic of soils in this great soil group is that the contact between the several horizons is sharp; there are no transitional horizons.

Rubicon and Weare sands are the only Podzol soils in this county. Rubicon sand occurs on level or nearly level sand plains or low knolls or ridges and consists of a layer of organic matter several inches thick (A_0); a thin layer, in most places less than 1 inch thick, of decom-

posed organic matter mixed with mineral soil (A_1); a 2- to 12-inch thoroughly leached light-gray or white layer (bleicherde) (A_2); a 4- to 12-inch brown or dark-brown layer (orterde or if cemented into a rocklike mass, ortstein) (B_2); a layer of yellowish-brown to brownish-yellow sand (B_3) that grades into the grayish-yellow sand substratum at a depth of about 3 feet. Weare sand occurs on low ridges and resembles Rubicon sand, but the profile, particularly the B_2 horizon, is not so strongly developed.

The Gray-Brown Podzolic soils include the Tuscola and Oshtemo series. These soils are developed in well-drained situations where moisture relations and nutrient content were favorable for the growth of hardwood trees, the leaves of which are less acid and more palatable than those of pines to soil fauna. The Tuscola soil is developed on interbedded very fine sand, silt, and clay and the Oshtemo in sandy outwash deposits.

The intrazonal great soil groups represented in this county are the Planosols, Ground-Water Podzol soils, Half Bog soils, and Bog soils. Intrazonal soils have developed definite profile characteristics, but development of zonal characteristics has been impeded or prevented by local factors of parent material, relief, or age. Here the fine texture of much of the parent material and the nearly level relief of most of the area have resulted in the development of poorly drained soils. In fact, 25 of the 38 mapping units, or about 87 percent of the total area, consists of intrazonal soils.

Planosols are slowly to poorly drained soils developed on nearly level, but usually slightly convex, situations where normal geologic erosion has not removed the products of soil development fast enough to prevent the formation of impervious layers. They have eluviated surface horizons and more strongly illuviated subsoil horizons than the associated zonal soils. In this county sufficient time apparently has not elapsed since the glacial period for definite Planosols to develop, but the light-colored imperfectly to poorly drained soils have been included in this group because they more closely resemble Planosols than members of other great soil groups. Included in this group of potential Planosols are the Kawkawlin and Selkirk soil series.

Kawkawlin loam, representative of the group, developed on nearly level deposits of pinkish-reddish-gray calcareous sandy glacial till. The original vegetation consisted largely of white pine, ash, red maple, beech, hickory, and elm trees. In virgin areas a 1- or 2-inch layer of organic matter is on the 3-inch dark-gray friable loam surface mineral soil. The reaction is slightly acid to neutral. The subsurface soil is gray or mottled gray and rust-brown sandy loam about 4 inches thick. It is neutral in reaction. The subsoil is mottled grayish-brown, gray, and brownish-yellow sandy clay or clay loam about 12 inches thick. It is neutral to alkaline in reaction. The substratum is pinkish- or reddish-gray, mottled with gray and yellowish brown, calcareous sandy glacial till. Selkirk soils are similar to the Kawkawlin, but the parent material is pink lacustrine clay, although in places pinkish colored glacial till, reworked in a glacial lake, forms the parent material.

Ground-Water Podzol soils are developed in sandy material where the water table is near the surface for long periods. The profile is

nearly similar to that of Podzol soils, but the B horizon, in most places an ortstein, forms in material that is wet during much of each year and the deeper subsoil and substratum are mottled. This great soil group is represented in this county by the Ogemaw, Macomb, Arenac, and Saugatuck series.

Ogemaw sandy loam, representative of the group, consists of a 6-inch layer of organic matter (A_0) on a 4- to 8-inch very light-gray to white layer of loamy sand (A_2). Both these layers are strongly acid in reaction. The subsoil is a dark-brown sandy loam that in most places is cemented into a rocklike mass (B_2, or ortstein), 6 to 12 inches thick. It is strongly acid in reaction. The deeper subsoil ($B_{2\,1}$) is mottled brownish-yellow, grayish-yellow, and yellowish-brown sand or loamy sand, 6 to 18 inches thick. The substratum is gray or pinkish-gray calcareous clay, a geologic stratum.

Macomb soil developed where a thin layer of sandy material was deposited on glacial till or where waves rather thoroughly reworked the upper part of this till and removed much of its fine material. Surface layers are sandy loam; yellow sandy clay lies between the sandy layers and heavy substratum. This soil is not a well-defined Ground-Water Podzol but more nearly an intermediate between that group and the Half Bog soils.

Arenac soils are transitional between Podzol and Ground-Water Podzol soils. They are somewhat better drained than Ogemaw soils, the mottling is less intense and occurs at a depth of about 2 feet, and the clay substratum usually lies at a depth of 3 feet or more. The Saugatuck soil is similar to the Ogemaw soils, except that the substratum is acid sand.

The Half Bog soils in this county are classified in the Brookston, Bergland, Toledo, Munuscong, Colwood, Granby, and Newton series. They are developed under forest cover in depressions or broad, nearly level areas where the water table lies at or near the surface and are characterized by dark-colored surface soils and gray subsoils. In most places a thin layer of peat or muck is on the mineral soil, and in extreme cases this organic layer is as much as a foot thick and rests directly on gray mineral soil.

Brookston silty clay loam is representative of the group. In virgin areas a 3- to 5-inch layer of black or very dark-brown organic matter is on the 8-inch dark-gray silty clay loam mineral surface soil. The reaction is neutral. The subsoil is gray, mottled with yellowish brown, silty clay loam, 10 to 15 inches thick. The substratum is gray or mottled gray and grayish-yellow calcareous silty clay loam glacial till.

Bergland soils are similar to the Brookston, except that in most places the organic layer rests directly on the gray subsoil and the substratum is reddish-gray or pink calcareous glacial till. The Toledo soil is developed on lacustrine clay. Munuscong soils occur in poorly drained positions where a deposit of sand 1 to 3 feet thick rests on clay. Colwood soils are developed in interbedded sands, silts, and clays; Granby soils in neutral sands or sandy loams; and the Newton soil in acid sands.

Bog soils include Carlisle and Kerston mucks and also many areas of organic soils not classified but shown as peat and muck on the soil map. They develop in the low, very wet areas and consist of partly decayed remains of former vegetation. Most areas in this county are

shallow—1 to 3 feet thick—whereas in some parts of Michigan the accumulation of organic matter is 20 feet or more thick; also, many areas have burned so that little remains except a thin layer of ash and whatever organic matter that was very wet at the time of burning.

Typical Carlisle muck is black or dark brown at the surface, highly decomposed, and granular or loamy. It is a so-called high-lime muck and is nearly neutral or alkaline in reaction. The subsoil of the thicker deposits is brown muck or peat, which is nearly neutral to slightly acid in reaction. Kerston muck occurs in wet stream bottoms and consists of layers of muck and mineral alluvium.

Azonal soils have no definite genetic horizons and occur (1) where the parent material has accumulated recently, as in stream bottoms; (2) where it is composed of relatively inert material, as silica sand or very hard rock; and (3) where the products of soil development are removed by erosion as fast as they are formed. In this county only one azonal great soil group—Alluvial soils—is recognized. Alluvial soils occur in stream bottoms, and genetic horizons have not developed because new material is deposited on the surface during floods. Genessee and Griffin, the only Alluvial soils in this county, are neutral to mildly alkaline throughout the thickness of the alluvial deposits. Genesee soils are well drained and have brown surface soils and light-brown subsoils, whereas the Griffin are poorly drained and have dark grayish-brown surface soils and mottled brownish-gray and rust-brown subsoils.

The mechanical analyses of samples of four soils from this county are given in table 11.

TABLE 11.—*Mechanical analyses of samples of four soils from Midland County, Mich.*

Soil type and sample No	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Colwood very fine sandy loam								
305812	0-4	0 5	0 8	0 9	18 4	34 2	32 0	13 2
305813	4-6	0	2	5	14 0	41 1	30 4	13 8
305814	6-16	0	2	5	15 9	44 0	28 8	10 6
305815	16-30	0	3	6	18 0	46 4	25 1	9 6
305816	30+	0	1	2	8	1 6	63 0	34 3
Macomb sandy loam								
305838	0-4	1 5	9 7	16 8	27 9	12 8	21 1	10 2
305839	4-13	2 2	10 1	7 8	39 7	14 2	16 5	9 5
305840	13-22	1 6	9 0	14 8	21 6	9 0	24 6	19 4
305841	22-30	3 2	6 8	12 6	27 1	11 7	26 6	12 0
305842	30+	1 6	4 8	9 4	21 0	10 3	28 8	24 1
Brookston loam								
305843	0-6	8	4 2	10 4	23 9	11 0	28 6	21 1
305844	6-12	1 3	4 4	10 6	24 9	11 8	28 9	18 1
305845	12-24	1 0	4 1	10 5	24 8	11 8	28 3	19 5
305846	24-36	1 2	4 6	18 7	24 0	8 6	23 9	19 0
305847	36-40	1 2	4 1	8 5	18 2	10 5	35 1	22 4
305848	40+	3 1	8 5	13 7	28 9	12 9	25 5	7 4
Selkirk silt loam								
305854	0-2	2	7	2 7	4 1	2 7	73 6	16 0
305855	2-3½	0	8	3 8	5 5	2 6	75 7	11 6
305856	3½-6	1	8	3 3	5 3	2 4	74 7	13 4
305857	6-7	0	9	3 5	5 5	3 6	73 5	13 0
305858	7-9	0	7	2 9	4 4	3 1	63 2	25 7
305859	9-15	0	4	1 8	3 2	2 1	52 8	39 7
305860	15-20	0	2	6	1 0	5	75 0	22 7
305861	20-36	0	2	5	8	3	74 8	23 4

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Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the

Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by:

(1) mail: U.S. Department of Agriculture
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

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