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Soil Survey

of

MARQUETTE COUNTY
WISCONSIN

The University of Wisconsin
Wisconsin Geological and Natural History Survey
Soil Survey Division

G. F. HANSON,
Director and State Geologist

F. D. HOLE, in charge,
Soil Survey Division

In Cooperation with
The Soils Department, College of Agriculture
and
The Soil Conservation Service, U.S.D.A.

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Figure 1. Index map showing location of Marquette County, Wisconsin.

THE UNIVERSITY OF WISCONSIN
WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY
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by
THEODORE R. PECK and GERHARD B. LEE
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PREFACE

In 1957 and 1958, the Soil Survey Division of the Wisconsin Geological and Natural History Survey, in cooperation with the United States Department of Agriculture Soil Conservation Service, carried out soil survey operations in Marquette County. Both county-wide reconnaissance and local detailed studies were made. Particular attention was given to problems of soil classification and the mapping of major soil associations. This work was carried out in conjunction with research on the nature and distribution of soil parent materials in the county.

As a result of this survey, a colored soil map and this report have been prepared. The cartographic units shown on the map consist of soil associations, and in some cases, geographically related groups of soil associations. The report describes the major soils and discusses the nature and composition of the various cartographic units. Brief discussions of other natural and cultural features of the county, and of man's use of the soil, are also included.

Those who are interested in obtaining detailed information about a particular tract of land, or in obtaining a detailed soil map of a particular farm, should consult the county agent or representatives of the U.S.D.A. Soil Conservation Service in Montello.

Figure 2. This monument on the shores of Ennis Lake commemorates the memory of John Muir, who grew to manhood on a pioneer farm in Marquette County.

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by Theodore R. Peck and Gerhard B. Lee
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GENERAL NATURE OF MARQUETTE COUNTY

LOCATION AND SIZE

Marquette County is located in the southeastern portion of the central Wisconsin plain, in the Upper Fox River Valley. The county is bounded on the south by Columbia County, on the west by Adams County, on the north by Waushara County, and on the east by Green Lake County. Its land area is 291,244 acres, ranking it sixty-first in land area among the seventy-one Wisconsin counties. Five thousand six hundred and forty-one acres of lakes and streams increase the total area to 296,885 acres.

PHYSIOGRAPHY AND RELIEF

Elevations range generally from 770 to 860 feet above sea level (Packwaukee, 771; Montello, 772; Endeavor, 781; Neshkoro, 803; Oxford, 855; Westfield, 856 feet). Observatory Hill (1,100 feet) and Glovers Bluff (1,160 feet) are high points in the county. Topographically the county may be described as rolling to undulating with included plains and basins. The southeastern and south central area is characterized by long drumlin-like ridges oriented in an east-west direction. Projecting above this area is Observatory Hill, a monadnock of igneous rock. The northeastern, north central, and central areas have isolated high hills surrounded by gently undulating terraces intermixed with low wet lands. The northwestern part of the county is characterized by irregular morainal ridges and hills, and high pitted outwash terraces. The most prominent feature of this landscape are several high limestone hills the most conspicuous of which is Glovers Bluff. The west central and southwestern areas consist of low terraces, level basins and hilly morainal ridges.

DRAINAGE

Drainage is accomplished by numerous small tributary streams, draining into the Fox River which eventually flows into Green Bay and Lake Michigan. Shallow lakes are formed by dams on several rivers and streams (Buffalo Lake, dam on the Fox River at Montello; Montello Lake, dam on the Montello River at Montello; Mason Lake, dam at Briggsville; Neshkoro Mill Pond, dam on the White River at Neshkoro; Harris Pond, dam on the Westfield Creek at Harrisville; Westfield Pond, dam on the Westfield Creek at Westfield; Lawrence Pond, dam on the Lawrence Creek at Lawrence; Oxford Mill Pond, dam on Neenah Creek at Oxford). Other small lakes occur in natural depressions which are characteristic remnants of glaciation.

CLIMATE

Warm, humid summers and cold, snowy winters are characteristic of the area. Both summers and winters are slightly warmer than the state average. The average annual precipitation is 31 inches. Distribution follows the seasonal pattern of the state. Most of it falls during the growing season; 60% in the five months, May to September. During the winter there is an average of 38 inches of snow.

The average growing season in Marquette County is between 140–150 days in length. Early May and late September are the average expected times for the last killing spring frost and first killing frost in the fall.

Figure 3. Prairie grasses growing on sandy soils in northern Marquette County. Jack pine and scrub oak can be seen in the background.

VEGETATION

Present day native vegetation is little changed from the natural vegetation at the time of the original land survey (Circa 1840). Soil and climate in Marquette County have largely prevented plant succession from reaching a forest climax. Immediately after glaciation boreal forest probably occupied the area but disappeared as the climate grew warmer and drier. Since then short-term climatic fluctuations together with soils of low water holding capacity have caused much of the native vegetation to be in a continual flux between prairie and forest communities. In the southern part of the county dark colored prairie soils are often found on south slopes and light colored forest soils on north slopes of the same hill.

Present-day vegetation on uncultivated sandy soils consists largely of scrub oak and jack pine with many prairie grasses and forbs (See Figure 3). Black and hybrid oaks, and prairie plants, are found on loamy soils. Soils underlain by calcareous silts and clays support hardwoods such as white oak and hickory (See Figure 4). Sedges, grasses, and reeds grow in marshes. Tamarack is the most common swamp tree, while sphagnum and heath plants are found in bogs.

Figure 4. Hardwoods (mainly white oak and hickory) growing on Briggsville soils in western Marquette County.

GEOLOGY

The bedrock consists predominantly of Cambrian sandstones of the Dresbach formation (upper Cambrian system) as indicated by the bedrock map (Figure 5). These sandstones are composed of weakly cemented grains of silicious sand, with local layers of shale and limestone. Formations are generally soft, easily eroded and display a variety of colors. They are believed to be the major source of sand in the glacial deposits of Marquette County. Sandstone outcrops noted during the survey are at Sections 29, 32 and 36, T14N., R10E., Sec. 30, T15N., R9E., Sec. 5, T16N., R10E., Sec. 12, T17N., R8E., and Sec. 31, T17N., R10E., (See Figure 6).

Pre-Cambrian crystalline rock outcrops at the following places: granite in Sec. 9, T15N., R10E.; rhyolite in Sec. 8, T14N., R10E., Sec. 17, T14N., R10E., and Sections 5 and 8, T14N., R9E. Ordovician (Prairie du Chien)

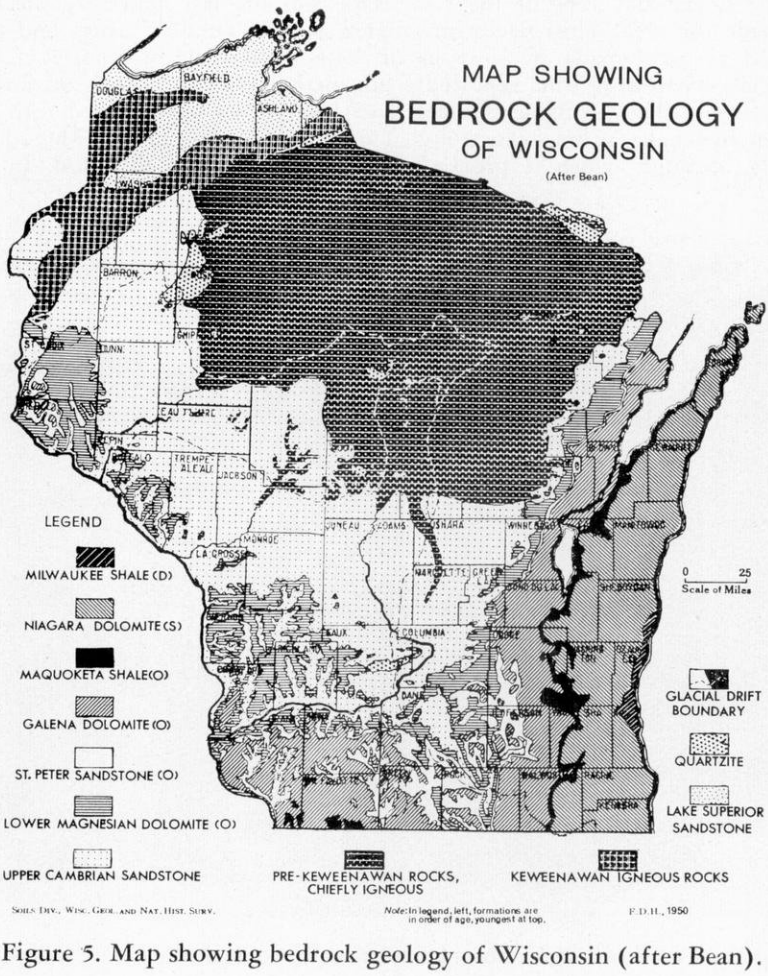

Figure 5. Map showing bedrock geology of Wisconsin (after Bean).

dolomite is found in Sections 7 and 3, T17N., R8E. The section in the vicinity of Glovers Bluff is described in Table 1. These crystalline and dolomite formations are of little importance so far as the soils of the county are concerned, but are of interest in a consideration of the geology of the area.

Geographically the western edge of the county nearly coincides with the westerly advance of Cary ice. Most of the bedrock in the county, therefore, with the exception of the outcrops previously noted, is buried under glacial drift (see Table 2). Consequently, while soil parent materials are primarily glacial sediments of local origin, their composition has also been influenced by drift from the bedrock formations to the north and east, the direction from which Cary ice entered the area. These are, from youngest to oldest, Niagara dolomite, Maquoketa shale, Galena–Platteville dolomite, St. Peter sandstone, Prairie du Chien ("Lower Magnesian") dolomite and crystalline rocks such as granite of Pre-Cambrian age.

The Green Bay lobe of the Cary stage was the last major ice sheet to override the area. This glacier originated at the Labrador center and proceeded across Canada by a series of lobes following previously eroded channels, coalescing and repeatedly advancing. One such lobe advancing down the Lake Michigan channel, had part of its ice diverted into the Green Bay–Lake Winnebago trough (previously eroded in soft Maquoketa shale), through which it proceeded in a southwesterly direction. In the

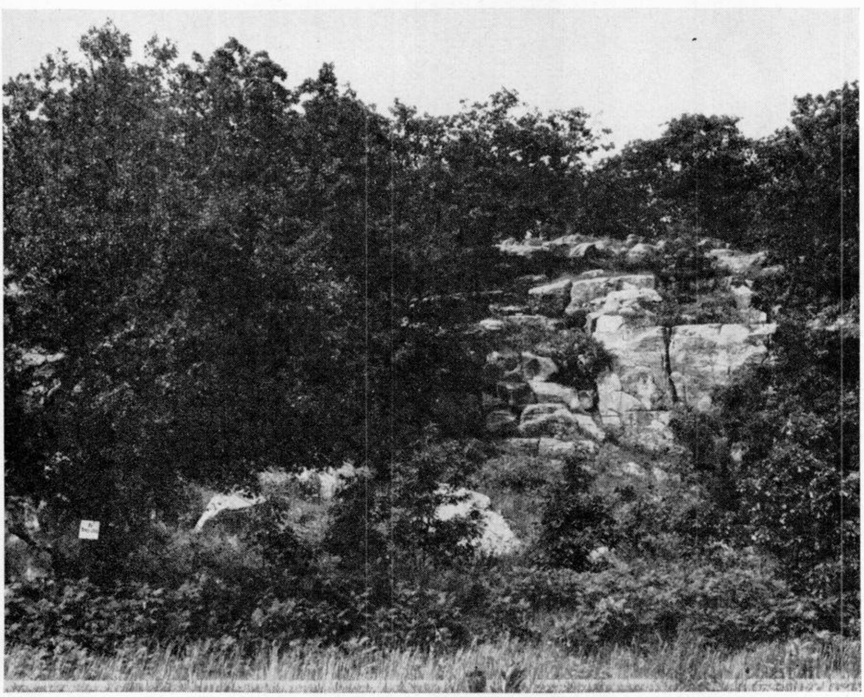

Figure 6. Outcrop of Cambrian sandstone in central Marquette County.

vicinity of Lake Winnebago it spread radially and thus crossed Marquette and adjacent counties in a west to southwesterly direction (Figure 7).

This ice sheet left in its wake a variety of land forms and several kinds of glacial deposits. Included in the latter are glacial till, glacio-fluvial deposits, glacio-lacustrine materials, and eolian sediments. Land forms include ground moraine, end or recessional moraines, drumlins, terraces, and kames. The many lakes and marshes of the county occupy lowlands which are also the result of glaciation.

TABLE 1. GEOLOGIC COLUMN IN THE VICINITY OF GLOVERS BLUFF, MARQUETTE COUNTY, WISCONSIN (SEC. 3, T17N., R8E)[1]

System	Group, Formation or Member	Character of Rock	Approximate Thickness Feet
Ordovician	Prairie du Chien ("Lower Magnesian")	Dolomite, gray, cherty	200
Cambrian	Trempealeau (Jordan)	Sandstone, white and yellow, medium to fine grained, top quartzitic	20
Cambrian	Trempealeau (St. Lawrence)	Dolomite, sandy yellowish gray, thin bedded	30
Cambrian	Franconia (Mazomanie)	Sandstone, fine grained, red, yellow, white, dolomitic, glauconitic	75
Cambrian	Franconia (Birkmose)	Sandstone, fine to very fine grained, green, red, gray, very glauconitic; gray, sandy, micaceous shale at base	25
Cambrian	Dresbach	Sandstone, medium grained, white, thick bedded, ripple marked, round headed trilobites at top	100
Cambrian	Dresbach	Sandstone, fine to medium grained, gray, thin bedded	200
Cambrian	Dresbach	Sandstone, coarse grained, light gray, heavily bedded, some shale beds	300
Pre-Cambrian		Igneous and metamorphic rocks	

[1] After Ekern and Thwaites, 1930. Terminology modified after Thomasson, 1959. (See Bibliography)

TABLE 2. THICKNESSES OF DRIFT PENETRATED DURING WELL DRILLING OPERATIONS IN MARQUETTE COUNTY[1]

Location	Thickness of Drift
Sec. 6, T14N., R9E. —Endeavor	80 feet to sandstone
Sec. 21, T14N., R8E. —Oxford, 1½ miles SE	190 feet to sandstone
Sec. 21, T15N., R8E. —Oxford, Creamery	230 feet to sandstone
Sec. 32, T15N., R9E. —Packwaukee	180 feet to "granite"
Sec. 8, T15N., R10E.—Montello, village well	150 feet to sandstone
Sec. 20, T15N., R10E.—Lake Puckaway, N. shore	330 feet—still in clay
Sec. 12, T16N., R8E. —Westfield, Dairy Co-op	160 feet to sandstone
Sec. 15, T16N., R8E. —Westfield, 2 miles SW	360 feet to "granite"
Sec. 28, T17N., R10E.—Budsin shop	242 feet—still in drift

[1] From Alden and well records of the Wisconsin Geological and Natural History Survey.

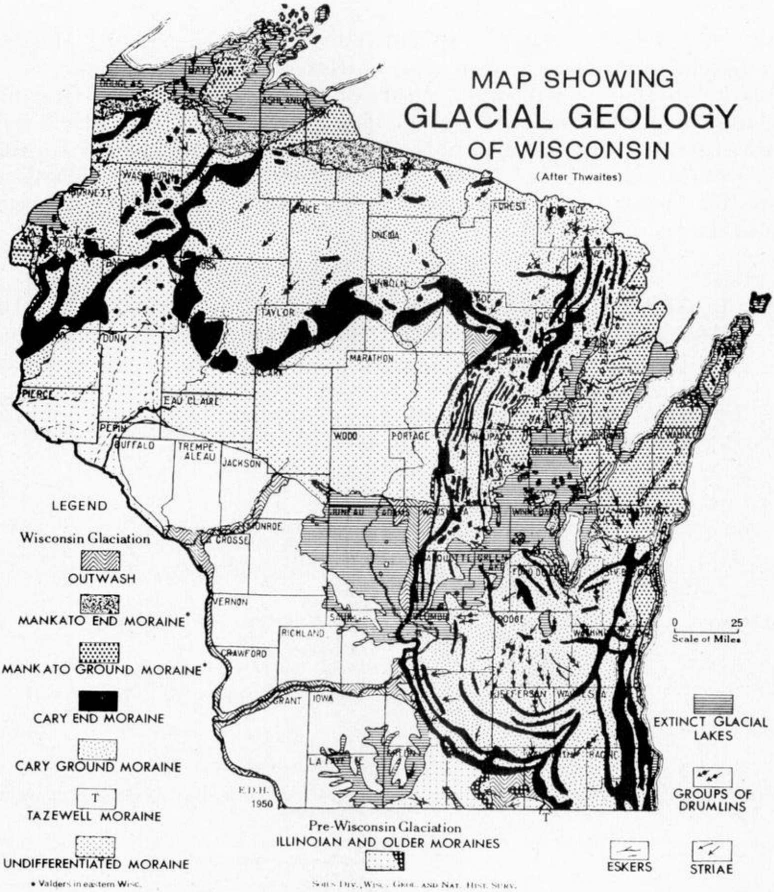

Figure 7. Map showing glacial geology of Wisconsin.

SOILS OF MARQUETTE COUNTY

FORMATION

Soils are formed by numerous processes which are related to five factors as follows:

1) Parent material—Rock or broken up rock (mineral soils), and organic deposits (peat and muck).

2) Relief—The position and slope on which parent material occurs in a landscape.

3) Climate—The general climate of the region and also local variations, as for example the microclimate on the north slope of a hill as compared with that on the south slope.

4) Biological factors—The influence of different kinds of vegetation and also the disturbing effect of animals.

5) Time—The period over which climatic and biological factors have been changing parent material into soil.

PARENT MATERIALS AND RELIEF

The most important factor affecting the characteristics of soils in Marquette County is kind of parent material. A study of soil parent materials in the county[1] has shown that a number of different kinds are present (see Appendix for Laboratory Analysis). Some of these (glacial tills) were deposited by glacial ice, some (glacio-fluvial sediments) consist of waterlaid deposits, and others (glacio-lacustrine sediments) are lake-laid deposits.

All of these may vary in texture and lithology and have been subdivided on that basis. Some of them, particularly the glacial tills, appear to be covered with surface layers of eolian origin.

Organic deposits have been the parent materials of peat and muck soils.

Glacial Till

Glacial till parent materials are found throughout the county. These were deposited by Cary ice. They are found for the most part on sloping to rolling high ground. Included materials vary from sand to loam in texture and contain variable amounts of gravel and coarse rock fragments. Much of the coarse fraction appears to be reworked glacial material, being well rounded. Glacial till is recognized by its wide range in composition and lack of stratification.

Calcareous light brown loamy till. This till is found in the southwestern and south central parts of the county. Surface deposits are confined to uplands where they form long drumlin-like hills with a general east-west orientation. The till is a light yellowish brown sandy loam containing about 18 to 20 percent of gravel. About 75 percent of this gravel is dolomite. Soil samples analyzed had an average calcium carbonate equivalent of 18 percent. The ratio of acid soluble calcium to magnesium is fairly constant at about 1.85. Available phosphorus by the Bray No. 1 test is low, about 5.3 ppm. This till can be recognized in the field by (a) its light brown (10YR 6/3–6/4) color; (b) its fine sandy loam texture; (c) effervescence with dilute acid; (d) lithology and amount of gravel; (e) lack of stratification; and (f) land form. Surface coverings of fine sandy loam or loamy fine sand, ranging in thickness from a few inches to several feet, are commonly present.

Calcareous reddish brown sandy till. Calcareous tills throughout the rest of the county have a definite pinkish or reddish hue. These occur on land forms similar to the loamy tills, however, these are distributed more sporadically and afford lower relief to the topography. This till is a light brown to light reddish brown loamy fine sand, containing about 14 percent gravel. About 73 percent of the gravel is dolomite. Samples analyzed had an average calcium carbonate equivalent of 14 percent. The carbonates in this till react very rapidly with dilute acid. The ratio of acid soluble calcium to magnesium is fairly constant at about 1.85. Available phosphorus by the Bray No. 1 test is low, averaging about 4.6 ppm. Field recognition of this till depends on (a) light reddish brown (7.5YR–5YR 6/4) color; (b) mainly loamy fine sand texture; (c) its violent reaction with dilute acid;

[1] See Bibliography, item 11.

(d) lithology and amount of gravel; (e) lack of stratification; and (f) land form. These materials are distinguished from the light brown tills by (a) redder hues; (b) somewhat sandier texture and lower gravel content; and (c) more rapid reaction with dilute acid. Surface coverings are usually present on this till also. These are usually of loamy fine sand texture and range from a few inches to several feet in thickness.

Acid or slightly calcareous brown sandy till. This kind of till is found mainly in the western one-third of the county, in the terminal moraine, and sporadically throughout the remainder of the county. It appears to be largely of local origin, from Cambrian sandstones, with some mixing of rock from foreign sources (erratics). These deposits are classified as tills because of their wide variation in particle size and composition, their lack of stratification, and their occurrence in irregularly shaped hilly land forms. Considerable variation in composition occurs because the relatively uniform and inert sandstone is greatly influenced by any addition of foreign material. In general the gravel content is low, averaging about 5 percent in the samples analyzed. Predominant rock types are various igneous erratics, chert and sandstone. The character of the gravel-free soil (particles less than 2mm in diameter) can be best described as exhibiting a variety of brown to reddish-brown colors, as being generally acid but locally neutral or even slightly calcareous, and in having a variable content of calcium, magnesium and phosphorus. Texturally, the materials are largely sand. This kind of till can be recognized in the field by (a) its sandy texture; (b) a generally acid reaction; (c) low gravel content and lack of dolomite in the gravel; (d) lack of stratification; and (e) occurrence on irregularily shaped hilly land forms.

Sandy glacial drift. This type of parent material consists mainly of sands or sandy loams but includes lenses of loam to clay. It is calcareous with depth and often includes calcareous gravels. Geographically this type of parent material is found mainly in the western one-third of the county, usually in association with the end and recessional moraines of the area. Packwaukee soils are formed from this type of drift.

Glacio-Fluvial Deposits

Glacio-fluvial deposits are the most common soil parent materials in Marquette County. They are found throughout the county. In some areas they occur as broad outwash flats, but in other areas they are hilly. Often they are found as small local deposits intermingled with other types of parent materials. These deposits have been divided into two main groups namely: (1) the calcareous gravels and sands, and (2) the acid sands. The calcareous gravels and sands usually have acid surface layers ranging in texture from sandy loam to sand and being a few inches to several feet in thickness. The acid sands are often underlain by calcareous drift below five feet or more. Locally, calcareous strata may be found at shallower depths.

Calcareous gravel and sand. This type of parent material is most common in the southeastern and east-central parts of the county. However, it may also be found in other areas. Commonly 60 to 70 percent of this material is gravel (particles are larger than 2 mm in diameter) and the fine fraction is composed largely of sand. Dolomite makes up from 65 to 85 percent of the gravel. Chert, sandstone and crystalline pebbles are much less common. This type of parent material is characterized by (a) its light brown color, (b) coarse texture, (c) high content of dolomitic gravel, (d) stratification, and (e) its occurrence on level terraces or on complex hilly land forms.

Acid sands. Acid sands are found throughout the county. However, largest areas are in the north-central and northeastern parts. Deposits vary slightly in texture and lithology. In some places sandy loam layers occur, or gravelly strata are found. In other areas the sands may be neutral or calcareous in reaction. Most deposits, however, consist of light brown fine to medium sands that are acid (about pH 5.8) to depths of 5 feet or more. These sands are very low in calcium and magnesium and show no consistent ratio of these basic cations. Phosphorus determined by acid extraction is low and variable. This type of parent material may be recognized by (a) its light brown color, (b) sandy texture, (c) generally acid reaction and (d) occurrence on broad flats, as valley fill, or on hilly and complex, morainic topography.

Glacio-Lacustrine Sediments

Glacio-lacustrine sediments are found mainly on flats and in basin areas. However, they also occur on terrace remnants found on end moraines in the western part of the county. They have been divided into two main groups; namely (1) the calcareous reddish-brown silts and clays, and (2) the calcareous silts and fine sands. The first of these is found as a surface deposit mainly in the western one-third of the county, particularly just east of the recessional moraines. The second kind is apt to be found locally along former drainage ways. Fairly large deposits occur in the northeastern part of the county.

Calcareous reddish-brown silts and clays. Largest areas are found in the townships of Douglas, Harris, Oxford, Springfield and Newton. Sediments range in texture from silt to clay. However, surface layers of loam or fine sands are commonly present. These may range in depth up to five feet or more. Calcium carbonate equivalent averages about 25–30 percent. The available phosphorus content is low as determined by the Bray No. 1 test. The acid-soluble calcium-magnesium ratio is about 1.80. Deposits often show distinct laminations. They are gravel-free except for local pebbles and stones, probably deposited from ice rafts. Some deposits are very deep. Landowners report the thickness of "clay" in well borings to be 80 feet. "Lignite" (probably a buried peat layer), has been reported at the bottom of the "clay". The best agricultural soils in Marquette County are formed from these lacustrine parent materials. Recognition is based on (a) reddish-brown color, (b) silt loam to clay texture, (c) effervescence with dilute acid, (d) lack of gravel, (e) laminations, and (f) occurrence in basin-like areas although these sediments are also found on upland slopes.

Calcareous silts and fine sands. Largest areas are found in Neshkoro and Mecan townships. These sediments consist mainly of stratified fine sands and silts. However, silty clay loams and silty clays may also be included. In general, deposits are calcareous. They may be recognized by (a) silt loam and fine sand textures, (b) stratification, (c) effervescence with dilute acid, (d) lack of gravel and (e) occurrence on former stream terraces and in local basins.

Other Mineral Sediments

Eolian and colluvial loams. Locally, particularly in the southeastern part of the county, deposits of loams or fine sands are found which appear to be of eolian or colluvial origin. These are gravel-free sediments in upland, valley and footslope positions where they usually overlie glacial till. Combinations of silts and loams, or fine sands, occur in similar positions in the landscape. Such deposits are the parent materials of the Astico, Puchyan, and related soils.

Recent alluvium. Recent alluvium of variable texture and thickness is found sporadically along the various streams in the county. Also, there are local accumulations of recent slope wash, or colluvium, in some places. Neither of these deposits is believed to be extensive.

Organic Deposits

Three main kinds of vegetation have contributed to the peat in the county. These are (1) sedges, rushes, grasses, and associated water loving plants, (2) wood, mainly tamarack, and (3) mosses, mainly sphagnum, and other heath plants. The first of these is believed to be the main source of peat. Wood is mainly found in layers or as individual pieces in a matrix of herbaceous and grassy material. Moss is found locally, particularly in bogs formed in kettles. However, it is seldom over two feet deep and is usually underlain by sedge peat.

CLIMATE AND VEGETATION

During and immediately following glaciation the climate of Marquette County must have been much colder than at present. According to pollen studies, boreal forests, similar to those of colder regions today, invaded the region after glaciation. Some time later the climate became warmer and drier to a point that most of Marquette County was probably a prairie. Fires may have helped to perpetuate and extend it. Organic soil profiles usually show one or more buried mucky layers, some of which contain charcoal, indicative of periods during which water tables were low and oxidation and even actual burning of the peat occurred.

Following this dry period, the climate became quite similar to that of today. At present Marquette County appears to be in a tension zone between forest and prairie types of vegetation.

TIME

Soil parent materials are believed to have been mainly deposited by Cary ice or associated meltwaters. Some of these deposits had probably undergone previous weathering. However, the present soils must have been formed since the retreat of Cary ice.

There is some evidence that the Mecan soils are formed in till deposited over Cary outwash and may, therefore, be somewhat younger than some other till soils in the county.

Glacio-fluvial sediments are also believed to be of Cary Age. The reddish-brown glacio-lacustrine deposits appear to have been deposited in glacial Lake Oshkosh. Eolian sediments were probably deposited quite soon after the area was free of ice.

The very recent alluvial and colluvial sediments found in the county have been deposited since settlement. These very young soils do not show horizonation or other characteristics of advanced soil development.

GENETIC KEYS

In Tables 3 and 4, the soils of Marquette County are grouped into genetic keys. Such a classification brings out the relationship of soils to some of the soil-forming factors.

TABLE 3. GENETIC KEY TO MAJOR MINERAL SOILS IN MARQUETTE COUNTY

SOIL PARENT MATERIAL	NATIVE VEGETATION (Zonal Soils)	SOILS —AZONAL—	ZONAL				— INTRAZONAL —	
		NATURAL SOIL DRAINAGE						
		Excessive	Somewhat Excessive	Well	Moderately Well	Imperfect	Poor	Very Poor
1. Loamy or sandy glacial till.								
1.1 Calcareous light brown sandy loams and loamy sands with loamy or sandy coverings of variable thickness.	Black and Hybrid Oaks	Hennepin		Lapeer				
	Oak Opening	Hennepin		*Pardeeville				
1.2 Calcareous reddish-brown loamy sands and sandy loams with loamy or sandy coverings of variable thickness.	Black and Hybrid Oaks	Hennepin		*Mecan				
1.3 Acid or weakly calcareous sandy glacial drift.	Black Oak, Scrub Oak and Oak Opening		*Wyocena					
1.4 Sandy glacial drift having included lenses of loam to clay.	Hardwoods (Oak types)		*Packwaukee					
2. Calcareous sand and gravel with loamy or sandy coverings.								
2.1 Shallow to moderately deep loamy or sandy coverings. Free carbonates within 42 inches.	Black and Hybrid Oaks	Rodman	Casco	Boyer Fox				
	Oak Opening		*Puckaway Lorenzo	Dresden				
2.2 Deep, mainly sandy coverings. Free carbonates usually between 42 and 60 inches.	Black and Hybrid Oaks		Oshtemo					
	Oak Opening							
3. Deep sands with local gravelly layers in some places. Mainly acid but usually underlain by calcareous drift at depth.								
3.1 Sands or sandy loams with gravelly (mainly acid) substrata.	Oak Opening, Black Oak and Jack Pine		*Pleasant Lake					

TABLE 3. GENETIC KEY TO MAJOR MINERAL SOILS IN MARQUETTE COUNTY—Continued

SOIL PARENT MATERIAL	NATIVE VEGETATION (Zonal Soils)	SOILS						
		—AZONAL—	ZONAL				— INTRAZONAL —	
		NATURAL SOIL DRAINAGE						
		Excessive	Somewhat Excessive	Well	Moderately Well	Imperfect	Poor	Very Poor
3.2 Sandy loams and loamy sands.	Scrub Oak or Oak Opening		Meridian					
3.3 Loamy sands.	Oak Opening or Scrub Oak	Gotham						
3.4 Sands and loamy sands.	Scrub Oak —Jack Pine Oak Opening	Plainfield Sparta			Nekoosa	Morocco		
3.5 Sands and loamy sands, neutral to weakly calcareous.							Granby Maumee	
4. Calcareous reddish-brown silts and clays with silt loam to fine sand coverings.								
4.1 Shallow (less than 12 inches) silt loam to loamy fine sand coverings.								
4.11 Over clays and silty clays.	Hardwoods Oak Openings			*Oshkosh *Winneconne			Poygan *Poy (Stratified substratum)	
4.12 Over silty clay loams and silt loams.	Hardwoods (Oak types) Oak Openings			*Briggsville *Dark colored variant				
4.2 Moderately deep (12 to 36 inches) fine sandy loam to fine sand coverings.	Hardwoods (Oak types) Oak Openings			*Tustin *Delton (acid C)	Seward	Rimer	Wauseon	
4.3 Deep (36 to 60 inches) fine sandy loam to fine sand coverings.	Hardwoods (Oak types) Oak Openings			Ottawa	Berrien	*Neshkoro		

TABLE 3. GENETIC KEY TO MAJOR MINERAL SOILS IN MARQUETTE COUNTY—Continued

SOIL PARENT MATERIAL	NATIVE VEGETATION (Zonal Soils)	SOILS —AZONAL—	ZONAL				— INTRAZONAL —	
		NATURAL SOIL DRAINAGE						
		Excessive	Somewhat Excessive	Well	Moderately Well	Imperfect	Poor	Very Poor
5. Calcareous stratified silts and fine sands.	Hardwoods (Oak types) Oak Openings			Tuscola		*Shiocton *Dark colored variant	*Keowns	
6. Other mineral soils.								
6.1 Sandy loams or loamy sands, shallow over sandstone bedrock.	Black and Hybrid Oaks Oak Opening	Boone	Lapeer (Shallow substratum variant) *Pardeeville (Shallow substratum variant)					
6.2 Eolian or colluvial loams on upland slopes.	Black and Hybrid Oaks Oak Opening		*Astico *Dark colored variant					
6.3 Loamy fine sands to fine sandy loams over silts at 18 to 36 inches.	Black and Hybrid Oaks Oak Opening			*Puchyan *Dark colored variant		*Lost Lake *Dark colored variant	*Fall River (Silts at 30–60″)	
6.4 Recent alluvium or colluvium.						Not classified		

* Refers to proposed or tentative soil series.

TABLE 4. GENETIC KEY TO ORGANIC SOILS OF THE MARQUETTE COUNTY AREA[1]

Character of Organic Material: Lower Story	Character of Organic Material: Surface Layer	Where Found	Thickness of Organic Material and Composition of Mineral Substratum: Deep (48″+)	Shallow to Moderately Deep (12–48″): Sands	Shallow to Moderately Deep (12–48″): Silts and Fine Sands	Shallow to Moderately Deep (12–48″): Loams	Shallow to Moderately Deep (12–48″): Clays	Shallow to Moderately Deep (12–48″): Marl
Disintegrated peat formed mainly from sedges, rushes, and grasses. Basal layers of sedimentary peat usually thin or absent. Profiles may include layers of fibrous peat, wood, or moss. Granular and blocky horizons are characteristic. pH ranges from 5.5 to 6.5.	Peat	Marshes and Swamps	*Horicon Peat	—— Peat	*Waubesa Peat	*Scuppernong Peat	—— Peat	—— Peat
	Muck		*Horicon Muck	—— Muck	*Waubesa Muck	*Scuppernong Muck	—— Muck	—— Muck
	Moss and Wood (<12″)	Swamps and Bogs	—— Peat					
Disintegrated or fibrous peat formed mainly from sedges, rushes, and grasses, but including layers of wood or moss. Sedimentary peat may or may not be present as a basal layer. Generally strongly acid (pH 5.5).	Moss (>12″) wood may be included	Bogs and Swamps	—— Peat					
Floating peat	Moss	Bogs	—— Peat					
	Sedges and Rushes	Lake or Stream Borders	—— Peat or Muck					

* Refers to proposed or tentative soil series.
—— Refers to unclassified organic soils.
[1] Not all of the soils shown may be found in Marquette County.

SOIL CLASSIFICATION AND MORPHOLOGY
INTRODUCTION

Individual soils can be thought of as being 3-dimensional. That is, they not only have depth but also occupy an area on the earth's surface. They may have rather abrupt lateral boundaries due to a change in parent material or drainage or, more commonly, grade into neighboring soils.

Each soil in this landscape mosaic has a characteristic profile or cross-section. Within the area occupied by a soil it's profile may vary within certain limits before another soil is recognized. Features such as number and arrangement of horizons or layers, the color, texture, structure, consistence, and acidity of each, are some of the most important morphological features of soil profiles. The process of grouping together soils with similar morphologies is called taxonomic soil classification. This is a grouping of individuals based on their characteristics.

SOIL CLASSIFICATION[1]

The basic unit in the taxonomic system of soil classification is the soil type. A soil type includes all the individual soils in existence which resemble each other closely enough to be thought of as one kind. The next higher category, the series, is made up of one or more types. It is composed of soils that are either alike in every respect as in the type, or differ only in texture of the A horizon. Soil names are composed of the series name followed by the textural class name of the type. Each series is named for the locality where it was first described.

Closely related soil series are sometimes grouped into families. More commonly, however, they are classified directly into great soil groups. All soils having the same kind and arrangement of horizons are included in the same great soil group. These soils may differ from one another in many important ways such as texture, mineralogy, or degree of development, but they all must have the same general kind of profile. Soils whose profiles are transitional in character between two or more great soil groups are often called intergrades.

A still higher category is the suborder. A suborder is composed of the soils in one or more great soil groups, whose profiles reflect the same major soil-forming process. For example, podzolized soils belonging to several great soil groups are all included in one suborder.

The highest category is the order. All of the soils in the world can be grouped into three orders—zonal, intrazonal, and azonal. Soils whose profiles reflect the dominating influence of climate and vegetation as soil-forming factors are classified as zonal soils. Intrazonal soils have important morphological features that are related to local genetic factors such as parent material, relief, and time. Azonal soils are usually young. They are soils without well-developed profiles.

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[1] The system of classification used in this report is that described in "Soils and Men," (USDA Yearbook of Agriculture, 1938) and later modified in "Soil Science," Volume 67, 1949.

Taxonomic classification is based on a knowledge of soil characteristics. Such knowledge can only be supplied by morphological descriptions of individual soil profiles. Soil profile descriptions also contain much of the basic information needed to make sensible decisions regarding the use and management of individual soils. They are therefore an important part of our permanent fund of soil knowledge.

In Table 5 the soils of Marquette County are classified into three categories of the taxonomic system, namely Order, Great Soil Group, and Series. In the Great Soil Group category the Zonal soils are classified as Gray-Brown Podzolics, Prairie (or Brunizem), and Prairie soils intergrading to Gray-Brown Podzolics (see Figure 8). Included with the latter are some soils which locally exhibit profiles closely resembling those of true Prairie soils.

Many of the sandy soils, or soils formed in sands over loamy materials, do not display good Gray-Brown Podzolic profiles. They often have a somewhat dark and thick surface horizon, with or without a discernible A_2, and

Figure 8. Profiles of Gray-Brown Podzolic (left) and Prairie-Gray-Brown Podzolic intergrade soils (right).

a brown (color) B horizon close beneath. In many cases the "color B" appears similar to that found in Podzol or Brown Podzolic soils. Descriptive names such as "relict Prairie soils," "podzolized Prairie soils," or "Oak Podzols" have sometimes been used to describe such profiles. It has also been suggested, that these soils might be classified in the Sol Brun Acide group.

TABLE 5. TAXONOMIC CLASSIFICATION OF MARQUETTE COUNTY SOILS

AZONAL SOILS

Lithosols	Regosols	Alluvial Soils
Boone	Plainfield (dune phase)	Alluvial Soils (Series undifferentiated)

ZONAL SOILS INTERGRADING TO AZONAL REGOSOLS

Hennepin	Plainfield Rodman

ZONAL SOILS

Gray-Brown Podzolic Soils		Prairie (Brunizem) and Prairie-Gray-Brown Podzolic Intergrades
Berrien	Nekoosa	*Astico (dark colored variant)
Boyer	*Oshkosh	*Briggsville (dark colored variant)
*Briggsville	Oshtemo	Dresden
Casco	Ottawa	Gotham
*Delton	*Packwaukee	Lorenzo
Fox	Seward	*Pardeeville
Lapeer	Tuscola	*Pardeeville (shallow substratum variant)
Lapeer (shallow substratum variant)	*Tustin	*Pleasant Lake
*Mecan	*Wyocena	*Puchyan (dark colored variant)
Meridian		*Puckaway
		Sparta
		*Winneconne

ZONAL SOILS INTERGRADING TO INTRAZONAL HUMIC-GLEY SOILS

*Lost Lake (dark colored variant)	Rimer
Morocco	*Shiocton
*Neshkoro	

INTRAZONAL SOILS

Humic-Gley Soils		Bog Soils
*Fall River	Maumee	*Horicon
Granby	*Poy	Other, undifferentiated series.
*Keowns	Poygan	
	Wauseon	

*Tentative or proposed series.

SOIL MORPHOLOGY

Soils described in this section have been grouped according to kind of parent material. Soil nomenclature used follows in general that described in the Soil Survey Manual.[1] Color names and symbols describe moist soil colors according to the Munsell system. pH values were determined by use of the Hellige–Truog pH kit.

Soils Formed from Glacial Till

Lapeer. The Lapeer series includes light-colored, well to somewhat excessively drained Gray-Brown Podzolic soils formed from calcareous sandy loam till and loamy surface coverings of variable thickness (see Figure 8). These soils are believed to have developed under deciduous forest. Both a normal and a deep phase have been recognized. In some cases the deep phase exhibits a bisequal profile which in virgin soils has an upper B_{ir} horizon and a lower B_t horizon. Associated with the Lapeer soils, on narrow convex ridgetops and steep slopes, are shallow regosolic soils classified as Hennepin. Where sandstone bedrock is found within 2 to 4 feet of the surface a shallow substratum variant is recognized.

The following profile was exposed in a pit dug in an idle field in southern Marquette County (NE¼NE¼ sec. 36, T14N., R9E.). The site was sloping toward the southwest. Stones were noted both on the surface and in the profile.

Soil Profile: Lapeer fine sandy loam—cultivated.

A_p	0–5″	Very dark grayish brown to dark brown (10YR 3/2–3/3) fine sandy loam; moderate medium granular structure; very friable; pH 6.5; abrupt boundary.
A_2	5–12″	Yellowish-brown to dark yellowish-brown (10YR 5/4–4/4) light sandy loam; weak to moderate coarse platy structure; friable; pH 6.5; clear boundary.
II B_{21}	12–16″	Brown (7.5YR 4/4) light clay loam; moderate medium subangular blocky structure; firm; pH 5.3; clear boundary.
II B_{22}	16–22″	Brown (7.5YR 4/4) clay loam; strong medium subangular blocky structure; peds are coated dark brown (7.5YR 3/2); hard dry; slightly plastic wet; a few limestone pebbles; pH 5.6; clear boundary.
II B_3	22–27″	Brown to dark yellowish-brown (7.5YR–10YR 4/4) light sandy clay loam; weak coarse subangular blocky structure; slightly firm; a few limestone pebbles; pH 5.6; clear wavy boundary.
II C_1	27–33″	Yellowish-brown (10YR 5/4) gravelly sandy loam to loamy sand; massive; very friable; calcareous (effervesces slowly); clear wavy boundary.
II C_2	33″+	Light yellowish-brown (10YR 6/4) gravelly sandy loam to loamy sand; massive; very friable; calcareous (effervesces rapidly).

In other places, Lapeer soils are less well developed. The following profile was examined in a corn field west of Highway 22 in the southern part of the county SE¼NW¼ sec. 21, T14N., R10E.). This site had a northern exposure. Prairie-Gray-Brown Podzolic intergrade soils were found on the crest of the ridge, and on the south-facing slopes. This was a broad ridge underlain by sandstone bedrock.

[1] See Bibliography, item 14.

Soil Profile: Lapeer sandy loam—cultivated.

A_p 0–7″		Dark brown (10YR 4/3 moist, 10YR 5/3–5/4 dry) sandy loam; weak fine granular structure; friable; pH 5.9.
B_{21}	7–18″	Strong brown (7.5YR 4/6 moist, 7.5YR 5/6 dry) loam; moderate medium subangular blocky structure; friable; firm; pH 6.4.
B_{22}	18–28″	Strong brown (7.5YR 5/6 moist and dry) sandy loam; moderate medium subangular blocky structure; friable; pH 5.9.
B_3	28–32″	Strong brown (7.5YR 5/6 moist, 10YR 6/6 dry) sandy loam; weak medium subangular blocky structure; friable; pH 6.2.
C	32″+	Light yellowish-brown (10YR 6/4) loamy sand; single grain; friable to loose; calcareous gravelly till.

**Pardeeville.* The Pardeeville series is a newly proposed series. It includes dark, or moderately dark colored, somewhat excessively drained soils formed from calcareous sandy loam till and loamy surface coverings of variable thickness. These soils are classified as Prairie soils intergrading to Gray Brown Podzolics (see Figure 8). They are believed to have developed mainly under prairie grasses and forbs, and scattered oaks. Pardeeville soils are closely associated with the Lapeer and Hennepin soils in southern Marquette County.

As with the Lapeer, the Pardeeville soils have a deep phase, a shallow variant, and a shallow to bedrock variant.

The following profile was exposed in a pit dug in an uncultivated field in southern Marquette County (SE¼SW¼ sec. 36, T14N., R10E.). The site had a southerly aspect. The soil in an adjacent cultivated field had a very dark brown (10YR 2/2) A_p horizon 8 inches thick.

Soil Profile: *Pardeeville fine sandy loam—virgin.

A_1	0–5″	Very dark brown (10YR 2/2–3/2) fine sandy loam; moderate medium and fine granular structure; friable; pH 6.8; clear boundary.
A_3	5–7″	Dark brown (10YR 3/3) and dark yellowish-brown (10YR 4/4) loam; weak medium subangular blocky structure; friable; pH 6.5; clear boundary.
B_1	7–10″	Dark brown (10YR–7.5YR 4/4) loam; weak to moderate subangular blocky structure; friable; pH 6.1; clear boundary.
II B_{21}	10–18″	Dark brown (7.5YR 4/4) loam; moderate to weak medium subangular blocky structure; peds are coated dark brown (7.5YR 3/4); slightly firm; pH 5.8; a few pebbles; gradual boundary.
II B_{22}	18–22″	Dark brown (7.5YR 4/4) loam; weak medium subangular blocky structure; slightly firm; pH 5.9; a few pebbles and stones; clear boundary.
II B_3	22–25″	Dark brown (7.5YR–10YR 4/4–5/4) fine sandy loam; very weak medium subangular blocky structure; very friable; pH 6.0; a few pebbles and stones; clear boundary.
II C_1	25–33″	Yellowish-brown (10YR 5/4) gravelly fine sandy loam; massive; very friable to loose; slightly calcareous; a few stones; gradual boundary.
II C_2	33″+	Yellowish-brown (10YR 5/4) gravelly fine sandy loam; massive; friable to loose; numerous stones; calcareous.

Many slopes in the till uplands of Marquette County are quite steep. In the Lapeer–Pardeeville area, the crests of drumlins are often narrow and strongly convex. Soils formed on such sites are usually stony and shallow. They appear to be regosolic Prairie soils, and have been classified as members of the Hennepin series. A profile of such a soil is described as follows:

Soil Profile: Hennepin fine sandy loam.

A_1	0–5″	Very dark grayish-brown (10YR 3/2) fine sandy loam; moderate medium granular structure; friable; alkaline; a few pebbles; abrupt wavy boundary.
B_2	5–9″	Dark brown (7.5YR 4/4) loam to fine sandy loam; weak medium subangular blocky structure; slightly firm; alkaline; a few pebbles; clear boundary.
B_3	9–14″	Dark yellowish-brown to brown (10YR–7.5YR 4/4) fine sandy loam; very weak medium subangular blocky structure; very friable; alkaline; weathering rinds on dolomitic gravels; clear boundary.
C_1	14–20″	Yellowish-brown (10YR 5/4) gravelly fine sandy loam; massive; very friable to loose; calcareous; gradual boundary.
C_2	20″+	Brown (10YR 5/3) gravelly fine sandy loam; massive; loose; calcareous.

Sandstone outcrops at a number of places in Marquette County. Regosols formed in residual sands are classified as Boone. In other places, broad ridges and long gentle slopes may have a thin mantle of glacial drift underlain by sandstone at relatively shallow depth. Where sandstone occurs at about 4 feet or less, in a Pardeeville or Lapeer profile, a variant of one of those series has been recognized.

Such a soil was described on a gently sloping broad ridge in southern Marquette County. (NE¼SE¼ sec. 14, T14N., R10E.) Most of this profile appeared to be formed in loamy colluvium, or eolian sediments, with only the lower part formed from till. Sandstone bedrock was encountered at 36 inches.

Soil Profile: *Pardeeville loam (shallow substratum variant).

A_p	0–10″	Very dark brown (10YR 2/2) loam; moderate medium granular structure; friable; pH 7.5; abrupt boundary.
B_{21}	10–20″	Dark brown (7.5YR 4/4) loam; weak medium prismatic structure; prisms break into moderate medium subangular blocky aggregates; individual peds are coated dark brown (7.5YR 3/4); slightly firm; pH 7.5; cobble layer at 20 inches; clear boundary.
B_{22}	20–31″	Dark brown (7.5YR 4/4) sandy loam; weak medium prismatic structure; prisms break into weak medium subangular blocky aggregates; peds have dark brown (7.5YR 3/4) coatings which are less distinct than in the above horizon; friable to slightly firm; pH 7.5; clear boundary.
II B_{23}	31–36″	Dark brown (7.5YR 4/4) clay loam; weak medium prismatic structure; prisms break into moderate medium subangular blocky aggregates; thick, dark brown (7.5YR 3/4) coatings on peds; firm; slightly sticky wet; pH 6.0; this appears to be a beta horizon; abrupt boundary.
III D_1	36–40″	Yellowish-brown to light yellowish-brown (10YR 5/4–6/4) fine sand; single grain; loose; pH 6.2; clear boundary.
III D_2	40″+	White (10YR 8/2) fine sand; single grain; loose; pH 6.3; this is weakly cemented sandstone bedrock.

Associated with the Lapeer and Pardeeville soils are soils formed in non-stony loams and fine sands. These soils usually occur in the valleys and on the gently sloping concave footslopes of till uplands. They have dark colored surface layers and have been classified as dark colored variants of the proposed Astico, Puchyan, and Lost Lake series.

***Astico (dark colored variant).** These are well to moderately well drained soils formed in loamy sediments that overlie loamy calcareous glacial drift. The following profile was described in a pit dug in a gently sloping valley adjacent to an upland slope. Associated soils were Pardeeville, Puchyan, and Gotham. This profile was underlain by calcareous silts. Astico soils are usually underlain by glacial till.

Soil Profile: *Astico loamy fine sand (dark colored variant).

A_p	0–9″	Very dark grayish-brown (10YR 3/2) loamy fine sand; weak granular structure; friable; pH 5.3; abrupt boundary.
A_2	9–18″	Brown (10YR–2.5YR 5/3) fine sand; single grain; very friable; pH 6.5; clear boundary.
A_3-B_1	18–21″	Dark yellowish-brown and brown (10YR 4/4 and 5/3) fine sandy loam; weak to moderate; subangular blocky structure; friable; pH 6.5; clear boundary.
B_{21}	21–27″	Dark brown (7.5YR 4/4) clay loam; moderate medium subangular blocky structure; firm; pH 6.5; clear boundary.
B_{22}	27–35″	Dark yellowish-brown (10YR 4/4) fine sandy loam; weak medium subangular blocky structure; thin patchy dark coatings on peds; friable; pH 6.3; gradual boundary.
B_3	35–40″	Yellowish-brown (10YR 5/4) fine sandy loam; weak medium subangular blocky structure; thin patchy dark coatings and manganese stains on peds; pH 5.3; gradual boundary.
II D_1	40″+	Pale brown (10YR 6/3) fine sands and silts; massive; possibly stratified; pH 5.3.

***Puchyan, *Lost Lake (dark colored variants).** These are well to moderately well, and imperfectly drained, respectively, soils formed in fine sands or loams over silts at depths of about 12 to 36 inches. These dark colored variants are probably Prairie-Gray-Brown Podzolic intergrades. However, bisequal profiles showing evidences of podzolization have also been noted.

The following profile was described in a pit dug in a shallow valley between two parallel till ridges in southern Marquette County. This profile included a dark colored surface horizon underlain by a brown (B_{ir}) horizon, with a B_t horizon at depth. Besides being darker colored than its Gray-Brown Podzolic analogue this profile was also more acid, and is underlain by calcareous sand rather than loamy till.

Soil Profile: *Puchyan fine sandy loam (dark colored variant).

A_p	0–9″	Very dark brown to very dark gray (10YR 2/2–3/1) fine sandy loam; dark grayish-brown (10YR 4/2) when dry; moderate, fine and medium granular structure; very friable; pH 5..8; abrupt boundary.
A_2 and B_{ir}	9–13″	Mixed brown and dark brown (10YR 5/3 and 4/3) loamy fine sand; lighter colored material is single grain and loose; dark brown sand exists as weakly cemented very coarse granules which are very friable when crushed; pH 5.6; abrupt lower boundary.
A_{21}	13–21″	Brown (10YR 5/3) loamy fine sand; very weak coarse platy structure; plates break into single grains; very friable to loose; pH 5.6; abrupt to clear boundary.
II B_{t1}	21–27″	Dark yellowish-brown (10YR 4/4) silty clay loam; moderate medium subangular blocky structure; firm moist; slightly sticky wet; a few pebbles and a little fine sand in this horizon; pH 5.3; gradual boundary.
II B_{t2}	27–41″	Yellowish-brown (10YR 5/4) silty clay loam; few fine faint mottles; moderate to strong medium subangular blocky structure; thin patchy dark brown (10YR 4/3) coatings on peds; firm moist; pH 5.4; clear to gradual boundary.

II B_3	41–48″	Brown to yellowish-brown (10YR 5/3–5–4) heavy silt loam; few large distinct (10YR 5/6) mottles; weak coarse subangular blocky structure; slightly firm; pH 5.3; abrupt boundary.
II C_1	48–68″	Stratified brown (10YR 5/3) silt and yellowish-brown (10YR 5/6) fine sand; the silts are friable and the sand is loose; pH 5.4 (sand) and 6.3 (silt); abrupt boundary.
III D	68–92″+	Pale brown (10YR 6/3) fine sand; single grain; loose; calcareous.

**Mecan.* The Mecan series includes light-colored, well to somewhat excessively drained Gray-Brown Podzolic soils formed from calcareous reddish-brown loamy sand or sandy loam till, and sand or loamy surface coverings of variable thickness. These soils are believed to have developed under deciduous forest. Both a normal and deep phase have been recognized. The deep phase is apt to have a bisequal profile that includes an upper B_{ir} horizon and a lower B_t horizon. Profiles tend to be shallow on steep or strongly convex slopes. Occasionally sandstone is found within 4 feet.

The following profile was exposed in a road cut in north central Marquette County SW¼SE¼ sec. 17, T17N., R10E.). This area is characterized by isolated till ridges projecting above a general plain composed of glacio-fluvial sands, which are gravelly in places. The profile described was formed in glacial till and shallow coverings of loam to fine sand.

Soil Profile: *Mecan fine sandy loam.

A_1	0–3″	Very dark grayish-brown (10YR 3/2) loam; weak fine granular structure; very friable; pH 6.4; clear boundary.
A_2	3–10″	Light brown to brown (7.5YR 6/4–5/4) loamy fine sand; very weak platy structure; friable to loose; pH 5.7; gradual boundary.
A_3	10–17″	Light brown (7.5YR 6/4) loamy fine sand; very weak fine subangular blocky structure; friable to loose; pH 5.3; abrupt boundary.
II B_{21}	17–22″	Red (5YR 4/6 moist) sandy clay loam to clay loam; moderate medium subangular blocky structure; firm; pH 4.5; clear boundary.
II B_{22}	22–32″	Red (5YR 4/6 moist) light sandy clay loam; weak to moderate medium subangular blocky structure; slightly firm; pH 4.6; gradual boundary.
II B_3	32–41″	Red (5YR 4/6–5/6 moist) sandy loam; weak medium subangular blocky structure; slightly firm; pH 4.8 at 34 inches and 6.5 at 39 inches; gradual boundary.
II C_1	41″+	Light reddish-brown (5YR 6/4 moist) sandy loam; massive; friable; calcareous gravelly till.

Surface coverings in the Mecan soil areas are often quite thick. Where this occurs a bisequal profile is often found. This is tentatively included with the Mecan series as a deep phase. It usually occurs when soil depth exceeds 42 inches.

The following profile was described in a road cut in the central part of the county (SE¼NE¼ sec. 9, T15N., R9E.). The area consists of ground moraine with deep sands on lower slopes and level areas. Associated soils included Plainfield and Gotham. The profile described was formed in fine sands, about 40 inches thick, and the underlying calcareous loamy sand till. It appears to have weak podzol development in its upper sequum.

Soil Profile: *Mecan loamy fine sand (deep phase).

A_1 0–2″ Dark grayish-brown to very dark grayish-brown (10YR 4/2–3/2) loamy fine sand having a salt and pepper appearance; weak fine granular structure; very friable; pH 6.2; clear boundary.

A_2 2–5″ Yellowish-brown to brown (10YR–7.5YR 5/4) loamy fine sand; single grain; loose; pH 5.O; clear boundary.

B_{hir} 5–20″ Dark yellowish brown (10YR 4/3) loamy fine sand; very weak medium subangular blocky structure; very friable to loose; pH 5.5; gradual boundary.

B_{ir} 20–28″ Brown (7.5YR 5/4) fine sand; single grain; loose; pH 6.0; gradual boundary.

C 28–40″ Brown (10YR 5/3) fine sand; single grain; loose; pH 6.3; abrupt boundary.

II B_{t1} 40–56″ Yellowish-red to strong brown (5YR–7.5YR 4/6) sandy clay loam; moderate medium subangular blocky structure; firm; pH values are 5.9 at 42 inches, 5.4 at 48 inches and 5.8 at 56 inches; clear boundary.

II B_{t2} 56–66″ Strong brown (7.5YR 4/6) loam; weak medium subangular blocky structure becoming massive with depth; slightly firm to friable; pH 6.0; clear boundary.

II C_1 66″+ Brown (7.5YR 5/4; moist) to pinkish-gray (5YR 7/2, dry) calcareous loamy sand till containing dolomitic gravel. In some places stratified, calcareous, sands and gravel have been observed below this till.

**Wyocena.* The Wyocena series includes light to moderately dark colored, somewhat excessively drained Gray-Brown Podzolic soils formed from acid or very weakly calcareous, sandy till. These soils were probably developed under black and scrub oak which is the same type of natural vegetation they support today. Wyocena soils are usually found on morainic topography. They are sandier than the Lapeer and Mecan soils and their illuvial (B) horizons are more variable in texture. Substrata (C horizons) are acid or only slightly calcareous.

The following profile was examined on a hilly upland slope in northeastern Marquette County (NE¼NE¼ sec. 21, T17N., R11E.). This profile has a heavier textured B horizon than many Wyocena profiles.

Soil Profile: *Wyocena fine sand—cultivated.

A_p 0–11″ Dark brown (10YR 4/3) fine sand; weak medium granular structure; very friable to loose; pH 5.7; abrupt boundary.

A_3 11–30″ Light yellowish-brown (10YR 6/4) loamy fine sand; single grain; loose; pH 7.1; clear boundary.

B_2 30–42″ Yellowish-red (5YR 5/6) sandy clay loam; weak medium subangular blocky structure; firm; pH 7.2; gradual boundary.

B_3 42–50″ Yellowish-red (5YR 5/6) sandy loam; weak medium subangular blocky structure; friable; pH 6.2; gradual boundary.

C_1 50–56″ Yellowish-red (5YR 5/6) sandy loam; massive; friable; pH 6.8; clear boundary.

C_2 56–64″ Yellowish-red (5YR 5/6) loamy sand; single grain; loose; pH 6.5.

***Packwaukee:** The Packwaukee series is newly proposed. It includes light colored, somewhat excessively drained, Gray-Brown Podzolic soils formed from sandy glacial drift that has included lenses of loam to clay (see Figure 9). These soils are usually found on end or recessional moraines and are frequently underlain by stratified deposits. Hardwoods, mainly oak, are the natural vegetation.

The following profile was examined at the top of a deep gravel pit south of Packwaukee (SE¼NW¼ sec. 29, T15N., R9E.).

Soil Profile: *Packwaukee sandy loam.

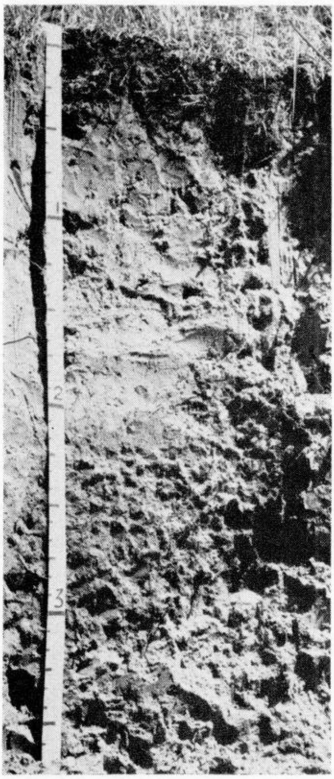

Figure 9. Packwaukee sandy loam.

A_1	0–2″	Dark brown (10YR 4/3) sandy loam; very weak fine granular strucure; very friable; pH 6.7; abrupt boundary.
A_2	2–10″	Light yellowish-brown (10YR 6/4) sandy loam to loamy sand; very weak fine platy structure; friable to loose; pH 6.8; abrupt boundary.
A_3	10–13″	Light yellowish-brown to yellowish brown (10YR 6/4–5/4) sandy loam to loamy sand; very weak fine subangular blocky structure; loose; pH 5.7; clear boundary.
B_1	13–15″	Strong brown (7.5YR 5/6) sandy loam; weak fine subangular blocky structure; friable; pH 5.5; clear boundary.
B_{22}	15–30″	Yellowish-red (5YR 4/6) clay loam; moderate medium subangular blocky structure; slightly sticky; pH 5.5; gradual boundary.
B_{23}	30–39″	Yellowish-red (5YR 4/6–5/6) loam; weak to moderate medium subangular blocky structure; friable to slightly sticky; pH 5.5; clear boundary.
B_3	39–44″	Yellowish-red (5YR 5/6) loam to sandy loam; massive to very weak medium subangular blocky structure; friable; pH 5.8; clear boundary.
C_1	44″+	Light yellowish-brown (10YR 6/4) fine to medium sand with a few gravels; single grain; calcareous.

Soils Formed from Glacio-Fluvial Deposits

Casco and Lorenzo. The Casco series includes light colored, somewhat excessively drained Gray-Brown Podzolic soils formed from stratified, calcareous, gravelly, glacio-fluvial deposits. Thin loamy surface coverings may be present. Depth to carbonates is usually less than 24 inches. The Lorenzo soils are dark colored Prairie soils formed from the same kind of parent material.

Both soils may be found on level outwash terraces or on complex, hilly topography. On very steep or sharply convex slopes, such as terrace escarpments, a shallow, regosolic soil is formed. This is called Rodman. Other common associates include the Fox and Dresden soils.

The following profile description was made in a pit dug in a small terrace between two drumlins in southern Marquette County (SW¼SW¼ sec. 35, T14N., R10E.). The particular profile is somewhat darker colored than many of the soils classified as Casco.

Soil Profile: Casco loam—cultivated.

A_p	0–7"	Very dark grayish-brown (10YR 3/2) loam; dark grayish brown (10YR 4/2) when dry; moderate medium granular structure; friable; pH 6.0; abrupt boundary.
B_{21}	7–14"	Brown (7.5YR 4/4–4/6) sandy clay loam; moderate medium subangular blocky structure; hard dry, firm moist, slightly sticky wet; pH 5.8; clear boundary.
B_{22}	14–20"	Brown (7.5YR 4/4–4/6) clay loam; moderate coarse and medium subangular blocky structure; patchy dark brown (7.5YR 3/2) coatings on peds; aggregates are strongly pedal and break into strong fine subangular blocky peds; hard dry, firm moist, and slightly sticky wet; a few pebbles; pH 5.7; clear wavy boundary.
C_1	20–22"	Yellowish-brown and dark yellowish-brown (10YR 5/4 and 4/4) gravelly sand; single grain; loose; calcareous; this transitional horizon coisists of partially weathered sand and limestone gravel.
C_2	22"+	Yellowish-brown (10YR 5/4) sand and gravel; stratified; loose; calcareous.

The dark colored counterpart of the Casco soil is a common soil in southeastern Marquette. The following profile was described in a pit dug in a dissected terrace adjacent to a drumlin (NW¼SE¼ sec. 26, T14N., R.10E.). Associated soils were Pardeeville, and Gotham.

Soil Profile: Lorenzo loam—cultivated.

A_p	0–9"	Very dark brown (10YR 2/2) loam; salt and pepper appearance when examined closely; weak coarse blocky structure; blocks break into moderate medium granular peds; friable; abrupt boundary.
B_{21}	9–13"	Dark brown (7.5YR 3/4) loam; weak to moderate medium subangular blocky structure; peds are coated very dark brown (7.5YR 3/2); slightly firm, slightly sticky; clear boundary.
B_{22}	13–19"	Dark brown (7.5YR 3/4) loam to sandy clay loam; moderate medium subangular blocky structure; slightly sticky; many nonlimy pebbles; clear boundary.

B_3	19–24″	Dark brown (7.5YR 3/3) gravelly sandy loam; single grain; very friable; clear boundary.
C_1	24″+	Yellowish-brown (10YR 5/4) cobbly gravel and sand outwash; calcareous.

Fox and Dresden. The Fox and Dresden soils are formed in the same kind and sequence of parent materials as the Casco and Lorenzo. However, the loamy surface layers are somewhat deeper with the result that profiles are somewhat thicker. Depth to carbonates range from about 24 to about 42 inches although somewhat deeper profiles are also included. Fox soils are light colored (see Figure 10). They were formed under forest vegetation and are classified as Gray-Brown Podzolics. Dresden soils are dark colored. They were formed under prairie plants or oak openings and are classified as Prairie-Gray-Brown Podzolic intergrades.

The following profile was described in southern Marquette County (NE¼NE¼ sec. 9, T14N., R10E.). The site was a small terrace adjacent to till uplands.

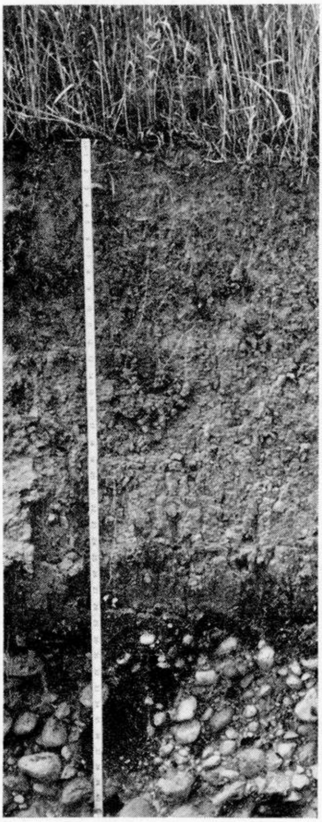

Figure 10. Fox profile. Note the dolomitic gravel in the C horizon.

Soil Profile: Fox loam.

A_1	0–3½″	Very dark grayish-brown (10YR 3/2) loam; weak fine granular structure; very friable; pH 6.7; clear boundary.
A_2	3½–5″	Yellowish-brown to light yellowish brown (10YR 5/4 to 6/4) loamy sand; suggestion of very fine platy st:ucture; friable to loose; pH 6.5; gradual boundary.
A_3	5–7″	Yellowish-brown (10YR 5/4 moist) loamy sand; very weak fine subangu!ar blocky structure; friable to loose; pH 6.3; gradual boundary.
B_{21}	7–27″	Brown to dark brown (7 5YR 5/4–4/4) loam; weak medium subangular blocky structure; friable to firm; pH 6.3; gradual boundary.
B_{22}	27–39″	Strong brown (7.5YR 5/6 moist) sandy clay loam; weak to moderate medium subangular blocky structure; firm to friable; pH 5.8; clear boundary.
B_3	39–48″	Strong brown to yellowish-brown (7.5YR 5/6–10YR 5/6 moist) light sandy clay loam; massive, breaking to weak medium subangular blo:ky strucure; friable; pH 5.8; abrupt boundary.
C_1	48–50″	Yellow (10YR 8/6–7/6 mo'st) coarse sand; loose; alkaline.
C_2	50″+	Calcareous sand and gravel outwash.

Dresden soils are most common in the southeastern part of the county where they are associated with the Pardeeville and Lorenzo soils. They are also found locally in other parts of the county. The following profile was described on a small terrace in central Marquette County (SW¼SW¼ sec. 16, T16N., R10E.). Here Dresden and Lorenzo soils were found in association with Mecan and Plainfield soils.

Soil Profile: Dresden loam—cultivated.

A_p	0–7″	Black (10YR 2/1) loam; moderate medium granular structure; friable; pH 6.3; abrupt boundary.
A_3	7–10″	Very dark brown to very dark grayish-brown (10YR 2/3–3/2) loam; weak medium platy structure; plates break into weak fine subangular blocky aggregates; friable; pH 6.3; clear boundary.
B_{21}	10–14″	Dark brown (7.5YR 3/3) sandy clay loam; moderate medium subangular blocky structure; slightly firm; pH 5.3; clear boundary.
B_{22}	14–19″	Dark brown (7.5YR 3/3) clay loam; moderate medium subangular blocky structure; firm; pH 5.4; clear boundary.
B_{23}	19–22″	Dark brown (7.5YR 3/3) gravelly loam; weak medium subangular blocky structure; friable; pH 5.6; abrupt boundary.
B_3	22–25″	Dark brown (10YR 4/3) gravelly sandy loam; very weak medium subangular blocky structure; very friable; abrupt boundary.
C_1	25″+	Light brownish-yellow (10YR 6/4) sand and gravel; stratified; loose; pH 8.0 in upper few inches becoming calcareous with depth.

*Boyer and *Puckaway.* Boyer and Puckaway are somewhat excessively drained soils formed in loams over calcareous sands and gravels at about 24 to 42 inches. These soils are about the same depth as the Fox and Dresden soils but are somewhat sandier throughout and have less textural development in their illuvial horizons. The Boyer is light colored while the Puckaway is dark colored.

The following profile was described in a pit dug in a corn field on a low dissected terrace in southern Marquette County (SW¼NE¼ sec. 7, T14N., R10E.). The surface horizon is somewhat dark for a Gray-Brown Podzolic soil.

Soil Profile: Boyer sandy loam—cultivated.

A_p	0–9″	Dark yellowish-brown (10YR 3/4 moist) sandy loam; weak fine granular structure; firm to friable consistence; pH 7.0.
A_3	9–15″	Yellowish-brown (10YR 5/4) sandy loam; very weak fine subangular blocky structure; friable; pH 6.4.
B_1	15–18″	Yellowish-brown (10YR 56) heavy loam; weak medium subangular blocky structure; friable (slightly sticky when wet); pH 5.8.
B_2	18–28″	Yellowish-brown (10YR 5/6) heavy loam; weak medium subangular blocky structure; slightly sticky wet; pH 5.5.
B_3	28–40″	Brownish-yellow 10YR 6/6 moist loamy sand; very weak medium subangular blocky structure; friable; pH 5.8.
C_1	40–44″	Sand; alkaline reaction.
C_2	44″+	Calcareous sand and gravel.

The Puckaway series is newly proposed. It includes dark colored soils similar to the light colored Boyer soils in texture, lithology, and natural drainage. The Puckaway soils are classified as Prairie-Gray-Brown Podzolic intergrades and are believed to have formed under prairie vegetation and scattered oak.

The following profile was described in southeastern Marquette County (NE¼SE¼ sec. 22, T14N., R10E.). The site location consisted of a nearly level terrace adjacent to upland slopes. Associated soils included Lapeer, Lorenzo, Oshtemo, and Gotham.

Soil Profile: *Puckaway loam—cultivated.

A_p	0–8″	Black (10YR 2/1) light loam; cloddy lumps break into moderate medium granules; friable; abrupt boundary.
B_1	8–13″	Dark brown (7.5YR 3/2–2/2) light loam; weak medium subangular blocky structure; friable; clear boundary.
B_{21}	13–19″	Dark brown (7.5YR 3/2) sandy loam; very weak medium subangular blocky structure; friable; clear boundary.
B_{22}	19–25″	Brown (7.5YR 4/4) sandy loam; very weak medium subangular blocky structure; friable; clear boundary.
B_3	25–31″	Brown (7.5YR 4/4) sandy loam to loamy sand; massive; very friable; clear boundary.
C_1	31–38″	Pale brown (10YR 6/3) calcareous gravel and sand.
C_2	38–54″	Pale brown (10YR 6/3) fine sand; calcareous.

Oshtemo. Oshtemo soils are somewhat excessively drained Gray-Brown Podzolic soils formed in loams and sands over calcareous sand and gravel at depths ranging from 42 to 60 inches. They resemble the Boyer and Puckaway soils somewhat but are generally sandier in texture and acid to a greater depth. Oshtemo soils are light colored, however, dark colored soils of similar texture and lithology are also found in Marquette County. The latter soils are probably similar to the Constantine soils of Michigan. Both are commonly associated with the Gotham soils.

The following profile was described in a terrace cut west of Germania (NW¼NE¼ sec. 11, T16N., R10E.). This profile is representative of Oshtemo soils showing considerable textural development in their illuvial horizon.

Soil Profile: Oshtemo loamy fine sand—cultivated.

A_p	0–7″	Brown (10YR 4/3 moist, 10YR 5/3 dry) loamy fine sand; very weak fine granular structure; friable; pH 6.8.
A_3	7–18″	Yellowish-brown (10YR 5/4 moist, 10YR 6/4 dry) loamy fine sand; single grain; friable; pH at 7–13 inches is 6.5; at 13–18 inches, pH 5.4.
B_{21}	18–20″	Dark brown to dark yellowish-brown (10YR–7.5YR 4/4) sandy clay loam; moderate medium subangular blocky structure; firm; pH 5.7.
B_{22}	20–26″	Dark brown to reddish-brown (7.5YR–5YR 4/4 clay loam; moderate medium subangular blocky structure; firm; pH 5.5.
B_{31}	26–33″	Strong brown (7.5YR 5/8) sandy loam; weak medium subangular blocky structure; friable to firm; pH 5.5.
B_{32}	33–42″	Strong brown (7.5YR 5/6) loamy sand; single grain; firm; pH 5.7.
B_{3t}	42–45″	Yellowish-brown (10YR 5/4) gravelly heavy sandy loam with clay skins (5YR 4/4); moderate fine medium subangular blocky structure; firm; pH 5.4.
C	45″+	Calcareous sand and gravel.

A slightly different kind of profile has also been included in the Oshtemo series in Marquette County. This profile is usually sandier and calcareous materials are not found within 5 feet. There appears to be an upper B_{ir} horizon in many of these soils. The following profile is typical. It is found on a high terrace north of Montello.

Soil Profile: Oshtemo loamy sand—cultivated.

A_p	0–8″	Dark brown (10YR 3/3–3/4) loamy sand; very weak medium granular structure; friable; loose; pH 6.3; abrupt boundary.
B_{ir}	8–22″	Strong brown (7.5YR 5/6–4/6) loamy sand; weak medium subangular blocky structure; friable; pH 6.3; clear boundary.
B_{21}	22–28″	Strong brown (7.5YR 4/6) light sandy loam (some chert pebbles); weak medium subangular blocky structure; friable; pH 6.0; clear boundary.
B_{22}	28–32″	Strong brown to dark yellowish-brown (7.5YR 4/6–4/4) sandy clay loam; (some chert pebbles); weak medium to fine subangular blocky structure; friable; pH 6.2.
B_{31}	32–36″	Strong brown (7.5YR 4/6 moist) sandy loam; very weak fine subangular blocky structure; friable; pH 6.2.
B_{32}	36–54″	Strong brown (7.5YR 5/6–5/8) medium sand; single grain; loose; pH 6.2.
C_1	54″+	Yellowish-brown (10YR 5/4 moist) medium sand; single grain; loose; pH 6.2.
C_2	6–7′	Calcareous sand and gravel.

***Pleasant Lake.* This is a newly proposed series. Pleasant Lake soils are found in the northwest part of Marquette County where they occur on terraces consisting of loams over stratified sands and gravel. These glacio-fluvial deposits appear to be more highly weathered than the parent materials of the Boyer and Fox soils. They are usually acid but include scattered lenses of calcareous material.

Pleasant Lake soils have bisequal profiles. The upper sequum consists of a dark colored surface layer underlain by a dark brown (Podzol) horizon. A textural B is found in the lower sequum. Profile morphology appears to reflect the influence of both prairie and forest vegetation. These soils are classified as Prairie-Gray-Brown Podzolic or Podzol intergrades.

The following profile was described on a gentle slope of an undulating terrace in Springfield Township (SW¼NW¼ sec. 4, T17N., R8E.). This particular profile includes a 4 inch thick calcareous layer in the C horizon.

Soil Profile: *Pleasant Lake sandy loam.

A_1	0–3″	Very dark brown (10YR 2/2) sandy loam; weak medium granular structure; very friable; pH 5.2; clear wavy boundary 2–6 inches thick.
B_{irh1}	3–6″	Dark brown (10YR 3/3) sandy loam; very weak medium subangular blocky structure; very friable; pH 5.3; clear wavy boundary.
B_{irh2}	6–10″	Dark brown (7.5YR 4/4) sandy loam; weak medium subangular blocky structure; patchy dark brown (organic?) stains on peds; very friable; pH 5.3; abrupt boundary.
II B_{t1}	10–16″	Dark brown (7.5YR 4/4–3/4) gravelly sandy loam; weak medium subangular blocky structure; very friable; pH 5.8; clear boundary. Gravel is non-dolomitic and is composed mainly of granite, chert, rhyolite, greenstone, and quartz.
II B_{t2}	16–32″	Dark brown (7.5YR 4/4) gravelly sandy clay loam to loam; moderate medium subangular blocky structure; friable moist; slightly sticky wet; pH 5.8; abrupt boundary. Gravel composition similar to above horizon.
II C_1	32–36″	Pale brown (10YR 6/3) sand and gravel; single grain; loose; calcareous; abrupt boundary. Gravel is composed mainly of dolomite, granite, rhyolite, chert, greenstone, and quartz.
II C_2	36″+	Pale brown (10YR 6/3) sand; single grain; loose; pH 7.0.

Meridian. The Meridian series includes somewhat excessively drained, light to moderately dark colored soils of sandy loam texture. They are tentatively classified as Gray-Brown Podzolics. These soils are found on terraces, usually in association with the Gotham soils. They are acid throughout.

The following profile was described on a terrace in southwestern Marquette County (SW¼SW¼ sec. 32, T14N., R8E.).

Soil Profile: Meridian loam—cultivated.

A_p	0–6″	Dark brown (10YR 3/3) loam; weak medium granular structure; very friable; pH 6.2; abrupt boundary.
A_3	6–12″	Yellowish-brown (10YR 5/6) sandy loam; very weak fine granular structure; very friable; pH 6.0; clear boundary.
B_1	12–18″	Dark yellowish-brown (10YR 4/6) sandy loam; weak fine subangular blocky structure; very friable; pH 5.8; clear boundary.
B_{21}	18–24″	Dark yellowish-brown (10YR 4/4) sandy loam; weak fine subangular blocky structure; very friable; pH 6.0; clear boundary.
B_{22}	24–30″	Yellowish-brown (10YR 5/6) loam; moderate medium subangular blocky structure; friable; pH 5.8; clear boundary.
B_3	30–35″	Yellowish-brown (10YR 5/6) fine sandy loam; very weak medium subangular blocky structure; very friable; pH 5.8; clear boundary.
C_1	35″+	Brownish-yellow (10YR 6/6) fine sand; single grain; loose; pH 5.8. Thin bands of fine sandy loam were encountered at 40, 45, and 53 inch depths.

Gotham. The Gotham series includes somewhat excessively drained, moderately dark to light colored soils of loamy sand texture (see Figure 11). They closely resemble the Plainfield soils but have somewhat better developed structure in their B horizon. Gotham soils are classified as Prairie-Gray-Brown Podzolic intergrade soils. They are found on terraces, often in association with the Meridian, Plainfield, or Oshtemo soils. They occupy a large acreage in Marquette County.

The following profile was described on a small gently sloping valley terrace in south central Marquette County (SE¼ sec. 21, T14N., R10E.).

Soil Profile: Gotham loamy fine sand—cultivated.

A_p	0–8″	Dark brown (7.5YR 3/2) loamy fine sand; weak medium granular structure; very friable; pH 5.7; abrupt boundary.
B_2	8–20″	Dark brown to strong brown (7.5YR 4/4–4/6) loamy fine sand; very weak medium subangular blocky structure; very friable; pH 5.5; clear, irregular boundary.
B_3	20–30″	Strong brown (7.5YR 5/6) fine sand; single grains; loose; pH 5.7; clear, irregular boundary.
C	30″+	Pale brown to light yellowish-brown (10YR 6/3–6/4) sand; single grain; loose; non-calcareous to at least five feet.

Plainfield and Sparta. The Plainfield and Sparta are moderately dark and dark colored soils, respectively, formed in acid sands. They are found on nearly level terraces, on dunes and beach ridges, and on highly complex morainic topography. Soils of the Plainfield series (in Wisconsin) have been classified as Gray-Brown Podzolics, or Regosols, and as Sols Brun Acide. They have also been called "relict Prairie soils". Sparta soils are believed to be Prairie, or Prairie soils intergrading to Regosols.

The Plainfield is a very extensive soil in Marquette County. Only a few areas of Sparta occur.

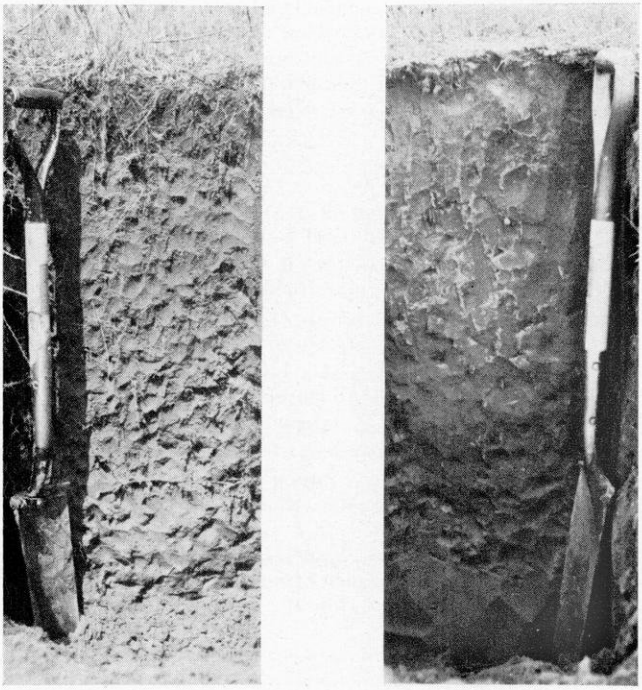

Figure 11. Profiles of Gotham loamy sand (left) and Plainfield sand (right).

The following Plainfield profile was examined in a pit dug in a long ridge in northeastern Marquette County (NE¼SE¼ sec. 32, T17N., R11E.). This profile is regosolic in character (see Figure 11).

Soil Profile: Plainfield fine sand—cultivated.

A_p	0–7″	Dark brown (10YR 4/3–3/3) fine to medium sand; very weak granular structure; loose; pH 7.2; abrupt boundary.
B_2	7–21″	Strong brown (7.5YR 5/6) medium sand; single grain; loose; pH 5.2; clear boundary.
B_3	21–27″	Reddish-yellow (7.5YR 6/6) medium sand; single grain; loose; pH 5.8; gradual boundary.
C	27″+	Light yellowish-brown (10YR 6/4) medium sand; single grain; loose; pH 5.8.

A profile representative of the sloping phase of Plainfield was examined on a rolling morainic ridge in west central Marquette County. This soil would have been included with the Coloma series at one time because of its topographic position.

Soil Profile: Plainfield fine sand—virgin.

A_1	0–2″	Very dark grayish-brown to dark grayish-brown (10YR 3/2–4/2) fine sand; very weak medium granular structure; very friable to loose; pH 5.0; abrupt boundary.
B_1	2–8″	Dark yellowish-brown to brown (10YR–7.5YR 4/4) fine sand; very weak medium subangular blocky structure; very friable to loose; pH 5.5; clear boundary.

B_2	8–16″	Yellowish-brown (7.5YR 5/6) fine sand; very weak medium subangular blocky structure becoming single grained with depth; very friable to loose; pH 5.8; clear boundary.
B_3	16–22″	Yellowish-brown (10YR 5/6) fine sand; single grain; loose; pH 5.8; clear boundary.
C	22″+	Light yellowish-brown (10YR 6/4) fine sand; single grain; loose; pH 6.2.

Nekoosa–Morocco. These are the moderately well drained and imperfectly drained catenal associates of the Plainfield soils. They have mottled subsoils and somewhat darker and thicker surface horizons than the Plainfield soils.

A moderately well drained profile was examined in a pit dug in a low terrace east of Kilby Lake (NE¼NE¼ sec. 7, T15N., R10E.).

Soil Profile: Nekoosa loamy sand.

A_p	0–10″	Very dark gray (10YR 3/1) loamy sand; weak medium granular structure; very friable; pH 6.5; abrupt boundary.
B_g	10–36″	Dark yellowish-brown (10YR 4/4) loamy sand; very weak subangular blocky structure; very friable; common strong brown (7.5YR 5/6) mottles beginning at about 20 inches; pH 5.5; gradual boundary.
C_1	36″+	Pale brown (10YR 6/3) fine sand; single grain; loose; common strong brown (7.5YR 5/6) mottles; pH 5.5. Water table at 5 feet.

The Morocco soils are mottled at shallower depths and have a more drab profile.

Granby and Maumee. The poor and very poorly drained sandy soils in Marquette County are generally less acid than their well drained associates. For this reason these soils are classified as Granby and Maumee rather than Newton and Dillon.

These soils are both developed on sands. They differ in that the Maumee has a somewhat deeper and darker A horizon. While both soils occur in the county, the Granby is probably more common.

The following profile was examined in a pit dug in a large level lake terrace north of present Lake Puckaway (NW¼ sec. 16, T15N., R11E.). Associated soils included less poorly drained sandy soils (Morocco, Nekoosa and Plainfield) as well as weakly developed Ground-Water Podzols which are found locally in the area.

Soil Profile: Granby loamy fine sand.

A_1	0–8″	Black (10YR 2/1) loamy fine sand; weak medium granular structure; very friable; slightly acid to neutral; clear boundary.
A_{3g}	8–11″	Very dark grayish-brown and grayish-brown (10YR 3/2 and 4/2) fine sand; very weak medium subangular blocky structure; very friable; slightly acid to neutral; clear boundary.
BG	11–16″	Pale brown (10YR–2.5YR 6/3) fine sand; few fine yellowish-brown (10YR 5/6) mottles; very weak medium subangular blocky structure; very friable; slightly acid to neutral; clear boundary.
CG_1	16–25″	Pale brown (10YR 6/3) fine sand; common fine yellowish-brown (10YR 5/6) mottles; single grain; loose; slightly acid to neutral; clear boundary.
CG_{2h}	25–28″	Black and dark grayish-brown (10YR 2/1 and 4/2) loamy fine sand; common medium dark yellowish-brown and yellowish-brown (10YR 4/4 and 5/6) mottles; single grain; loose; slightly acid to neutral; clear boundary. This horizon appears to have an accumulation of organic matter (and iron?).
CG_3	28″+	Pale brown (10YR 6/3) fine sand; single grain; loose; near neutral.

Soils Formed from Glacio-Lacustrine Sediments

***Oshkosh.** The Oshkosh series includes light colored, well to moderately well drained Gray-Brown Podzolic soils. These soils are formed from calcareous reddish brown glacio-lacustrine clays and silts, under deciduous forest vegetation. Surface (A) horizons may be formed in thin coverings of silt loam to fine sandy loam texture. These are usually less than 12 inches thick. These soils are found mainly on level or gently sloping glacial lake terraces in the western part of Marquette County. The Oshkosh is a proposed series.

The following profile was examined in a gently sloping basin in southwestern Marquette County (NW¼NW¼ sec. 5, T14N., R8E.).This soil is leached somewhat deeper than the Oshkosh soils in the Fox River Valley, however, it appears to be within the range of that series.

Soil Profile: *Oshkosh silt loam—cultivated.

A_p	0–7″	Very dark grayish-brown (10YR 3/2) silt loam; moderate medium granular structure; friable; pH 6.5; abrupt boundary.
A_2	7–16″	Light yellowish-brown (10YR 6/4) light silty clay loam; weak to moderate medium platy structure; friable; pH 6.0; clear boundary.
B_1	16–18″	Dark yellowish-brown (10YR 4/4) silty clay; strong medium subangular blocky structure; firm; pH 5.8; clear boundary.
B_2	18–33″	Reddish-brown to brown (5YR–7.5YR 4/4) silty clay; strong medium subangular blocky structure; firm; pH 5.8; clear boundary.
B_3	33–40″	Brown (7.5YR 4/4) silty clay; strong coarse subangular blocky structure; firm; pH 6.2; clear boundary.
C_1	40–43″	Brown (7.5YR 4/4) silty clay; platy; firm; calcareous; clear boundary.
C_2	43–60″	Light brown (7.5YR 6/3) laminated silt loams, silty clay loams, and silty clays; highly calcareous.

***Winneconne.** The proposed Winneconne series includes soils that are similar to the Oshkosh soils except that they have a thick, dark, surface (A) horizon, believed to have been formed under prairie vegetation or oak openings.

The following profile was found on the level terraces along the Mecan river in northeastern Marquette County (SE¼SE¼ sec. 25, T16N., R10E.). It is a moderately well drained profile with ground water at 60 inches (June 4, 1959).

Soil Profile: *Winneconne silt loam—cultivated.

A_p	0–9″	Black (N 2/0) silt loam; moderate coarse granular structure; friable; alkaline; abrupt boundary.
A_3	9–12″	Very dark grayish-brown (10YR 3/2) silty clay loam; weak medium subangular blocky structure; firm; alkaline; clear boundary.
II B_{21}	12–21″	Reddish-brown (5YR 4/3) silty clay loam to silty clay; moderate medium subangular blocky structure; blocks break into strong fine angular aggregates; peds are coated dark reddish-brown (5YR 3/3); firm moist; sticky wet; alkaline; clear boundary.
II B_3	21–24″	Reddish-brown to brown (5YR–7.5YR 5/4) silty clay loam; moderate medium subangular blocky structure; firm; alkaline; clear boundary.
II C_1	24–36″	Reddish-brown to brown (5YR–7.5 YR 5/4) silty clay loam; common fine strong brown (7.5YR 5/8) mottles; weak coarse subangular blocky structure; firm; calcareous; clear boundary.

II C_2	36″+	Light reddish-brown (5YR 6/4–5/4) silty clay loam and silt loam; laminated; firm; calcareous; segregated pink (5YR 7/3) carbonates in upper part of horizon.

*Poygan and *Poy.* Poygan soils are very dark colored, poor to very poorly drained, Humic Gley soils formed from reddish-brown calcareous clayey drift. Poy profiles include lenses of sand. In Marquette County both soils occur in the lower-lying parts of glacial lake plains.

The following profile was found in the southwestern part of the county (NE¼NE¼ sec. 19, T14N., R8E.). The area had been drained and was under cultivation.

Soil Profile: Poygan silt loam—cultivated.

A_p	0–8″	Black (N 2/0) silt loam; strong medium granular structure; friable; alkaline; abrupt boundary.
A_{3g}	8–11″	Black to very dark gray (2.5Y 2/0–3/0) silty clay; moderate medium subangular blocky structure; firm; alkaline; clear boundary.
B_{2G}	11–16″	Gray (5Y 4/1) silty clay; strong medium subangular blocky structure; very firm; alkaline; clear boundary.
B_{3G}	16–26″	Light olive-gray (5Y 6/2) silty clay; common medium distinct light brown (7.5YR 6/4) mottles in lower 2 inches; strong to moderate medium subangular blocky structure; very firm; calcareous; clear boundary.
C_{1G}	26–32″	Light brown (7.5YR 6/4) clay or silty clay; common medium reddish-yellow (7.5YR 6/8) mottles; weak coarse subangular blocky structure becoming massive with depth; calcareous; gradual boundary.
C_{2g}	32″+	Light reddish-brown (5Y–7.5YR 6/4) clay; traces of gleying to at least 60 inches; calcareous.

**Briggsville.* The newly proposed Briggsville series is intended to include light-colored well drained, Gray-Brown Podzolic soils formed from calcareous, glacio-lacustrine silts and clays (see Figure 12). As with the Oshkosh, these soils may have sandy or loamy surface (A) horizons. The Briggsville soils differ from Oshkosh soils in being somewhat siltier, particularly in their C horizons, and in being leached of carbonates to a greater depth, usually around 50 inches. They are also believed to have a more permeable substratum. Briggsville soils are found mainly in the western part of the county when they occur both on level lake terraces and on the slopes of moraines.

The following profile was examined in a freshly excavated trench silo located on the eastern slope of the end moraine in western Marquette County (SW¼SW¼ sec. 29, T15N., R8E.).

Soil Profile: *Briggsville fine sandy loam—virgin.

A_1	0–3″	Black (10YR 2/1) fine sandy loam; very weak granular structure; very friable; pH 5.9; abrupt boundary.
A_2	3–7″	Pale brown (10YR 6/3) loamy fine sand; weak medium platy structure; friable; pH 5.6; abrupt boundary.
A_3	7–16″	Brown (10YR 5/3) loamy fine sand; weak coarse platy structure; plates break into weak medium subangular blocky peds; very friable; pH 5.3; clear boundary.
I, II B_1	16–18″	Brown (7.5YR 5/4) sandy clay loam; weak to moderate subangular blocky structure; peds have very pale brown (10YR 7/3) coatings; friable; pH 5.2; clear boundary.
II B_{21}	18–32″	Brown to strong brown (7.5YR 5/4) silty clay loam; strong medium subangular blocky structure; peds have thick complete pinkish-gray (7.5YR 7/2) coatings; firm; pH 5.2; gradual boundary.

II B_{22}	32–38″	Dark brown (7.5YR 4/4) silty clay; coarse prismatic structure; prisms break into strong coarse subangular blocky aggregates; peds have dark reddish-brown (5YR 3/4) clay coatings; firm; pH 5.3; gradual boundary.
II B_3	38–46″	Strong brown (7.5YR 5/6) light silty clay loam; somewhat prismatic in place breaking into moderate very coarse subangular blocky aggregates; peds have clay coatings on vertical faces only; firm to friable; pH 5.4; clear irregular boundary.
II C_1	46–52″	Brown (7.5YR 5/4) silt loam; massive to very weak medium prismatic structure; very friable; pH 6.8.
II C_2	52″+	Reddish-brown (5YR 4/4 to 7.5YR 4/4) silts and silt loam; laminated; very friable; calcareous.

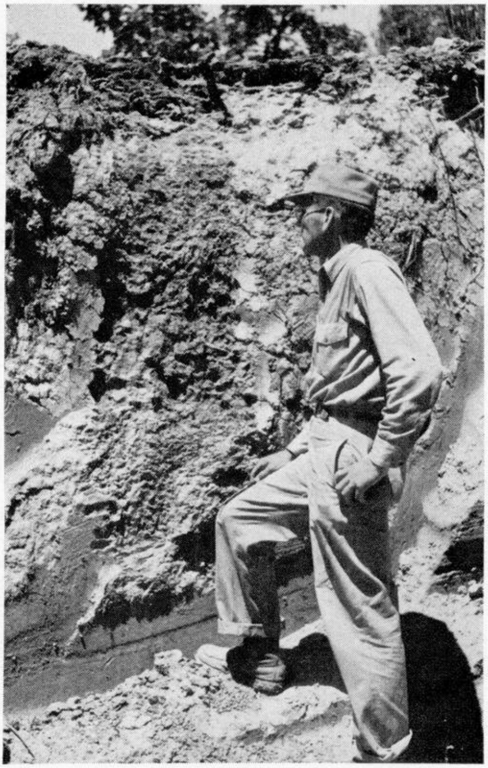

Figure 12. Briggsville fine sandy loam. Note smooth clayey subsoil.

Soils having thick dark colored surface horizons, but otherwise quite similar to soils of the Briggsville series, are also found in Marquette County. These are probably Prairie-Gray-Brown Podzolic intergrades. Because their extent is not known as yet they are included as a variant.

The following profile is an example of such a soil. This profile was examined in a valley west of Westfield (SE¼NW¼ sec. 35, T17N., R8E.). Associated soils included less well drained soils formed in glacio-lacustrine sediments and Wyocena and Packwaukee soils on adjacent morainic ridges.

Soil Profile: *Briggsville silt loam (dark colored variant).

A_p	0–8″	Very dark grayish-brown to very dark brown (10YR 3/2–2/2 silt loam; moderate medium granular structure; friable; pH 7.5; abrupt boundary.
A_2	8–10″	Brown (10YR 5/3) silt loam; moderate medium platy structure; friable; pH 7.5; clear boundary.
II B_1	10–17″	Reddish-brown (5YR 4/4) silty clay loam; moderate fine to medium subangular blocky structure; firm; pH 6.4; gradual boundary.
II B_2	17–38″	Reddish-brown (5YR 4/4) silty clay; strong medium subangular blocky structure; firm moist; slightly plastic wet; pH 6.5; gradual boundary.
II B_3	38–50″	Reddish-brown (5YR 4/4–5/4) silty clay loam; moderate to strong medium subangular blocky structure; firm moist; pH 7.5; clear wavy boundary.
II C_1	50″+	Reddish-brown (5YR 5/4) silt loam; massive; slightly firm; calcareous.

Tustin, Seward, Rimer, Wauseon. Tustin soils are well drained, Seward soils are moderately well drained, Rimer soils are imperfectly drained and Wauseon soils are poorly drained. These four soils constitute a catena of Gray-Brown Podzolic and Humic Gley soils formed in loams or sands over calcareous silts and clays. In Marquette County the upper, loamy portion of these soils ranges from about 12 to 36 inches in depth. B horizons are formed partly in it and partly in the underlying silts and clays. Surface (A) horizons of the Tustin, Seward and Rimer are often somewhat darker than is normal for Gray-Brown Podzolic soils. The surface color of these soils may have been influenced by past prairie vegetation although these same soils support good hardwood stands at present. These soils are found mainly in the western part of the county. Two profiles are described, the moderately well drained Seward, and the imperfectly drained Rimer. The Tustin is very similar to the Seward except for mottling in the latter. The Wauseon has a thick, dark colored, surface horizon and a gleyed subsoil.

The Seward profile was examined in a valley terrace in the northwest part of the county, (NE¼SW¼ sec. 13, T16N., R8E.).

Soil Profile: Seward loamy fine sand.

A_1	0–3″	Black (10YR 2/1) loamy fine sand; moderate medium granular structure; very friable; pH 5.3; a few stone and boulders on soil surface; clear boundary.
A_2-A_3	3–10″	Yellowish-brown (10YR 5/4–4/4) loamy fine sand; weak coarse platy structure; plates break into weak medium subangular blocky aggregates; very friable; loose when crushed; a few stones; clear boundary.
B_1	10–20″	Dark yellowish-brown (10YR 3/4–4/4) loamy fine sand; weak medium to coarse subangular blocky structure; very friable; a few stones; clear boundary.
I, II B_{21}	20–23″	Reddish-brown (5YR 4/3–4/4 clay loam; slightly mottled; moderate medium subanuglar blocky structure; firm; clear boundary.
II B_{22}	23–36″	Reddish-brown (5YR 4/4) silty clay; slightly mottled; moderate medium subangular block structure; firm moist; slightly plastic wet; clear boundary.
II C_1	36″+	Reddish-brown (5YR 5/4) silty clay loam; weak coarse subangular blocky structure; slightly sticky wet; calcareous.

The Rimer profile was also found in northwestern Marquette County (SE¼SW¼ sec. 23, T17N., R8E.). Corn was being grown on this soil.

Soil Profile: Rimer loam—cultivated.

A_p	0–9″	Very dark grayish-brown (10YR 3/2) loam; moderate medium granular structure; friable; pH 6.0; abrupt boundary.

A_3	9–11″	Light yellowish-brown (10YR 6/4) sandy loam; weak medium subangular blocky structure; friable; pH 6.2; abrupt boundary.
I, II B_1	11–13″	Yellowish-brown (10YR 5/8) light sandy clay loam; mottled; clear boundary.
I, II B_2	12–22″	Yellowish-brown to strong brown (10YR–7.5YR 5/8) sandy clay loam; mottled; slightly sticky wet; pH 6.7; abrupt boundary.
I, II B_3	22–24″	Strong brown (7.5YR 5/8) sandy loam; single grain; very friable; pH 7.4; abrupt boundary.
II C_1	24″+	Light brown (7.5YR 6/4) laminated silts, clays, and fine sands; reddish-yellow (7.5 YR 6/8) mottles; calcareous.

***Delton:** Soils included in the Delton series are well drained light-colored Gray-Brown Podzolic soils formed in loamy sediments over silts and clays of glacio-lacustrine origin. They differ from the Tustin soils in that carbonates are leached to greater depths. B and C horizons may be acid to depths of 60 inches or more. These soils may occur in association with soils of the Tustin catena or with soils such as Gotham, Plainfield or Packwaukee.

The following profile was examined on a slope south of Westfield (SE¼NW¼ sec. 13, T16N., R8E.). Rimer soils were found on a lower terrace.

Soil Profile: *Delton loamy fine sand—cultivated.

A_p	0–12″	Very dark grayish-brown (10YR 3/2) loamy fine sand; weak medium to coarse granular structure; loose to very friable; pH 5.3; abrupt boundary.
A_3B_1	12–16″	Yellowish-brown (10YR 5/4) loamy fine sand; very weak coarse platy structure; plates break into very weak medium subangular blocky aggregates; very friable to loose; pH 5.3; clear boundary.
B_{21}	16–32″	Dark yellowish-brown (10YR 4/4) loamy fine sand; very weak medium to coarse subangular blocky structure; very friable; pH 5.8; a few pebbles; clear boundary.
I, II B_{22}	32–36″	Reddish-brown (5YR 4/3–4/4) clay loam; moderate medium to coarse subangular blocky structure; a few patchy dark coatings on the ped surfaces; firm; pH 5.4; abrupt boundary.
II B_{23}	36–60″	Reddish-brown (5YR 4/4) silty clay; moderate medium blocky structure; very firm moist and slightly plastic wet; pH 5.2 in upper part of horizon becoming less acid with depth; gradual boundary.
II C	60″+	Brown (7.5YR 5/4) silty clay loam; massive; calcareous at depth.

Ottawa, Berrien, *Neshkoro. These three soils form a catena of well, moderately well, and imperfectly drained Gray-Brown Podzolic soils formed in sands and loams about 36 to 60 inches deep over calcareous silts and clays of glacio-lacustrine origin. The Neshkoro is a newly proposed series. As with the Tustin, Seward, and Rimer soils, these soils may have somewhat dark surface layers reflecting a past prairie type of vegetation. Natural vegetation at present, however, consists mainly of hardwoods (oak types). Soils of the Ottawa catena are found mainly on level glacial lake plains in association with soils of the Tustin catena, as well as Oshkosh, Gotham, and Shiocton soils.

The following profile was described on a level terrace in the northwest part of the county (NE¼NW¼ sec. 34, T17N., R9E.). This soil was believed to be imperfectly to moderately well drained. It would therefore be classified as Neshkoro.

Soil Profile: *Neshkoro loamy sand—cultivated.

A_p	0–7″	Very dark grayish-brown (10YR 3/2) loamy sand; very weak medium granular structure; very friable; pH 5.9; abrupt boundary.
A_{3g}	7–19″	Yellowish-brown (10YR 5/4) loamy sand; few to common fine strong brown (7.5YR 4/6) mottles; single grain; very friable but slightly coherent in place; pH 5.8; gradual boundary.

B_g	19–26″	Yellowish-brown (10YR 5/4) fine sand; few to common medium strong brown (7.5YR 4/6) mottles; single grain; very friable; pH 5.0; clear boundary.
B_{mg}	26–33″	Brown (7.5YR 5/4) fine sand; massive; friable; pH 5.8; weakly cemented; few yellowish red (5YR 5/6) soft concretions; clear boundary.
I, II C_{1g}	33–48″	Yellowish-red (5YR 5/6) fine sands and brown (7.5YR 5/2) silts; mottled; stratified; clear boundary.
II D_g	48″+	Light brownish-gray (10YR 6/2) silts; mottled reddish brown (5YR 4/4); pH 6.0 becoming calcareous with depth.

Ottawa and Berrien soils differ from the Neshkoro soils in having little or no mottling and gleying in their profiles.

***_Fall River._** The Fall River series includes poorly and very poorly drained Humic Gley soils formed in fine sands and loams overlying calcareous silts at depths of about 30 to 60 inches (see Figure 13). These soils have a dark colored surface horizon 8 to 12 inches thick. Beneath this is a drab layer transitional to a gleyed sandy C horizon which in turn is underlain by silts. These soils have been noted locally in Marquette County. They occur in association with the Puchyan, Neshkoro, Rimer, Shiocton, and sandy soils.

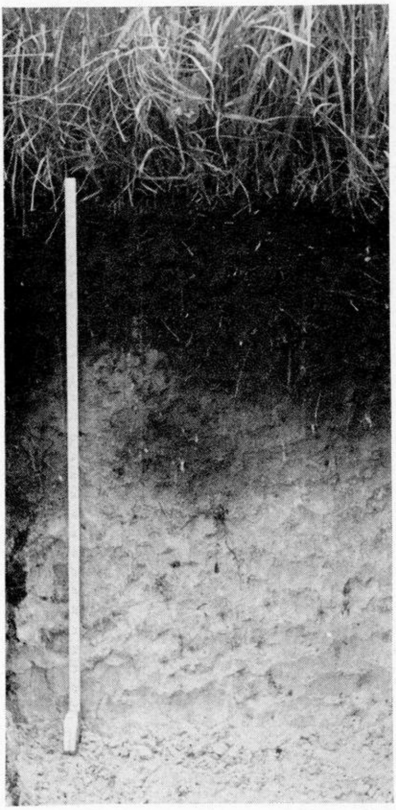

Figure 13. Fall River fine sandy loam. Note the thick, dark colored, surface horizon.

The following profile was described on large level glacio-lacustrine flat in the east-central part of the county (NE¼SE¼ sec. 30, T16 N., R11E.). It was associated with Nekoosa soils.

Soil Profile: *Fall River fine sandy loam—cultivated.

A_p	0–12″	Black (10YR 2/1) fine sandy loam; weak to moderate medium granular structure; very friable; slightly acid; abrupt boundary.
A_{3g}	12–17″	Very dark grayish-brown (2.5Y-10YR 3/2) loamy fine sand; very weak medium subangular blocky structure; slightly acid; clear boundary.
C_{1G}	17–24″	Grayish-brown (2.5Y 5/2–6/2) fine sand; stratified with light olive gray (5Y 6/2) lenses of silt; alkaline; clear boundary.
C_{2G}	24–40″	Light brownish-gray (2.5Y 6/2)fine sand and loamy fine sand; stratified; loose; alkaline; clear boundary.
II D_{1g}	40″+	Brown (7.5YR 5/4) silt; light brownish-gray (2.5 Y 6/2) streaks and mottles. Calcareous.

*Tuscola, *Shiocton, *Keowns.* Soils of this catena are formed from calcareous glaciolacustrine silts and fine sands, with occasional lenses of clay. These stratified parent materials contain more sandy layers and fewer clay layers than the parent materials of the Oshkosh and Briggsville soils. As a rule they do not have the pinkish or red hues also associated with the parent materials of the latter soils.

In Marquette County the Tuscola soil was considered to be well to moderately well drained, the Shiocton moderately well to imperfectly drained, and the Keowns poorly or very poorly drained. The Tuscola and Shiocton are light colored Gray-Brown Podzolic soils, although dark colored variants were also noted. The Keowns is a dark colored Humic Gley soil.

The following profile was studied in a pit dug in a nearly level glacial lake terrace of the Mecan river drainage basin (NW¼SW¼ sec. 2, T16N., R10E.). This profile is dark colored and imperfectly drained. It is generally silty throughout with a pronounced textural B horizon. Some of these soils lack a distinctive illuvial horizon. Both kinds of profiles may be found in close proximity.

Soil Profile: Shiocton silt loam (dark colored).

A_p	0–9″	Black (10YR 2/1) gritty silt loam; moderate coarse granular structure; friable; alkaline; abrupt boundary.
A_{2g}	9–13″	Dark grayish-brown (10YR 4/2) silt loam; few fine yellowish-brown (10YR 5/4) mottles; very weak coarse platy structure; plates break into weak medium subangular blocky aggregates; peds are coated dark gray (10YR 4/1); friable; alkaline; clear boundary.
B_{2g}	13–21″	Dark brown (7.5YR 4/3) silty clay loam; common fine strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; firm, very slightly sticky wet; alkaline; clear boundary.
B_{3g}	21–25″	Brown (7.5 YR 5/4) silt loam; common fine strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; slightly firm; alkaline; clear wavy boundary.
C_{1g}	25–30″	Brown and pinkish-gray (7.5YR 5/4 and 6/2) silt loam; common medium strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; slightly firm to friable; calcareous; gradual boundary.
C_{2g}	30″+	Brown and pinkish-gray (7.5YR 5/2 and 6/2) silt loam; common medium strong brown (7.5YR 5/6) mottles; laminated; friable; occasional laminae of fine sand or silty clay loam are found in this horizon.

Tuscola soils in Marquette County may also have distinctive illuvial horizons. Unlike the Shiocton soils, however, they have little or no mottling. Keowns soils do not have textural horizons although they include layers that vary in texture due to sedimentary processes. The following description is an example of a Keowns soil.

Soil Profile: *Keowns fine sandy loam (cultivated).

A_p	0–9″	Black (10YR 2/1) very fine sandy loam; moderate medium fine granular structure; very friable; pH 7.0; abrupt boundary.
A_{3g}	9–12″	Dark grayish-brown (2.5YR 4/2) fine sandy loam; weak medium prismatic structure; prisms break into weak medium subangular blocky aggregates; very friable; alkaline; clear boundary.
B_2G	12–20″	Light olive-brown (2.5Y 5/4) fine sandy loam; few fine brown (7.5YR 4/4) mottles; weak coarse prismatic structure; very friable; gradual boundary.
B_3G	20–24″	Light yellowish-brown (2.5Y 6/4) silt loam; many medium yellowish-brown (10YR 5/8) mottles; very weak coarse prismatic structure; friable; alkaline; clear boundary.
CG	24″+	Grayish-brown (2.5Y 5/2) silts and light olive brown (2.5Y 5/4) fine sands; laminated; calcareous.

Soils Formed from Recent Alluvium

Relatively few Alluvial soils are found in Marquette County. Where found they consist of recent stream alluvium or colluvial deposits below cultivated slopes. These sediments are variable in thickness and texture, and overlie several kinds of mineral soils as well as peat.

Organic Soils (Peat and Muck)

Large areas of wet lands are found in Marquette County. These include large sedge and grass marshes, tamarack swamps, and sphagnum moss bogs. These are largely peat and muck areas, however, in some places these organic deposits are thin and overlie a mineral substratum at shallow depths. In such cases the thickness of peat and the character of the substratum become important in its classification. Table 4 is a genetic key to the classification of these soils.

The following profile was described in a pit dug in a small pastured marsh between two drumlins in southern Marquette County. In general this organic deposit was over four feet deep and was underlain by gravel and sand. The water table was at a depth of 6 feet at the time of study (13 August 1958).

Soil Profile: *Horicon muck.

O_1	0–12″	Very dark brown (10YR 2/2) fibrous muck having a few layers about an inch thick of dark reddish (5YR 3/2) peat; the muck is characterized by moderate medium granular structure and is very friable. The peaty layers consist of the layered remains of coarse sedges, etc.; pH at 4 and 10 inches is 5.8; gradual boundary.
O_2	12–22″	Very dark brown (7.5YR 3/2) peat and very dark brown (10YR 2/2) fibrous muck; moderate coarse subangular blocky structure; pH 6.7; gradual lower boundary.
O_3	22–32″	Very dark brown (10YR 2/2) finely fibrous muck having a matrix of sedimentary peat; moderate medium granular structure; pH 7.0; appears massive in place; very friable; scattered streaks and individual grains of sand are conspicuous; clear boundary.
O_4	32–38″	Very dark brown and black (10YR 2/2 and 2/1) muck as in above horizon; pH 7.2; abrupt wavy boundary.
D_1	38–42″	Olive (5Y 5/3) silts and clays; some indication of laminations; sticky wet; pH 7.5; abrupt wavy boundary.
O_{b1}	42–46″	Black (10YR 2/1) peat that appears to include some charcoal; crudely platy crushing into hard granules; brittle; one to four inches thick; pH 7.8; abrupt wavy boundary.
O_{b2}	46–66″	Light olive-gray (5Y 6/2) sedimentary peat containing diffused carbonates and snail shells; laminated; snail shells are between laminae; greasy; calcareous; gradual boundary.
O_{b3}	66–84″	Very pale brown (10YR 7/3) sedimentary peat as in above horizon. This layer differs from the one above chiefly in color. The lower part of the horizon is completely saturated with water with free water first encountered at about 72″; abrupt boundary.
D_2	84″+	Gleyed sands and gravel; single grain; loose; calcareous; this appears to be glacial outwash.

Note: The horizon at 42 inches is interpreted as representing a dry climatic period during which fires occurred. The layer of silts and clays just above (38–42″) may represent deposition in a lake in a subsequent wet period, or erosion from surrounding slopes following drought and fires. If the peat and muck above this layer was deposited at the generally accepted average rate of 1 inch each 40 years, this would have occurred at least 1500 years ago.

Another profile was described several hundred yards from the shore of a former glacial lake in the central part of the county (NW¼SW¼ sec. 19, T16N., R10E.). This muck supports both sedge and moss vegetation at present. A fairly thick layer of sedimentary peat was present below the muck; this was underlain by sand.

Soil Profile: Unclassified peaty muck.

O_{00}	6–0″	Sedges, moss, and other vegetation.
O_1	0–18″	Black (5YR 2/1) peaty muck; granular; soft; alkaline.
O_2	18–30″	Black (N 2/0) muck; massive; soft and slippery; alkaline.
O_3	30–36″	Black (5YR 2/1) and very dark grayish-brown (10YR 3/2) sedimentary peat; massive; soft; alkaline; a few pieces of wood in this horizon.
O_4	36–48″	Black (5YR 2/1) sedimentary peat; soft; alkaline.
II D_1	48″+	Fine sand; gleyed; alkaline.

In some places, particularly in the north central part of the county, acid bogs are found. These bogs usually have a thin surface layer of sphagnum growing on acid herbaceous peat. The following profile was described by K. O. Schmude[1] in a small (3 acre) bog in the NE corner of section 36, T17N., R9E. About half of the surface was covered with sphagnum moss and bog blueberry, the remainder had sedges growing on it.

Soil Profile: Unclassified acid peat.

O_{00}	12–0″	Living sphagnum moss.
O_1	0–48″	Very dark brown (10YR 2/2) disintegrated peat with 20–30% yellowish-brown (10YR 5/4) fibrous material consisting mainly of sedge remains. pH 4.0; very friable.
O_2	48–120″	Black (10YR 2/1) disintegrated peat with less than 10% yellowish-brown (10YR 5/4) fibrous materials. pH 5.5; very friable; some hard, radish-size seeds noted.
O_3	120–124″	Dark olive-gray (5Y 3/2) sedimentary peat.
D_1	124″+	Loose, slightly calcareous sands.

[1] Soil Scientist, U.S.D.A. Soil Conservation Service.

SOIL GEOGRAPHY

INTRODUCTION

The land surface of Marquette County is a mosaic composed of individual soils. Within this mosaic a number of distinctive soil patterns, or landscapes occur. Some of these are simple, others are highly complex. Some include only a few soils, others many.

By studying the soils present and sketching boundaries on a map, a soil surveyor can divide each landscape into its natural components. These may be individual soils, or groups of soils. The latter are commonly called "soil associations". Each consists of two or more soils, not necessarily similar, although they may be, that are geographically associated in a distinctive pattern. Soil associations are commonly used as mapping units on reconnaissance soil surveys.

In Marquette County both individual soils and soil associations were used as mapping units in the field. These units were then compiled into the cartographic units shown on the colored soil map. Each cartographic or map unit consists of one, or several field units. Combinations were made on the basis of (1) similarity of soils present and (2) size in relation to scale of publication.

The names used for the various cartographic units indicate in general the dominant soils present. Usually, however, several minor components are also included. As in all soil maps, the boundary lines between cartographic units are only as accurate as map scale and mapping techniques permit.

The purpose of this chapter is to describe the various cartographic units shown on the soil map, tell where they occur, and their approximate acreage. To illustrate relationships between individual soils and the landscape in which they occur, a number of diagrams have been included.

DESCRIPTION OF CARTOGRAPHIC UNITS

Soils of the Glacial Till Uplands

Four soil associations (Cartographic units 1, 2, 3, and 4) are included in this group. One or more of the major soils in each association is formed in glacial till. Major associates are mainly formed from glacio-fluvial or eolian sediments.

The major soils in map units 1 (Lapeer), and 2 (Mecan), are formed from calcareous glacial till and loamy to sandy coverings. Lapeer till is typically brown and of sandy loam texture. Mecan till has a pinkish hue and ranges from loamy sand to sandy loam in texture.

Wyocena soils (map unit 3) are formed in sandy till that is acid or only slightly calcareous. Packwaukee soils (map unit 4) are formed in till of variable composition but including clayey layers.

Inclusions in all four cartographic units may consist of portions of adjoining associations and included small areas of poorly drained soils, and peat and muck.

Soils of the glacial till uplands are found throughout the county. However, each association is typically found in certain areas. The total area occupied by the individual map units of these four associations is 65,909 acres.

Lapeer—*Pardeeville—Boyer

Major soils—Lapeer and *Pardeeville fine sandy loams; Boyer and *Puckaway sandy loams.

Minor soils—Hennepin sandy loam; shallow substratum variants of Lapeer and *Pardeeville; Gotham and Oshtemo loamy sands.

Inclusions—*Astico (dark colored variant) fine sandy loam; *Puchyan and *Lost Lake (dark colored variants) fine sandy loams and loamy fine sands; poorly drained mineral soils of variable texture; peat and muck.

Where found—Mainly in the southeastern part of the county. Scattered areas are found elsewhere.

Total area—13,063 acres.

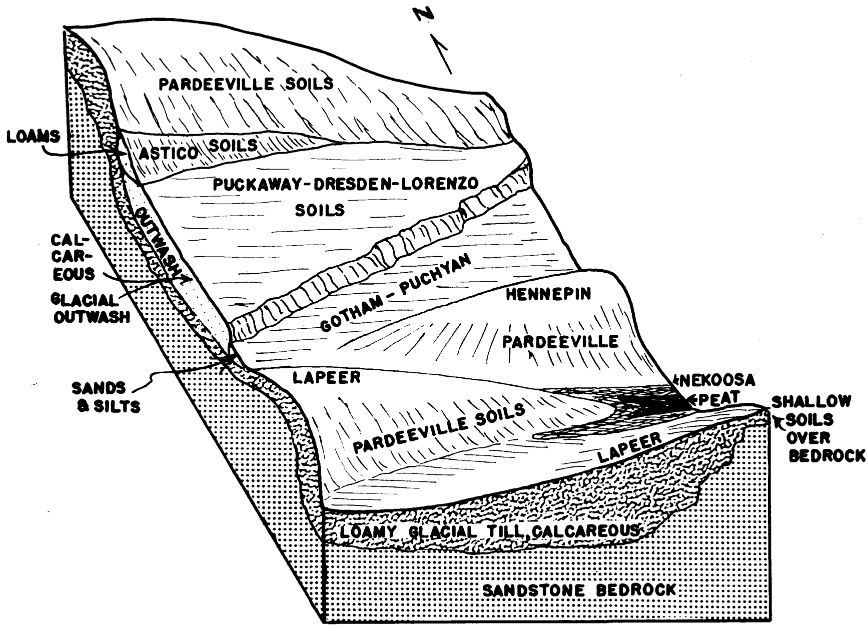

Figure 14. Landscape diagram showing Lapeer, Pardeeville, Boyer and associated soils.

Description—The areas in which these soils are found are underlain by sandstone, however dolomite outcrops are found only several miles to the east or south in Green Lake and Columbia Counties. Drumlins, oriented in an east-west direction are prominent land forms. The calcareous sandy loam till is blanketed with several inches to several feet of loamy gravel-free coverings. Slopes are characteristically smoothly convex and range from 6 to 20 percent in gradient. Between the drumlins are valleys, in which loamy to sandy sediments, and wet basin-like areas of peat and muck have accumulated. In some places, bench-like terraces have been formed from stratified sands and gravels. In other places, level or gently sloping uplands are underlain at shallow depth by sandstone bedrock. Figure 14 illustrates some of the relationships between landscape position, parent materials, and soils in this region.

Lapeer soils are well drained light colored soils, mainly of sandy loam texture. They are found on upland slopes in this area, particularly slopes having a northerly aspect. Pardeeville soils are similar to the Lapeer soils in textural and drainage characteristics, but, as a result of forming under prairie vegetation, have a deeper and darker suface layer. They are usually found on south-facing slopes where the prairies and oak openings existed prior to settlement. A shallow associate of the Pardeeville and Lapeer soils, the Hennepin, is usually found on narrow, sharply convex ridges and very steep slopes. Soils on the shallow-to-bedrock uplands are generally similar to the Lapeer and Pardeeville soils except for the presence of sandstone at about 2 to 4 feet. These soils have usually developed in a loamy overburden and a thin layer of glacial till. Usually no unweathered till is found between the solum and bedrock. Locally, the weathered till is also absent and a somewhat coarser soil is formed in shallow loams and sandstone.

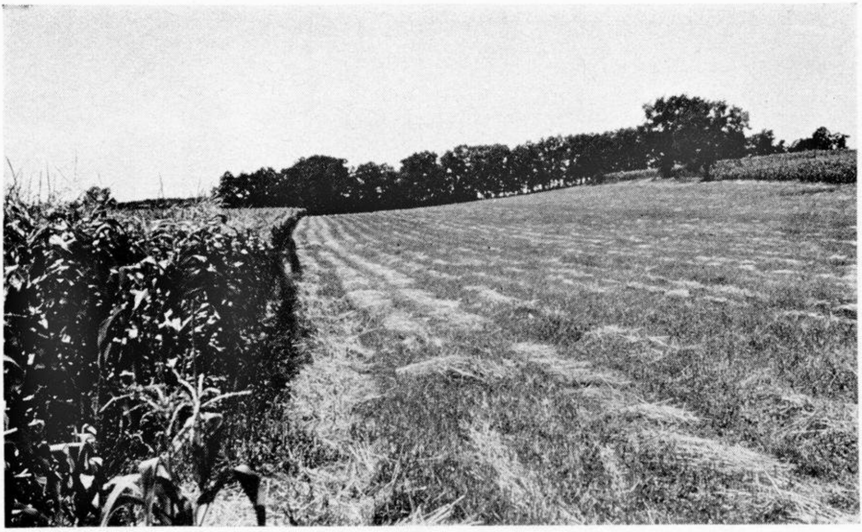

Figure 15. Puchyan soils are found in valleys such as this in southern Marquette County. Astico soils are on the adjacent footslope while Pardeeville soils are on the crest and flanks of the drumlin.

Boyer (light colored) and Puckaway (dark colored) are found on terraces within this unit. These soils are mainly of sandy loam texture moderately deep over calcareous gravel and sand. Other terrace soils may include the Dresden, Fox, Lorenzo, and Oshtemo. These soils are described under cartographic units 5 and 6.

Astico soils are formed from loamy sediments, of eolian or colluvial origin, that are found in scattered places, usually on concave slopes. Where 1 to 3 feet of fine sands or loams overlie silts, and the soil is formed in both materials it is called Puchyan (see Figure 15). Originally both of these soils were described as being light colored, however dark colored variants are most common in Marquette County.

Small areas of Gotham and Plainfield, somewhat excessively drained sandy soils, and less well drained soils of similar texture are also found in scattered places between the hills. These soils are described under cartographic units 10, 11, and 12.

Small areas of peat and muck are found in poorly drained basins. These are mainly sedge and grass peats. Larger areas are described under cartographic unit number 22.

*Mecan–Gotham

Major soils—Mecan fine sandy loam or loamy fine sand; Gotham loamy sand.

Minor soils—Hennepin sandy loam; Wyocena sandy loam or loamy sand; Oshtemo loamy sand; Boyer sandy loam.

Inclusions—Plainfield sand; poorly drained mineral soils of variable texture; peat and muck.

Areas of occurrence—Mainly in the northeastern and central parts of the county; scattered areas elsewhere.

Total area—16,329 acres.

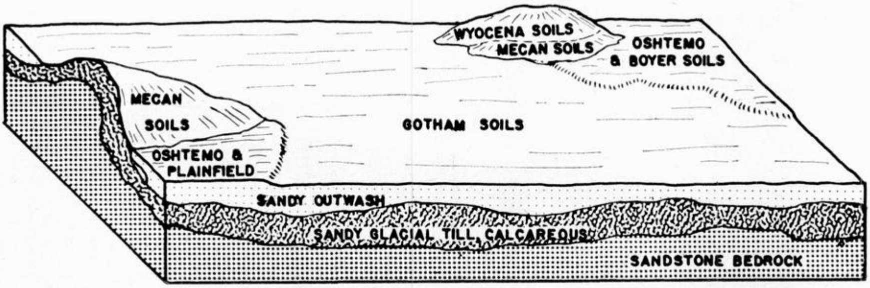

Figure 16. Landscape diagram showing Mecan, Gotham, and associated soils.

Description—In the northeastern and central areas, Mecan soils are found on till-covered sandstone hills surrounded by Gotham soils on sandy terraces. The Mecan soils are sloping to steep having slopes of about 6 to 20 percent. Gotham soils are level, or gently sloping (see Figure 16).

In other parts of the county Mecan soils are found on land forms having less relief. Slopes are apt to be longer and range from about 4 to 12 percent in gradient. Calcareous glacio-fluvial sediments are often found below the parent till of the Mecan soils in these areas. Where glacio-fluvial sediments extend into the surrounding terraces, Boyer and Oshtemo soils are common associates.

The Mecan soils are loamy to sandy, light-colored, well to somewhat excessively drained Gray-Brown Podzolic soils formed in two-storied parent materials.[1] The lower story consists of calcareous loamy fine sand or fine sandy loam till containing a noticeable amount of dolomitic gravel. This gravel is believed to have its origin in Ordivician outcrops found east of Marquette County.

The upper story consists of gravel-free loamy fine sand, or fine sandy loam, probably of eolian origin. When this upper story becomes thick, a bisequal (double) profile is sometimes found.

The Gotham soils are sandy throughout being formed from sands or loamy sands 5 feet or more in thickness. They are somewhat excessively to excessively drained and moderately dark to light colored. Gotham soils usually have somewhat darker surface horizons and deeper, more coherent subsoils than their close relatives, the Plainfield soils. The latter are also associated with the Mecan soils in some areas. Both Gotham and Mecan soils are believed to be underlain by calcareous drift at depth when they occur in association with soils formed from calcareous till or outwash.

Locally in Mecan–Gotham map units, particularly in the northeastern and central areas, the drift cover may be very thin and sandstone can be encountered within 2 to 4 feet of the surface. In other places, the till is sandy and contains very little dolomite. Wyocena soils are formed in this type of till and appear as associates of the Mecan soils where this type of till occurs.

[1] More detailed descriptions of this and other soils may be found in the preceding chapter.

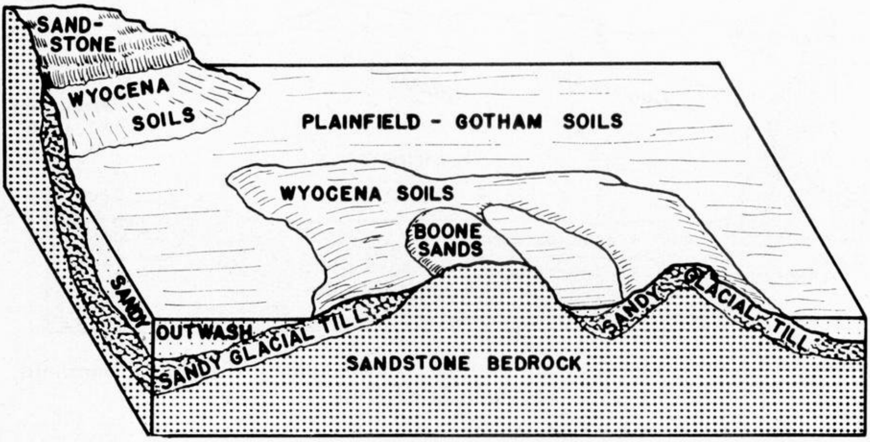

Figure 17. Landscape diagram showing Wyocena, Plainfield, and associated soils.

*Wyocena—Plainfield

Major soils—Wyocena sand and sandy loam; Plainfield sand.

Minor soils—Gotham loamy sand; Oshtemo loamy sand; Boyer sandy loam; Boone sand.

Inclusions—Mecan fine sandy loam or loamy fine sand; peat, muck, and poorly drained mineral soils of variable texture.

Areas of occurrence—Mainly in the central and western parts of the county. Many of these areas are associated with the recessional moraines.

Total area—29,689 acres.

Description—Wyocena soils are most commonly found on the sandy, drift covered sandstone hills of central and western Marquette County. Here they occur in close association with the sandy Plainfield and Gotham soils (see Figure 17).

Wyocena soils are commonly sloping to steep or hilly. Slopes range from about 6 to 25 percent or more and are usually irregular or complex. Plainfield and Gotham soils may be either level or sloping, and in some places hilly when they occur in this association.

The Wyocena soils are sandy to loamy, mainly light colored, somewhat excessively drained Gray-Brown Podzolic soils formed in acid or weakly calcareous sandy drift. This type of parent material grades into more calcareous till, and either Mecan or Lapeer soils, in the eastern part of the county.

In some parts of the Wyocena area, calcareous and acid drifts appear to be intermingled. Here, Mecan or Lapeer soils may be found in close association with Wyocena soils on upland slopes while Boyer or Oshtemo soils occur on associated terraces. Locally, especially on steep slopes where the drift cover is thin or absent, Boone-like soils are formed in sandstone.

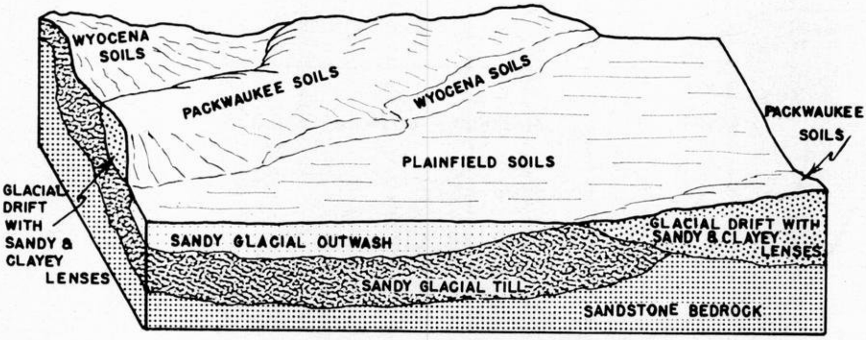

Figure 18. Landscape diagram showing Packwaukee, Wyocena, Plainfield, and associated soils.

*Packwaukee–*Wyocena–Plainfield

Major soils—Packwaukee and Wyocena sandy loams to sands; Plainfield sands.

Minor soils—Gotham loamy sand; Mecan fine sandy loam or loamy fine sand; Boyer sandy loam.

Inclusions—Peat and muck and poorly drained mineral soils of variable texture.

Areas of occurrence—Western Marquette County in the recessional moraines.

Total area—6,828 acres.

Description—Packwaukee soils are found on slopes of the morainal ridges which stretched from north to south across western Marquette County (See Figure 18). In some places these slopes are smooth and only gently sloping. In other places they are rolling, or hilly and complex. Included terraces are level to sloping.

Soil parent materials in the moraine are variable in texture and intermingled in a complex manner. The Packwaukee soils are formed from sands and loams having included layers, or lenses, of clayey drift. In many places they are underlain by calcareous sand and gravel.

Wyocena soils are formed on the associated sandy to loamy acid till; Mecan soils on loamy to sandy calcareous till. Plainfield and Gotham soils are found on associated acid terrace sands; Boyer soils on calcareous outwash which occurs sporadically throughout the area.

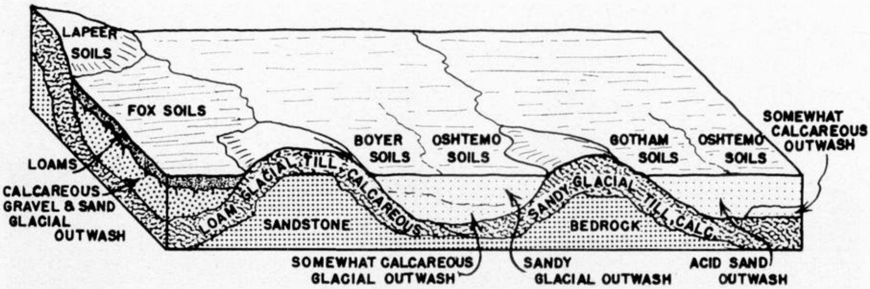

Figure 19. Landscape diagram showing soils formed in calcareous glacio-fluvial materials.

Soils Formed from Calcareous Glacio-Fluvial Deposits

Three soil associations (Cartographic units 5, 6, and 7) are included in this group. Most of the individual soils are formed in loams or sands over calcareous sands and gravel (see Figure 19). The latter materials consist mainly of well-rounded dolomitic gravel and coarse calcareous sands. Some evidence of stratification is usually present. Sorting varies from good to poor.

Going from soil associations 5 to 7, gravel content decreases, the sediments become less calcareous, surface layers become deeper and sandier, and map units include a higher proportion of soils formed in acid sands without calcareous substrata within 5 feet.

Main areas of these soils are found in the southern and central parts of the county with lesser amounts in the northeast. Scattered units may be found throughout the county, however, individual members of the various associations may be found as members of other associations.

Individual map units of all three associations may contain portions of adjoining map units plus inclusions such as shallow regosolic soils (Rodman), soils formed from other kinds of parent materials such as glacial till or glacio-lacustrine sediments, poorly drained mineral soils of variable texture, and peat or muck.

The total area occupied by the individual map units of these three associations is 43,939 acres.

Boyer–Fox–Dresden

Major soils—Fox and Dresden sandy loams and loams; Boyer and Puckaway sandy loams.

Minor soils—Casco and Lorenzo sandy loams and loams; Oshtemo loamy sand and dark colored soils of similar texture.

Inclusions—Rodman gravelly loam; Lapeer or Pardeeville fine sandy loam; dark colored poorly drained soils of variable texture; peat and muck.

Area of occurrence—Mainly in southeastern Marquette with a smaller area in the northeastern part of the county. Scattered areas elsewhere.

Total area—5,047 acres.

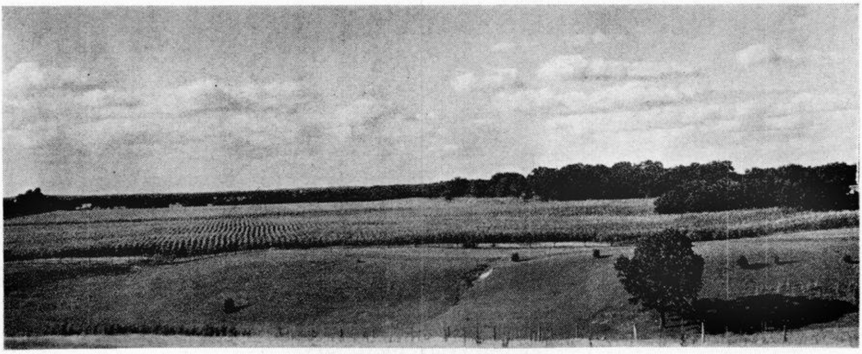

Figure 20. Corn growing on Dresden soils on terrace. Rodman soils on terrace escarpment.

Description—Soils of this association are found mainly on level to sloping glaciofluvial terraces which lie adjacent to or between the till uplands of southeastern Marquette County. Occasional kettles (steep-sided pits) and other natural depressions are included.

The Boyer soils are light colored somewhat excessively drained soils of sandy loam texture formed in loamy sediments overlying calcareous outwash. They are usually calcareous at depths of 24 to 42 inches.

Puckaway soils are similar in texture and lithology but have moderately thick and dark surface horizons.

Fox soils are light colored well to somewhat excessively drained soils of loam or sandy loam texture formed in loams overlying calcareous gravelly outwash. Like the Boyer soils they are usually calcareous at depths of 24 to 42 inches. They are somewhat heavier in texture than the Boyer soils, however, and have more strongly developed B horizons. C horizons usually contain a higher proportion of coarse gravel.

Dresden soils (see Figure 20) are similar to Fox soils in texture and lithology but are dark colored.

Cartographic units of this association also include somewhat shallow (less than 24") light colored Casco and dark colored Lorenzo soils. These soils are either sloping or level. On steep slopes such as terrace escarpments (see Figures 19 and 20) very shallow gravelly soils called Rodman are found.

Other associates may include the deep and sandy Oshtemo (see map unit 6).

Oshtemo–Boyer

Major soils—Oshtemo loamy sands; Boyer sandy loams.

Minor soils—Oshtemo loamy sands (dark phase); Puckaway sandy loams; Gotham loamy sands.

Inclusions—Shallow soils; dark colored poorly drained soils of variable texture; peat and muck.

Area of occurrence—Southern and eastern parts of the county with large areas around Montello and Germania.

Total area—8,313 acres.

Description—Soils of this association are found on level or undulating terraces. Kettles (pits) and other natural depressions are included.

Oshtemo soils are the dominant member of most map units. These are light colored somewhat excessively drained soils. Surface textures range from loamy sand to sandy loam. Subsoils range from sandy loam to sandy clay loam. Stratified, calcareous sands are found at depths of 40 to 60 inches. The gravel content is low.

In some places the Oshtemo soils have dark colored surface layers. Such profiles are probably Prairie or intergrade soils, however, they have not been recognized as a separate series to date.

Boyer and Puckaway soils are found where calcareous materials are found within 42 inches of the surface. These soils are less sandy and may contain larger amounts of gravel in their substrata.

Oshtemo–Gotham

Major soils—Oshtemo loamy sands; Gotham loamy sands.

Minor soils—Plainfield sand.

Inclusions—Dark colored poorly drained sandy soils; peat and muck including sphagnum bogs.

Areas of occurrence—Central and eastern Marquette County with scattered areas elsewhere. Largest areas are in the vicinity of Montello.

Total area—30,579 acres.

Description—This is the largest association of mineral soils in Marquette County. Oshtemo and Gotham soils occur as an association on sandy, level to undulating terraces where depth to calcareous outwash varies from about 40 inches to greater than 5 feet. In much of the area this variation occurs in a very intricate pattern. Consequently, the two soils frequently occur as a complex in which individual soils cannot be easily mapped out, even on large scale maps. Such an area may be found just north of Montello.

Oshtemo is the major soil present in most of the map units (see description of Oshtemo in map unit 6). The Gotham soils, as found in this association, are somewhat similar but lack the textural B horizon, and are acid throughout. Calcareous sediments can usually be found at depth throughout the association.

In some places the very sandy Plainfield soils are found in association with Oshtemo soils. Poorly drained sandy soils may be found locally, as are peat and muck. The latter may include bogs found in kettles or other depressions in the terrace.

Soils Formed from Acid Sands

Five soil associations (Cartographic units 8, 9, 10, 11, and 12) are included in this group. Individual soils are formed mainly in acid glaciofluvial sands, or in a few cases, loams on terraces or broad flats (see Figure 21). In some associations hilly areas are also included. With the exception of Pleasant Lake soils they are mainly gravel-free. Small differences in texture and degree of development, and differences in morphology due to variation in natural drainage are the main reasons for separating the various soils into different series.

Cartographic units 8, 9, and 10 consist mainly of somewhat excessive to excessively drained soils. Each may contain imperfect or poorly drained mineral soils, or peats and mucks, as minor inclusions. Cartographic unit 11 consists mainly of moderately well and imperfectly drained soils while map unit 12 consists mainly of dark colored poorly and very poorly drained soils. Units 11 and 12 may include droughty soils as inclusions, as well as peat and muck.

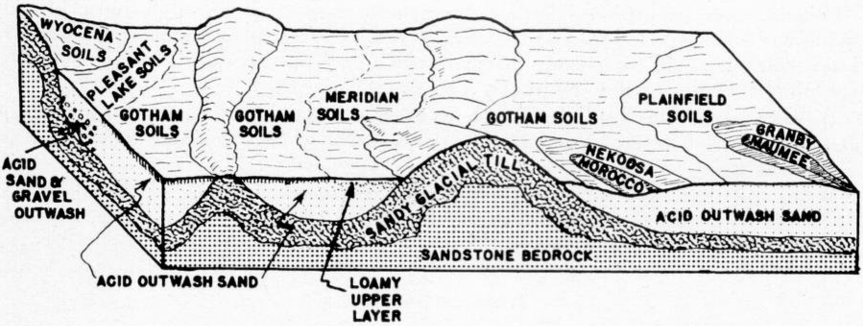

Figure 21. Landscape diagram showing soils formed in acid sands.

Sandy soils are found throughout Marquette County, either as members of the five associations described below or as individual soils in other associations. Largest individual areas are found in the north central part of the county. Total area occupied by all of the individual map units in the five associations described below is 56,706 acres.

Gotham–*Pleasant Lake

Major soils—Gotham loamy sand and Pleasant Lake sandy loam.

Minor soils—Meridian sandy loam.

Inclusions—Plainfield sand and Boyer sandy loam.

Area of occurrence—This association is confined to a relatively small area in the northwest corner of Marquette County.

Total area—2,672 acres.

Description—The Gotham–Pleasant Lake association is found on level to undulating terraces associated with the moraine in northwestern Marquette County. The Gotham soils are formed from deep acid sands while the Pleasant Lake soils occur on associated loams and sands that include gravelly layers. The gravel is generally non-dolomitic and acid, but may include calcareous material locally.

The Pleasant Lake soils have been tentatively classified as Prairie soils intergrading to Gray-Brown Podzolics. However, they have certain characteristics (B_{hir} horizons) that indicate that they are also closely related to Podzols. In general they can be described as moderately dark colored, somewhat excessively drained, loamy to sandy soils.

Meridian sandy loam or Plainfield sand may also be included in some map units. The former is an acid loamy soil (see description in map unit 9). Local areas of calcareous outwash gives rise to soils such as Boyer sandy loam.

Gotham–Meridian

Major soils—Gotham loamy sand and Meridian sandy loam.

Minor soils—none.

Inclusions—Imperfectly or poorly drained sandy soils; peat and muck.

Area of occurrence—North central and northwestern Marquette County bordering the Gotham–Pleasant Lake association in the latter area.

Total area—1,485 acres

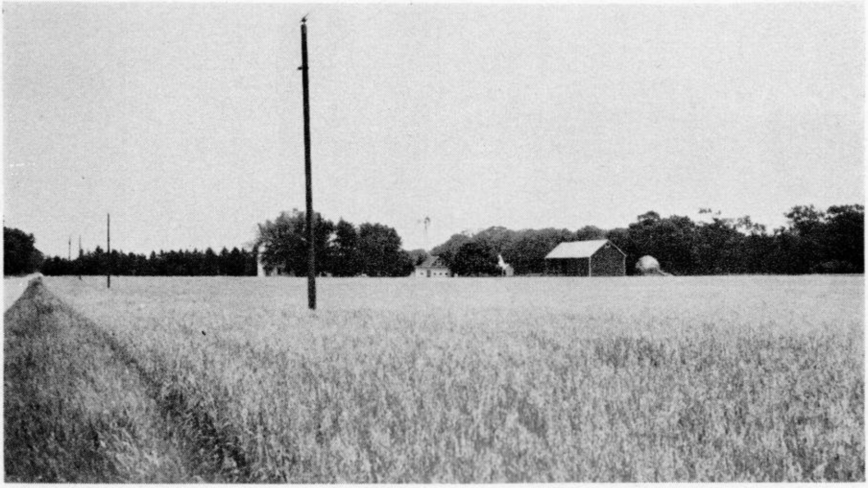

Figure 22. Grain on Meridian soils in northern Marquette County.

Description—This association is not extensive and has a relatively small total acreage. Included soils are formed on level to undulating sand terraces (see Figure 22). Meridian soils are found where loamy sediments overlie the sands.

The Meridian series includes light colored, somewhat excessively drained soils of sandy loam or light loam texture. They are acid throughout. Locally, in Marquette County, their surface layers may be somewhat dark colored.

There are no minor units included in this association. Inclusions may consist of imperfectly or poorly drained sands, or peat and muck.

Gotham–Plainfield

Major soils—Gotham loamy sand and Plainfield sandy loam.

Minor soils—Nekoosa and Morocco loamy sands or sands.

Inclusions—Dark colored and poorly drained mineral soils (Granby and Maumee); peat and muck.

Areas of occurrence—Throughout the county. Largest areas in the north central part.

Total area—23,751 acres.

Description—The Gotham–Plainfield association is an extensive, large-acreage unit. Individual map units may be either large or small. Most commonly these soils occur on nearly level or gently undulating terraces (see Figure 23). Sloping or rolling areas may also be found, however, and dune topography occurs locally.

The Gotham series includes somewhat excessively to excessively drained, moderately dark to light colored, acid soils of loamy sand texture. They closely resemble the Plainfield soils but have more coherent subsoils (B horizons) and oftentimes, darker and thicker surface horizons. They are classified as intergrade (Prairie-Gray-Brown Podzolic) soils but in many parts of Marquette County, light colored soils are included in the series.

Plainfield soils are somewhat excessively or excessively drained, light to moderately dark colored, acid soils of sand texture. They are somewhat more droughty and less productive than the Gotham soils. However, the two soils may intergrade and occur

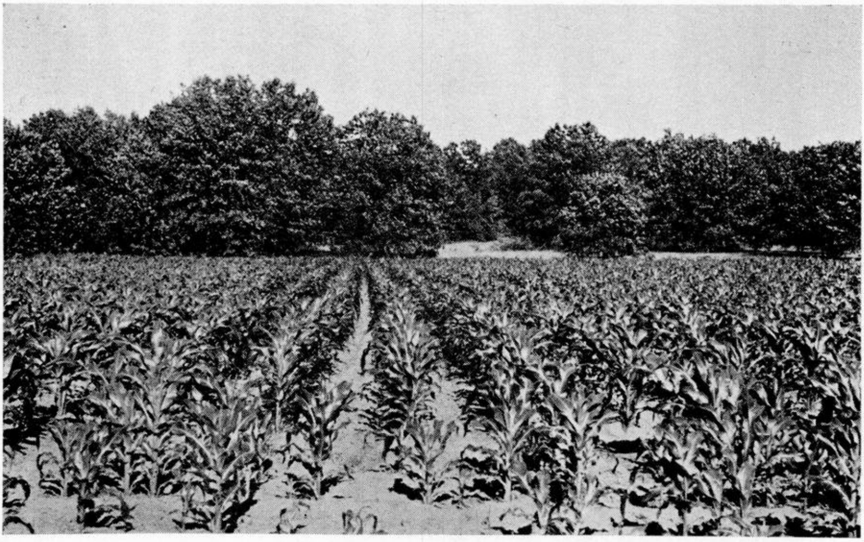

Figure 23. Corn with scrub oak in background on Gotham soils in southern Marquette County.

in such close association that accurate separation of them on a soil map is difficult in places.

As members of this association, and individually as members or inclusions in other associations, the Gotham and Plainfield soils are two of the most common soils in the county.

Nekoosa, moderately well drained, and Morocco, imperfectly drained sandy soils are minor components of the Gotham–Plainfield association. Poorly and very poorly drained Granby and Maumee soils, and peat or muck are common inclusions.

Nekoosa–Morocco

Major soils—Nekoosa and Morocco loamy sands and sands.

Minor soils—Gotham loamy sands. Plainfield sands.

Inclusions—Granby or Maumee loamy sands or sands; peat or muck.

Areas of occurrence—Throughout the county; largest areas are in the north central part.

Total area—21,376 acres.

Description—Nekoosa–Morocco map units have a large total acreage. Individual units, however, tend to be somewhat smaller than those of the Gotham–Plainfield association.

This map unit is found most commonly on level terraces or locally as gently sloping rises in a poorly drained area.

Nekoosa soils are moderately well drained, light colored, soils of sand or loamy sand texture. They differ from the Plainfield soils in having mottled subsoils. They may also have somewhat darker surface horizons and be less acid. The mottling indicates that these soils are saturated for short but significant periods during the year. Ground water is sometimes encountered within auger depth (5 feet).

Morocco soils are imperfectly drained light to dark colored soils, of sand or loamy sand texture. Morocco soils are mottled close to the surface and their subsoils often have a drab appearance. Surface horizons may be quite dark. These soils are (or have been if presently drained) saturated for significant periods during the year. Ground water is often encountered within auger depth (5 feet).

Gotham and Plainfield soils are often included in Nekoosa–Morocco map units. Granby and Maumee, and peat or muck may also occur as inclusions.

Granby–Maumee

Major soils—Granby and Maumee loamy sands and sands.

Minor soils—Morocco and Nekoosa loamy sands or sands.

Inclusions—Gotham loamy sand or Plainfield sand; peat or muck.

Areas of occurrence—Throughout the county. Large areas are found north of Lake Puckaway.

Total area—7,422 acres.

Description—Granby and Maumee soils are usually found on broad flats where a high water table exists, or in depressions of well drained areas.

Both soils are dark colored, neutral to slightly acid in reaction, and poorly to very poorly drained in their natural state. They are differentiated according to the thickness of their surface horizon. The Granby, which is the more common of the two soils in Marquette County, has a thinner surface horizon than the Maumee.

Both soils are formed in loamy sands or sands five feet or more in thickness. In some parts of the county they are underlain by silty or clayey sediments below that depth.

Nekoosa or Morocco soils may be found locally in this association, usually on low rises. Gotham and Plainfield soils may also occur on a local rise or on a bordering area that is included in the mapping unit. Peat and muck is quite often associated with Granby and Maumee soils and shallow peats and mucks over sand may sometimes be included in the association.

Soils Formed from Glacio-Lacustrine Sediments

Eight soil associations (Cartographic units 13–20) are included in this group. Soils are mainly level to undulating and are found in former glacial lake basins, on flats, or on stream terraces. In some places sloping lacustrine soils are found on moraines. These are probably remnants of former terraces.

The soils in six of these associations (Cartographic units 13–18) are formed in two-storied parent materials consisting of calcareous reddish-brown silts and clays, having shallow to deep, fine sandy loam or loamy fine sand surface covering (see Figures 24 and 26). Parent materials in the other two associations (map units 19 and 20) consist mainly of stratified fine sands and silts with included clay layers, or associated deep sands (see Figure 27).

The largest areas of lacustrine soils, formed from calcareous silts and clays, are found in the western part of the county, mainly west of U. S. Highway 51. Those formed in stratified sands, silts, and clays are found mainly in the northeastern and north central parts of the county.

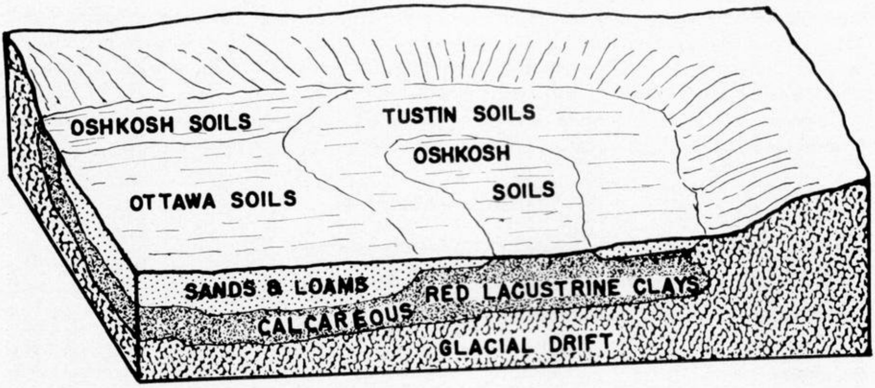

Figure 24. Landscape diagram showing soils formed in glacio-lacustrine silts and clays, some with loamy coverings.

*Oshkosh–*Briggsville–*Tustin

Major soils—Oshkosh and Briggsville silt loams and fine sandy loams; Tustin fine sandy loam or loamy fine sand.

Minor soils—Winneconne and a dark colored variant of the Briggsville series. Both are silt loams or fine sandy loams. Seward and Rimer fine sandy loams or loamy fine sands; Poygan (poorly drained) silty clay loam, silt loam, or loam.

Inclusions—Ottawa, Berrien and Neshkoro fine sandy loams or loamy fine sands.

Areas of occurrence—Mainly west of Highway 51. Large areas are found west of Westfield and east and north of Oxford.

Total area—28,501 acres.

Description—Soils of this association are found in basins, on flats, and on upland slopes, particularly the inner face of end moraines in western Marquette County. Slopes are mainly level to undulating, but sloping to rolling in some places, particularly on moraines.

These are the "red clay" soils of the region. They are formed in calcareous reddish-brown silts and clays, often laminated, and commonly having very shallow to moderately deep surface coverings of silt loam, fine sandy loam, or loamy fine sand texture. Oshkosh and Briggsville soils usually have silt loam or silty clay loam surface textures. Tustin soils are usually fine sandy loams. Subsoil horizons in the Oshkosh commonly range from silty clay to clay in texture, and in Briggsville soils from silty clay loam to silty clay. Tustin soils have sandy or loamy textures in the upper part of their subsoil but become silty or clayey with depth.

All of these soils are well drained, light colored, and acid in reaction. Briggsville soils differ from the Oshkosh in being less clayey and in being leached to a greater depth (see Figure 25). They also appear to have somewhat more permeable substrata.

Well drained dark colored Prairie soils are formed from the reddish-brown silts and clays in some places. The Winneconne soils are similar to the Oshkosh in texture and lithology but are dark colored. A dark colored variant of the Briggsville series has also been recognized.

Other, minor soils in the association include the Seward, and Rimer sandy loams. These are moderately well, and imperfectly drained members of the Tustin catena. Poygan soils may also be found. They are the poorly drained member of the Oshkosh catena.

Ottawa, Berrien, and Neshkoro soils may occur as inclusions in some map units. These are well, moderately well, and imperfectly drained soils found in loams or sands 40 to 60 inches thick over silts and clays.

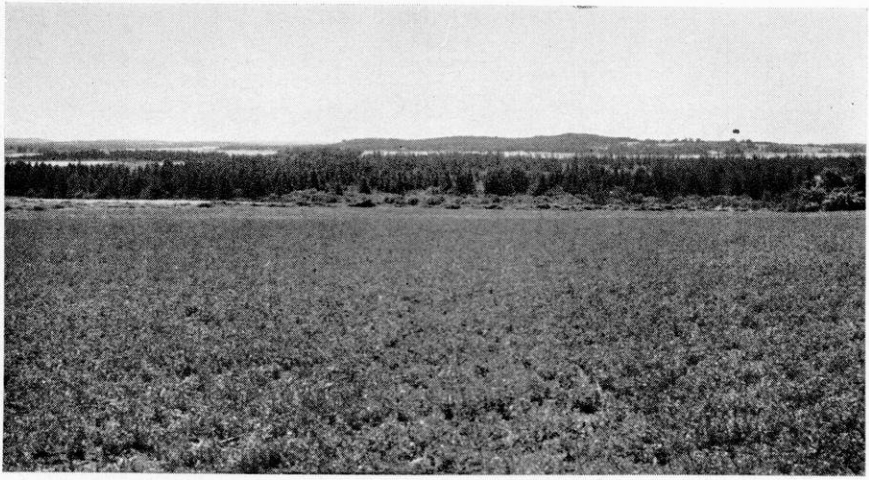

Figure 25. Briggsville landscape in western Marquette County. Note tamarack swamp and Observatory Hill in background.

Ottawa–*Tustin

Major soils—Ottawa and Tustin fine sandy loams and loamy fine sands.

Minor soils—Seward and Rimer, or Berrien and Neshkoro, fine sandy loams and loamy fine sands.

Inclusions—Delton and Packwaukee sandy loams or loamy sands.

Areas of occurrence—In association with the Oshkosh–Briggsville–Tustin association in western Marquette County and as the dominant unit in an area lying east of Highway 22, between Lake Puckaway and Germania in the northeastern part of the county.

Total area—7,422 acres.

Description—Soils of the Ottawa–Tustin association are level to undulating and are found mainly on flats or former glacial lake basins.

Parent materials are two-storied. They consist of calcareous reddish-brown silts and clays covered with loams or sands ranging in depth from about 12 to 60 inches. Ottawa soils are formed where the upper story is deepest, that is from about 36 to 60 inches. Tustin soils are formed where silty or clayey horizons are encountered at about 12 to 36 inches. Part of their B horizon is formed in the lower story.

In some places the depth to clay is fairly constant, or varies in a predictable manner. In other places the topography of the lower story is very irregular and the two soils exist in an intricate complex.

Both soils are light colored and well to somewhat excessively drained. They are acid in their upper horizons. The Tustin soils become calcareous soon after the silty and clayey horizons are encountered. Silty and clayey layers in the Ottawa soils are usually calcareous at the contact.

Less well drained catenal associates of both soils are often included in mapping units. In some places Delton and Packwaukee soils are also included. Delton soils are very similar to Tustin soils in natural drainage, texture and sequence of horizons. They differ from the Tustin soils in being leached to a greater depth. Packwaukee soils have been described in map unit number 4.

Ottawa—*Neshkoro

Major soils—Ottawa, Berrien, and Neshkoro fine sandy loams and loamy fine sands.

Minor soils—none.

Inclusions—Soils of the Tustin catena; poorly drained mineral soils (Poygan and Poy); peat or muck.

Areas of occurrence—Mainly in western Marquette County, in association with other soils formed from glacio-lacustrine sediments.

Total area—3,266 acres.

Description—Soils of this association are level to undulating and are found mainly on flats or former glacial lake basins.

Parent materials are two-storied and consist of calcareous reddish-brown silts and clays overlain with loams or sands mainly 36 to 60 inches in depth.

The well drained Ottawa soil is the dominant member of this association, and is the most common soil in the majority of map units. Either Berrien (moderately well drained) or Neshkoro (imperfectly drained) soils, or both, are also included in most map units. These soils have mottled subsoils indicating saturation with water during significant periods during the year. This may be caused by a temporary high water table, or by seepage, or both. Small areas of poorly drained soils such as Poygan or Poy or peat and muck may also be found in some units.

*Neshkoro—Wauseon

Major soils—Neshkoro and Wauseon fine sandy loam or loamy fine sands.

Minor soils—Poygan or Poy silty clay loams to fine sandy loams.

Inclusions—Other soils formed in glacio-lacustrine sediments; peat or muck.

Areas of occurrence—Mainly in western Marquette County, in association with other soils formed from glacio-lacustrine sediments.

Total area—1,485 acres.

Description—Soils of this association have level or slightly concave slopes. They are found mainly on flats having a high water table or in slight depressions.

Parent materials are similar to those in map units 14 and 15 and consist of loams or sands over calcareous reddish-brown silts and clays.

The Wauseon series, as used in this association, includes poorly or very poorly drained dark colored soils, formed in loams or sands varying in depth from about 12 to 60 inches, over calcareous silts and clays. These soils have gray (gleyed) subsurface horizons.

The dark colored, poorly to very poorly drained, Poygan or Poy soils may also be found in individual map units. Both soils have gray (gleyed) subsoils formed under the influence of a high water table. Poygan soils are mainly of silty clay to clay texture (surface horizons may range from silty clay loam to fine sandy loam texture), while Poy soils are formed in stratified layers of clay and sand.

Other inclusions may consist of peat or muck.

Gotham—Ottawa

Major soils—Gotham loamy sand and Ottawa fine sandy loam and loamy fine sand.

Minor soils—Nekoosa or Morocco loamy fine sands or fine sands; Oshtemo loamy sands.

Inclusions—Catenal associates of the major soils, or other soils formed in glacio-fluvial sediments; peat and muck.

Areas of occurrence—Mainly in association with other soils formed from glacio-lacustrine sediments in western Marquette County.

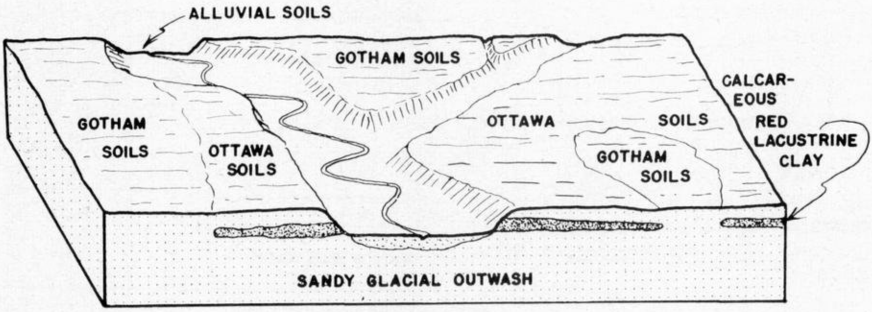

Figure 26. Landscape diagram showing Gotham, Ottawa, and associated soils.

Total area—1,781 acres.

Description—Soils in this association are level to undulating and are found mainly on flats or former glacial lake basins some of which have been dissected by erosion (see Figure 26).

Gotham and Ottawa soils are found as associates where deep sands are associated with sands underlain by calcareous silts and clays within 60 inches (see Figure 26). In some places the underlying silts and clays appear to occur as isolated lenses, in other places they apparently underlie entire areas but the topography of their surface is irregular resulting in a complex of Gotham and Ottawa soils.

Both soils are well drained, however, less well drained sandy soils or other soils formed from glacio-lacustrine sediments may be found in some mapping units. In some places Oshtemo soils (see Map unit 6 for description) may also be included.

Nekoosa–Ottawa

Major soils—Nekoosa loamy fine sand or fine sand; Ottawa fine sandy loam or loamy fine sand.

Minor soils—Gotham loamy sand. Morocco loamy fine sand or fine sand.

Inclusions—Catenal associates of major soils or other soils formed in glacio-fluvial sediments; peat and muck.

Areas of occurrence—Mainly in association with other soils formed from glacio-lacustrine sediments in western Marquette County.

Total area—1,188 acres.

Description—The Nekoosa–Ottawa and Gotham–Ottawa associations are very similar in respect to land form, slope and kind of parent material. Water table levels are somewhat higher in the former association however, and the sandy member is only moderately well drained.

Minor soils and inclusions in map units include Gotham and Morocco soils as well as catenal associates of the Ottawa.

Nekoosa–*Shiocton–*Neshkoro

Major soils—Nekoosa loamy sand or sand; Shiocton silt loam or fine sandy loam; Neshkoro and Berrien fine sandy loams and loamy fine sands.

Minor soils—Gotham loamy sand; Tuscola silt loam or fine sandy loam. Ottawa fine sandy loam or loamy fine sand.

Inclusions—Plainfield sand; Morocco loamy sand; Granby or Maumee loamy sands; peat or muck.

Areas of occurrence—North central and northeastern parts of Marquette County. Scattered areas elsewhere.

Total area—9,204 acres.

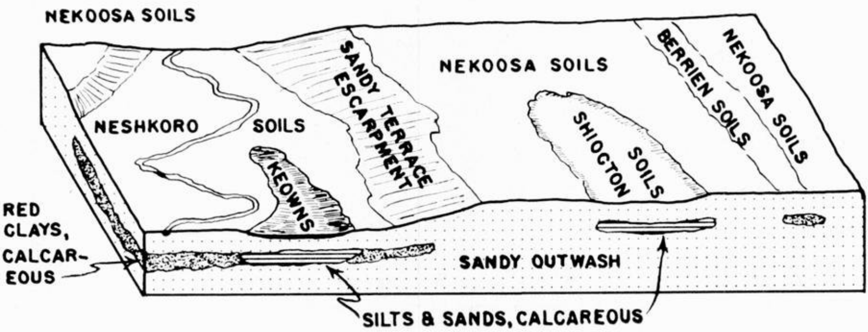

Figure 27. Landscape diagrams showing Nekoosa, Shiocton, Neshkoro and associated soils.

Description—This association of soils occurs most frequently along stream terraces (see Figure 27) on level to gently undulating slopes (included terrace escarpments are sloping to steep). Water tables are moderately high at least part of the year and the major soils are moderately well to imperfectly drained.

Three major kinds of parent materials are found in these areas. These are (1) deep sands, (2) stratified silts and fine sands with occasional clay layers, and (3) sands or loams underlain by calcareous silts and clays. Kind of parent material and natural drainage largely determines the soil pattern.

The Nekoosa soils, as described previously (see map unit 11) are moderately well drained sandy soils formed in acid sands. They are a major unit in this association. Shiocton soils are formed from stratified silts and fine sands. This series includes imperfectly to moderately well drained soils having silt loam, loam, or fine sandy loam surface textures. Surface colors range from light to moderately dark. Some of these soils may be intergrades or Prairie soils rather than Gray-Brown Podzolics. Subsoil textures range from sandy loam to silty clay loam. C horizons are stratified and calcareous.

Neshkoro soils are described in map units 15 and 16. They are imperfectly drained soils of sandy loam to loamy sand texture underlain by calcareous silts and clays at about 40 to 60 inches. Berrien soils are similar but moderately well drained.

Minor units and inclusions in this map unit may include small areas of Gotham, Plainfield, Morocco, Granby, and Maumee, all sandy soils varying in natural drainage from excessive to very poor. Tuscola a well to moderately well drained soil similar in texture and lithology to Shiocton. Ottawa, a well drained Neshkoro, and peat or muck.

Morocco–*Keowns–Wauseon

Major soils—Morocco loamy sand or sand; Keowns silt loam or fine sandy loam; Wauseon fine sandy loam.

Minor soils—Granby or Maumee loamy sands; Neshkoro fine sandy loam; Poy soils.

Inclusions—Shiocton silt loam; Nekoosa loamy fine sand; peat or muck.

Area of occurrence—North central and northeastern Marquette County. Scattered areas elsewhere.

Total area—2,375 acres.

Description—This association occupies a position in the landscape very similar to that occupied by the association described in Map unit 19 (see also Figure 27). It differs from it mainly in that the major soils are less well drained, occurring either on lower positions, or in areas having a generally higher water table. Slopes are mainly level. Depressions are common.

Parent materials are similar to those described in the Nekoosa–Shiocton–Neshkoro association.

The Morocco soils are major components of most map units. These are imperfectly drained, light to moderately dark colored sandy soils (see description in map unit 11). Keowns soils are similar in texture and lithology to the Shiocton soils, being formed in stratified silts and fine sands, but are poorly drained and have thick dark colored surface horizons.

Wauseon soils are also poorly drained and dark colored but are formed in loams or loamy sands over calcareous silts and clays at depths of about 18 to 60 inches.

Minor soils and inclusions in this map unit are the Granby and Maumee, Neshkoro and Berrien, Shiocton and Poy, and peat or muck soils.

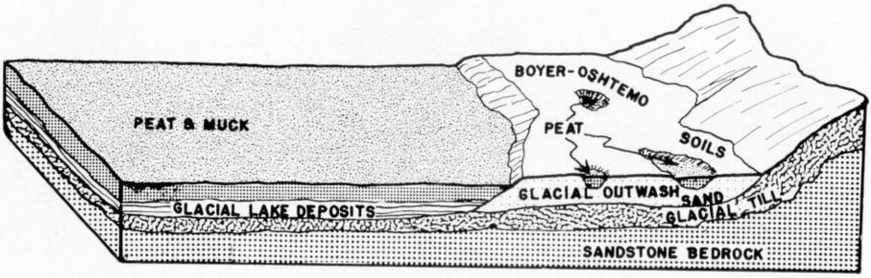

Figure 28. Landscape diagram showing peat and muck soils in broad depressions, and in steep-sided kettles.

Organic Soils (Peat and Muck)

Organic soils are the major components of Cartographic units 21 and 22. The total area occupied by organic soils in Marquette County is over 68,000 acres which is more than 20 percent of the total land area in the county.

Largest areas of peat and muck soils are found in broad glacial depressions particularly in the southern part of the county. At one time these depressions were probably lakes (see Figure 28) in which sedimentary peat was deposited. Later, as the lake grew shallow, various plants grew and died but did not decompose because of the wet, anaerobic, environment. In this way layers of peat and muck were formed.

Small peat deposits are found in steep-sided kettles, along stream or lake borders, and on steep slopes where they may occur as small benches or mounds. Many of these small areas cannot be shown on a soil association map and are therefore described as inclusions in other map units.

The kind of plant material from which peat and muck is formed varies from one deposit to another, and also vertically within a single deposit.

Figure 29. A sedge marsh. Note the brush encroaching upon its borders.

Sedges, grasses, and rushes, are the most important. Moss and wood may also be found. Well decomposed organic material is usually called muck, while plant material which is not decomposed is called peat. Finely divided, olive-colored material deposited in lake bottoms is called sedimentary peat. A layer of this material is often found between the mineral substratum and the overlying peat or muck.

The character of the mineral sediments is particularly important when considering the use of shallow peat soils. Sands, stratified silts and fine sands, loams, clays, and marl may all be found in various parts of the county.

Peat, Muck, and Associated Poorly Drained Mineral Soils

Major soils—Peats and mucks of various depths formed mainly from sedges, rushes, and grasses.

Minor soils—Very poorly to moderately well drained sandy soils; moss and wood peats.

Inclusions—Plainfield sand; Oshtemo loamy sand; floating bogs.

Areas of occurrence—The largest area is north of Germania in the northeastern part of the county. Another area is found west of highway 51 along the Marquette–Columbia county line.

Total area—5,641 acres.

Description—Map unit 21 is an association of organic and sandy mineral soils. Organic soils occupy about 75 percent of the area in individual map units.

This association is found in broad shallow depressions containing numerous low islands. The organic material is largely peat having mucky layers. Soils range in depth from 2 to 4 feet and have a sandy substratum.

Most of the peat appears to be formed from sedges, rushes and grass, however, layers of both sphagnum moss and wood may also be found. Present vegetation on undrained areas consists mainly of sedges and grasses. Tamarack is found in some places.

The associated mineral soils are mainly sandy. Nekoosa (moderately well drained) and Morocco (imperfectly drained) sands or loamy sands are the most common. Oshtemo soils may be found locally on calcareous drift. Scrub oak, birch, and aspen grow on these mineral soils. Ferns are also common.

Peat and Muck

Major soils—Peas and mucks of various depths from sedges, rushes and grasses (Horicon).

Minor soils—Moss and wood peats.

Inclusions—Floating bogs; poorly drained mineral soils of variable texture.

Areas of occurrence—Throughout the county.

Total area—63,237 acres.

Description—Map unit 22 consists mainly of organic soils with only minor inclusions of mineral soils, most of which are poorly drained.

These soils are found mainly in broad shallow depressions particularly in the southern part of the county.

Major parent materials appear to be sedges, rushes, and grasses with included layers of sphagnum moss or wood. Deposits are often 4 feet or more in depth and usually include basal layers of sedimentary peat. Surface layers may be either peat or muck and one or more layers of muck are often found below the surface in deep profiles. The mineral substratum is usually sandy, however, stratified silts and fine sands, loams, clays, or marl may also be found.

Sedges and grasses are the common vegetation on large undrained marshes. Alder, dogwood, and other shrubs or brush, are encroaching on these grassy areas in many places, and tamarack may also be found in some areas (see Figures 29 and 25).

Many peat deposits formed in kettles, (see Figure 30), particularly in the northern part of the county, consist of sphagnum moss growing on fibrous sedge peat. The moss is usually less than two feet thick. The peat in these bogs is somewhat more acid than that in the grassy marshes. Bog plants include, besides the sphagnum, labrador tea, leather leaf, cranberry, and other health plants. In some places, tamarack is found and occasionally black spruce.

Figure 30. A typical sphagnum bog in northern Marquette County. Surrounding mineral soils are Oshtemo and Gotham.

Rockland

Rockland is a miscellaneous land type that consists of rock outcrops and associated soils. Two types, based on kind of bedrock, are recognized in Marquette County. Total acreage is about 590 acres.

Dolomitic Limestone Outcrops (OD)

This miscellaneous land type is found in the dolomitic limestone hills of northwestern Marquette County (see Glovers Bluff in Chapter I). Map units include rock outcrops, shallow lithosolic soils developed in shallow sands over bedrock, and "Mecan-like" soils developed in glacial till over bedrock.

Figure 31. Glovers Bluff, an outcrop of Ordivician dolomite in northwestern Marquette County.

"Granite" Outcrops (OG)

Several outcroppings of crystalline rock are found in southern Marquette County. One is in the village of Montello, another is found near Endeavor, and a third at Observatory Hill.

Map units consist of rock outcrops and shallow lithosolic soils developed in sands shallow over bedrock. At the Montello and Endeavor outcrop, small areas of Oshtemo and Gotham soils may also be included in cartographic units. At Observatory Hill small areas of Lapeer and Wyocena soils formed in glacial till over sandstone, are included in the map unit.

SOIL PRODUCTIVITY

Farm crops are grown on a variety of soils in Marquette County. Some soils are naturally more suitable for the production of particular crops than others, and historically, yields have varied accordingly.

Soils may be modified by man, however. Naturally poorly drained soils can often be drained by tiling or ditching and subsequently out-produce some naturally well drained soils. Somewhat droughty soils may, with supplemental irrigation, out-produce less droughty soils. Under high levels of management all soils will produce larger crops, therefore, naturally infertile but well managed soils may sometimes out-produce inherently fertile soils which are not well managed.

In Marquette County, average yields of all major agricultural crops except corn have been maintained or slightly increased during the period 1940–1959. Yields of corn have been increased considerably (see Table 6).

TABLE 6. YIELDS PER ACRE OF MAJOR FARM CROPS IN MARQUETTE COUNTY FOR SELECTED YEARS DURING THE 1940–59 YEAR PERIOD

Year	Average Yield Per Acre			
	Tame Hay Tons	Corn Bu.	Oats Bu.	Rye Bu.
1940–44 (av.)	1.7	40	31	11
1952	1.9	53	34	11
1959	1.8	57	34	11

When considering the figures in Table 6 it should be remembered that land used for farming decreased by approximately 34,000 acres during this same period. Much of this was marginal land insofar as agricultural use was concerned, consisting of sandy soils, soils having steep slopes, eroded soils, and soils with inadequate drainage.

During the same period, improved farming practices such as the use of suitable crop rotations, the application of lime and fertilizer, the planting of row crops on the contour, strip cropping, terracing, artificial drainage, and in recent years, supplementary irrigation have been applied to an increased number of farm acres. In 1959, commercial fertilizer was applied to approximately 24,000 acres. If this were all harvested cropland, however, only one out of three acres received fertilizer. That same year, 10,085 tons of lime were applied to 4,520 acres of land.

An important factor in the increased yield per acre of corn has been the use of adapted hybrids in place of lower yielding open-pollinated varieties. The increase in yields of tame hay is probably due to the increased use of alfalfa in place of clover and timothy, or other lower yielding grasses. In Table 7 the cartographic units shown on the accompanying soil map are grouped into four categories on the basis of natural characteristics which affect their suitability for general agricultural use. It should be understood that individual soils within each map unit may be better or poorer agricultural soils than the association as a whole.

TABLE 7. NATURAL AGRICULTURAL PRODUCTIVITY OF SOIL ASSOCIATIONS SHOWN ON SOIL MAP[1]

A	B	C	D
Oshkosh–Briggsville–Tustin (13) Oshkosh–Tustin (14)	Lapeer–Pardeeville–Boyer (1) Mecan–Gotham (2) (sloping) Packwaukee–Wyocena–Plainfield (4) (sloping) Boyer–Fox–Dresden (5) Oshtemo–Boyer (6) Oshtemo–Gotham (7) Gotham–Pleasant Lake (8) Gotham–Meridian (9) Ottawa–Neshkoro (15) Gotham–Ottawa (17) Nekoosa–Ottawa (18)	Mecan–Gotham (2) (rolling) Packwaukee–Wyocena–Plainfield (4) (rolling) Gotham–Plainfield (10) Nekoosa–Morocco (11) Neshkoro–Wauseon (16) Nekoosa–Shiocton–Neshkoro (19)	Wyocena–Plainfield (3) Granby–Maumee (12) Peat muck and associated poorly drained mineral soils (21) Peat and muck (22)

[1] Group A includes the best agricultural soils, Group D the least productive for general farm crops under the type of management common to the area. When adequate artificial drainage is provided the imperfectly and poorly drained units in Groups C and D should be placed in a more productive group. Individual map units in groups A and B that consist mainly of rolling soils, should be downgraded.

Group A: Well drained soils having silty or loamy surface textures and silty clay loam or heavier subsoils. Light or dark colored. Level to gently sloping.

Group B: Somewhat excessively drained soils having loamy to sandy surface textures and sandy clay loam to loamy sand subsoils. Light or dark colored. Level to rolling.

Group C: Somewhat excessively to imperfectly drained soils having sandy to loamy surface and subsoil textures. Mainly light colored. Level to gently sloping with included rolling areas (4).

Group D: Very droughty and sandy, level to hilly soils (3); dark colored poorly drained level sandy soils (12); and very poorly drained organic soils (21) (22).

Detailed estimates regarding crop yields from many individual soils, under defined levels of management, may be obtained from the University of Wisconsin Agricultural Extension Service Special Circular "What Yields From Wisconsin Soils" (See Klingelhoets and Beatty in Bibliography). Personnel of the U.S.D.A. Soil Conservation Service and the Extension Service staff, located in Montello, should be consulted regarding the productivity of individual farms or other tracts of land in the county, and their suitability for particular uses.

SOIL MANAGEMENT

Some basic principles of soil management and their application to Marquette County soils are discussed briefly in this chapter. In considering these practices it should be realized that soil management varies from one field to another, depending on the type of farm operation being carried out and the kind of soil present. Individual soils may have special problems in regard to droughtiness, drainage, fertility, or erosion.

Suitable cropping systems—Cropping systems should be designed to provide good yields and meet the needs of the operator and at the same time maintain the soil in a productive condition. The basis of a successful cropping system is a cropping sequence with proper supporting practices. In planning it should be remembered that certain kinds of soil are not suited for particular uses. For example, steep droughty phases of Wyocena sand cannot be profitably used for growing corn. Rather they should be planted to trees. Some soils are not naturally suited for a particular purpose but with suitable supporting practices can be adapted for such a use. Sloping phases of Lapeer or Pardeeville sandy loam can often be used for row crops by cultivating on the contour or strip cropping. Level but droughty soils such as Plainfield or Gotham sand can sometimes be irrigated. Poorly drained soils can often be improved by controlling runoff from adjacent uplands with diversions and other suitable practices, and then tiling or ditching to facilitate drainage. Acid and infertile soils can be limed and fertilized.

Some practices are more easily applied or generally suitable than others. The use of lime and fertilizer according to soil test is widely recommended. Irrigation on the other hand is generally most profitable when used for growing high value crops since the investment, labor requirements, and fertility demands are high. To successfully irrigate requires careful selection of soil and a dependable supply of water. Loamy soils are generally most suitable. Sands are also suitable but require more careful management. Water sources include wells, pits, or ditches, and lakes or streams. As the usage of water is regulated by law, legal rights must be obtained.

Maintenance of organic matter—Organic matter promotes good soil structure; and, consequently, reduces erosion and provides a firm but well aerated seed bed. It is also a source of nitrogen, phosphorus, and other nutrient elements. In planning cropping sequence one should take into account the affect of each crop on the organic matter supply. Row crops and grain deplete the soil of organic matter while legumes and grass mixtures add to it.

Figure 32. Red pine growing on sloping, sandy (Plainfield) soil, formerly under cultivation.

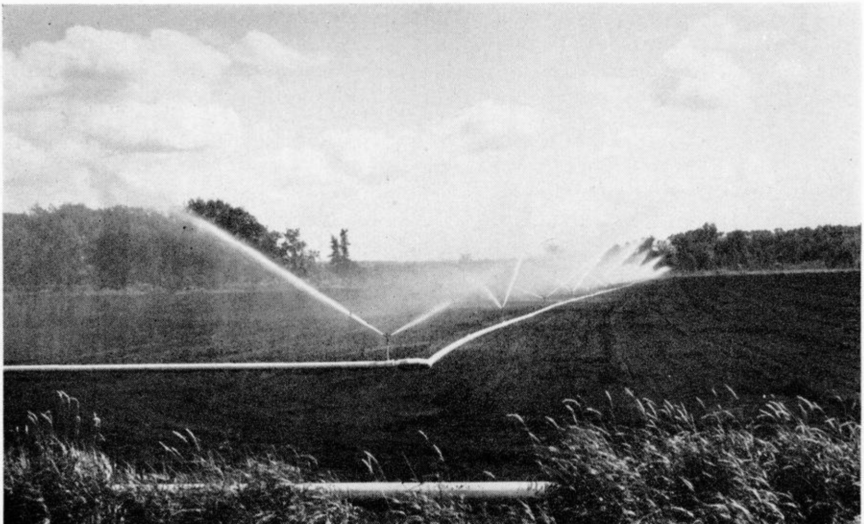

Figure 33. Sprinkler irrigation. This (peat) field is being irrigated to promote uniform germination.

Other important sources of organic matter include stable manure, green manure, and crop residues.

Liming and fertilizing according to soil test—Soil productivity is greatly influenced by soil pH and the supply of available nutrients.

Many Marquette County soils are low in plant nutrients because a large part of their parent material is composed of sandstone high in quartz. Their supply of the major nutrients, nitrogen, phosphorus, and potash, should be supplemented by fertilization. In some old fields, previous fertilization may have raised available phosphorus to an adequate level, but in many cases available potassium is still inadequate. Soil tests should be made to ascertain the fertility status. It is advisable to have soils tested once during every rotation or about every 3 to 5 years. Lime and fertilizer should then be applied according to test results.

Minor nutrients, such as manganese, copper, and zinc are usually present in sufficient supply for good plant growth of common crops on upland soils. However, under more intensive use, such as truck farming, deficiencies may occur. Low-lying soils with poor drainage and high pH may also be deficient. Available boron is frequently too low for legumes on light colored soils. It may be advisable to use borated fertilizers for topdressing these crops.

Most upland soils in Marquette County are also acid unless limed. For general agriculture it is most desirable to neutralize the acidity by liming to a pH of 6.5 to 7.0. Besides neutralizing soil acidity, liming may also supply plant nutrients. It is most economical in this region to use dolomitic limestone as this will supply both calcium and magnesium.

Erosion control—Upland soils are susceptible to erosion by both wind and water. Suitable control measures include contour strip cropping, terracing, and the use of grass waterways on sloping land. Steep or droughty soils are best protected by reforestation. Management of level or undulating soils may include strip cropping and shelter belts. Good rotations, and crops well supplied with lime and fertilizer also reduce erosion by providing large amounts of organic matter, and a dense soil cover.

Aid on specific problems and more detailed management practices may be obtained from the local Soil Conservation Service, the Marquette County Extension Agent or the College of Agriculture, University of Wisconsin.

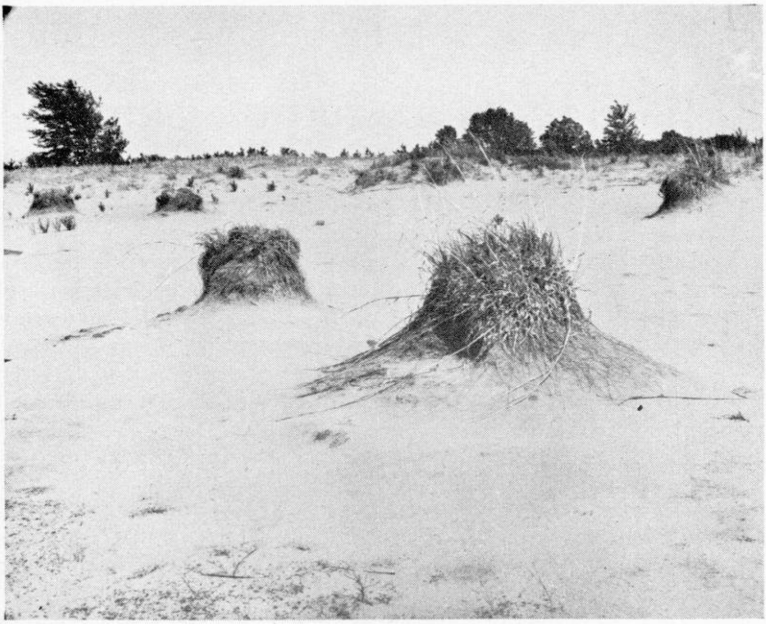

Figure 34. Wind-eroded sandy soil. Shelter belts help to prevent this type of erosion.

Figure 35. Soil and moisture conserving contour strips on sloping land.

LAND USE IN MARQUETTE COUNTY

PRIOR TO SETTLEMENT

Man's use of land in Marquette County began long before the time of written history. As the ice age came to an end and the glaciers retreated northward, plants became established in the raw glacial drift and soil formation began. Animals entered the area and then man—the early American Indian.

What little is known about the pre-historic Indians of this region has been pieced together from the fragmentary evidence supplied by artifacts found around old camp sites or in graves. Studies of pollen and fossil bones tell something about his environment. At first the climate was cooler and the vegetation was a more northerly type than is found in the region today. Animals such as the mastodon, elk, deer, and caribou inhabited the area. The evidence indicates that the early inhabitants lived by hunting and by fishing.

As the climate grew warmer, the environment changed and some animals such as the mastodon disappeared. Several cultural groups of Indians flourished and then vanished, or were absorbed by other cultures. In Marquette County, the habitat became one of mixed deciduous forests and prairie openings, dotted with lakes and crossed by streams and rivers. About the time of the birth of Christ, new groups of Indians moved into the region from the south, bringing with them agriculture. Such crops as corn, beans, squash, and tobacco were introduced and succeeding generations made their living by simple farming, hunting, fishing, and gathering. Important foods among the gathered crops in Marquette County must have been wild rice *(Zizania aquatica)* and acorns. Corn and other crops were grown in cleared fields near the villages. It has been estimated that five bushels of wild rice and five bushels of corn were an adequate year's supply for one family.

At that time many buffalo lived on the prairies and the Indians hunted them in the winter time with the aid of fire. No doubt this practice helped to perpetuate the prairies and consequently caused many soils to have dark surface horizons.

PIONEER DAYS

When the early French explorers entered Wisconsin in the early 1600's, they traveled down the Fox River, through Marquette County to the Wisconsin River at Portage, and then down to the Mississippi. It was for one of these early explorers, Father Jacques Marquette, that the county was named. These early explorers were mainly fur traders and missionaries, however, and did not settle in the area. It was not until the spring of 1848 that the first permanent settlers arrived. A wave of people followed and twelve years later, in 1860, the population was over 8,000.

Marquette County, unlike the counties to the north, never had extensive forests. Because of this its economic development began with farming, with the very early settlers growing things mainly for home use. Then came the wheat era and in 1860 the county produced a bumper crop of 171,000 bushels of this grain. After that, wheat growing declined and eventually gave way to dairying, hog raising, and beef production. Today large-scale truck farming on the peat and muck soils has also become an important part of the agricultural economy.

PRESENT DAY AGRICULTURAL USE

In Table 8 is shown the number and size of farms in Marquette County for 1860, 1920, and 1959. The number of farms increased up to 1920 and then decreased. Total farm acreage followed the same pattern. The size of individual farms, however, has become larger. Farm values, given for 1959, show a considerable increase over 1954 values.

TABLE 8. NUMBER, SIZE, AND VALUE OF FARMS, AND PERCENT OF LAND DEVOTED TO FARMING IN MARQUETTE COUNTY, 1860–1959

Year	Total Number of Farms	Total Farm Acreage	Average Size (acres)	Value		Percent of Land in Farms
				ave/acre	ave/farm	
1860	1,123	147,785	131.6			50.7
1920	1,432	271,317	189.5	$45.75	$ 8,667	93.0
1959	922	213,844	231.9	$74.58	$17,141	73.1

Several types of farms are found in Marquette County. In Table 9 these various types are shown for 1959.

TABLE 9. TYPES OF FARMS IN MARQUETTE COUNTY, 1959

Type of Farm	Number
Field crop farms (total)	51
Cash grain	45
Other field crops	6
Vegetable farms	20
Poultry	15
Dairy farms	396
Livestock (other than poultry and dairy)	120
General farms	75
Miscellaneous	250

In 1954 an average of 46.3 percent of the land on each farm was used for cropland. There was considerable variation in this figure, however, in various parts of the county. Average utilization of farm lands is shown in Table 10.

TABLE 10. UTILIZATION OF FARMLANDS IN MARQUETTE COUNTY, 1954

Cropland, harvested	33.0%
Cropland, pastured	6.3%
Cropland, other uses	7.0%
Woodland, unpastured	12.4%
Woodland, pastured	16.1%
Other land, pastured	12.5%
Other farm lands (building area, waste, etc.)	12.7%
Total	100.0%

Acreage trends have varied for the various crops grown in the county. At one time, during the Civil War period, wheat was the most important crop. The 1870 census shows that 13,638 acres were grown that year. By 1910, this acreage had been reduced to only 335. In that same year 6,429 acres of potatoes were raised but, by 1959 there were only 287 acres. In 1920, 31,590 acres of rye were grown. By 1959 rye still ranked fourth in total acreage but only 2,787 acres were harvested.

Tame hay, corn, and oats have been the large acreage crops in recent years. In 1959, there were 26,616 acres of tame hay, 23,022 acres of corn, and 13,046 acres of oats. The acreage and production of hay has been increasing steadily since 1920 when only 12,910 acres were harvested. Today, alfalfa makes up about 80 percent of the tame hay crop with the remainder consisting of clover and timothy, or other grass mixtures.

Other field crops grown in 1959 include rye, 2,787 acres, wild hay, 21,183, soybeans, 357, potatoes, 287, wheat, 187, barley, 120, and buckwheat, 62. In Table 11 total acres and total yields of major crops for 1959 are shown.

TABLE 11. TOTAL ACREAGE AND YIELD OF MAJOR CROPS IN MARQUETTE COUNTY, 1959

Crop	Total acres	Total yield
Corn		
Total	23,022	
For grain	17,838	1,012,538 bushels
Hay		
Total	26,616	
Alfalfa	20,859	42,534 tons
Clover-timothy	2,565	3,714 tons
Wild hay	2,183	2,564 tons
Oats	13,046	447,925 bushels
Rye	2,787	30,571 bushels
Vegetables (not including potatoes)	2,660	----------

Specialty crops are becoming an increasingly important part of the agricultural economy of Marquette County. Many of the peat and muck soils of the county, when properly drained and fertilized, are well adapted for truck farming. Other vegetable crops are grown on upland sands and loams. While these crops do not as yet involve an extensive acreage they are mainly high value crops and their production has increased considerably during the last few years. In 1954, 1,566 acres of vegetable crops were grown (not including potatoes) with sales of $294,803. In 1959, (see Table

11) 2,660 acres were planted to these crops with sales of $766,875. Head lettuce, onions, carrots, mint, and potatoes are major specialty crops grown on peat and muck soils. Smaller acreages of celery and spinach are also grown. The production of head lettuce in particular, has increased considerably during the past five years.

Some vegetables, and fruits of various kinds, are raised on sandy or loamy upland soils. Cucumbers and beans are grown for processing. Strawberries, raspberries, apples, grapes, melons, tomatoes, and asparagus are grown mainly for local sales. Nursery plants are also produced by several growers.

There is also an increasing amount of forest land in Marquette County. In 1951, 86,250 acres were designated as commercial forest land. About 84 percent of this was in farm woodlots. Oak was the most common tree. Forest products include saw timber, firewood, pulp, fence posts, and veneer. In 1959, 2,837 Christmas trees were sold.

FARM INCOME

Total cash farm income in 1956 was $4,995,000. Of this amount $612,000 (12.3 percent) was derived from crops, and $4,383,000 (87.7 percent) from livestock and livestock products. Milk was the largest single source of farm income totaling $2,113,000, 42.3 percent of the total.

FUTURE TRENDS IN LAND USE

Land use trends in Marquette County indicate that farms are becoming fewer but larger in size. Total land in farms has decreased somewhat in recent years and some land, particularly the less productive agricultural land is no longer being used for farm crops. Some of it is idle, some is planted to soil improving grasses and legumes. Much of the land withdrawn permanently from cropping is being planted to trees. Land now cropped is somewhat more productive on a yield per acre basis.

New farm lands are also being created, mainly by the drainage of peat and muck, or wet mineral soils. Many of these soils become very productive agricultural lands when properly drained and fertilized. Others, such as shallow, fibrous peats underlain by sand, are not suitable for drainage. In some places the soil may be suitable but it is not possible to obtain an adequate outlet. In other marshes excessive seepage and artesian pressures make drainage difficult.

It is extremely important therefore to determine both the type of soil present and the hydrologic characteristics of a wet area before drainage is attempted.

Another development that may create additional cropping acres, or add to the productiveness of certain soils presently used for crop production is the use of supplemental irrigation, particularly on sandy or loamy soils. This practice is dependent upon an adequate source of water together with soils having favorable slope characteristics and adequate drainage. In 1954, 131 acres were irrigated. This had increased to 692 acres in 1959.

Figure 36. Creating new cropland by land drainage.

Increased non-agricultural use of land will probably continue for some time. Some of this land will be used for roads and building sites. Other lands will be used for parks, for hunting and fishing or other recreational uses, or for wildlife sanctuaries. Resorts have been important in Marquette County for many years, bringing hundreds of visitors into the area to hunt, fish in the many lakes and streams, or enjoy other types of recreation made possible by the county's natural resources. There are many lakes in the county, some of them very small, however. Besides the lakes there are 50 miles of trout streams and the Fox River. About 3,000 acres are included in public hunting grounds. An indication of the economic importance of this type of land use is contained in the River Basin Studies Report of 1953[1] which estimated the value of recreational interests from Packwaukee to Princeton on the upper Fox River, to be $3,000,000.

[1] See reference number 16 in Bibliography.

INDUSTRY

Industry has played a small but important part in the economy of Marquette County. In 1848, a gristmill was built on the creek bank in the village of Westfield, the same site where one stands today. Soon after, in 1850, a dam was completed on the Montello River and a gristmill and sawmill began operations. In 1868, with the discovery of high quality red granite in Montello, the granite industry began. At one time, during the era of the paving block, this industry provided employment for 200 men. Today the granite industry is a smaller but continuing business, well known for the high quality red granite it produces. Another mineral industry is the sand and gravel business. Several dairy plants, feed mills, and other business enterprises are also found in the county.

POPULATION

Before settlement it has been estimated that the population density in the Upper Great Lakes Region was approximately one person per square mile. Twelve years after the first settlers arrived in Marquette County in 1860, the population had reached 8,233. It then increased until 1910 reaching a figure of 10,741 after which it declined. In 1957 there were 8,800 people living in the county or an average of about 19 people per square mile.

As in many other Wisconsin counties, the farm population has declined in recent years. In 1950, of 8,839 people living in the county, 4,577 or 51.8 percent lived on farms. Between 1934 and 1955 there was a 32 percent decrease in farm population.

GLOSSARY

A horizon—The surface horizon of an undisturbed mineral soil. It is usually subdivided into several subhorizons. The A_1 is dark colored and high in organic matter, the A_2 is usually light colored and leached, the A_3 is transitional to the B horizon. Some soils have all of these subhorizons, others do not.

A_p horizon—A plowed or otherwise mixed surface layer.

Aggregate—A cluster of soil particles. Often called a ped.

Alluvial Soils—Soils consisting of recently deposited sediments.

Alluvium—Soil material deposited by streams.

Association, Soil—A group of soils which may or may not resemble each other, geographically associated in a particular pattern.

B horizon—A master horizon in the soil profile usually found below the A horizon. It is usually characterized by blocky or prismatic structure, stronger colors (usually brown) than those in horizons above or below, an accumulation of clay or iron, or all three. It is usually subdivided into several subhorizons.

Bir—A brown B horizon high in iron. Typical of Podzol soils.

Bh—A dark brown horizon high in organic matter. "h" and "ir" are often used together when describing Podzols.

B_t—A B horizon having an accumulation of Clay. This is usually called B_2 in Gray-Brown Podzolic and Prairie soils.

Bisequal (soil)—A soil having two sequa, one above the other. For example a Podzol A_2 and B_{ir} horizon over a Gray-Brown Podzolic A_2 and B_t horizon. See Sequum.

Bog (soil)—An organic soil. Bog in this sense refers to all organic soils.

Bog (peat)—A peat deposit usually consisting of moss peat, upon which bog plants are growing. Bogs are usually found in enclosed depressions.

C horizon—A layer of relatively unweathered material similar to the material from which at least a part of the soil above it was formed. Soil parent material.

Calcareous (soil)—Soil containing free lime. It effervesces when dilute (1:10) HCl is applied.

Catena—A group of soils developed from similar parent material but differing in morphology because of differences in natural drainage.

Clay—The smallest mineral grains, less than 0.002 mm in diameter.

Clay (texture)—Soil that contains 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay loam—Soil consisting of 27 to 40 percent clay, and 20 to 45 percent sand.

Colluvium—Deposits of soil accumulated at the base of slopes by the influence of gravity. Slope wash.

Complex, Soil—Several soils, so closely intermingled that they cannot be shown separately at the map scale being used.

Consistence, Soil—The resistance of soil to separation or deformation. Soil consistence varies with moisture content. It is described in terms such as loose, friable, firm, hard, sticky, etc.

D horizon—A layer or stratum below the C horizon, or the B horizon if no C is present, which is unlike the C or the material from which the soil has been formed.

Drainage, Soil—Natural soil drainage refers to the speed with which water is removed from the soil surface and through the soil itself. Seven classes have been recognized in this report as follows: Excessive, somewhat excessive, well, moderately well, imperfect, poor, and very poor. Artificial drainage refers to water removed by ditching, tiling, or other means.

Drumlin—An oval or cigar-shaped hill of glacial drift (usually till), ordinarily with its long axis parallel to the movement of ice which formed it.

Eluvial (horizon)—A horizon that has lost bases, iron, clay, etc. by soil-forming processes. A_2 horizons are eluvial.

Forbs—Herbacious plants other than grass.

G or g—A soil horizon that is gleyed (See gleyed).

Glacial Drift—A general term used to describe all kinds of glacial deposits.

Glacial till—Unsorted glacial drift transported and deposited by ice.

Glacio-fluvial deposits—Sediments deposited by glacial streams. These deposits are usually sandy or gravelly and are often stratified.

Glacio-lacustrine deposits—Sediments deposited in glacial lakes. These include fine sands, silts, and clays. They may be stratified, or varved.

Gleyed (soil)—Soil material which is olive gray or bluish gray in color. Gleyed horizons are usually found below a dark colored surface layer in poorly drained soils.

Gray-Brown Podzolic soils—The kind of soils usually developed under forest vegetation in southern Wisconsin. These soils have light colored surface horizons, brown illuvial (clayey) subsoils, and are generally acid.

Horizon, Soil—A layer of soil more or less parallel to the land surface and having characteristics produced by soil formation.

Humic Gley—A naturally poorly drained soil having a thick, dark colored surface horizon and a gray (gleyed) subsoil.

Illuvial horizon—Horizons that have received material (bases, clay etc.) from an eluvial horizon. B horizons of Gray-Brown Podzolic soils are illuvial.

Intergrade—A soil that does not clearly belong to any great soil group but has some characteristics of several.

Leaching—Removal of material in solution. For example the removal of lime from the upper part of a soil.

Lithosol—A shallow soil consisting of a dark colored surface soil underlain by bedrock.

Loam (texture)—Soil that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

Loamy sand—Soil that contains at the upper limit 85 to 90 percent sand, and the percentage of silt plus 1½ times the percentage of clay is less than 15. At the lower limit it contains not less than 70 to 85 percent sand and the percentage of silt plus twice the percentage of clay does not exceed 30.

Marl—An earthy deposit consisting of calcium carbonate (lime), silt and clay. Found in many lake bottoms or below peat. There are marl deposits in Ennis Lake.

Marsh—A wet area supporting sedge, grass, and reed vegetation.

Monadnock—A hill of resistant rock surmounting a penaplain.

Morphology, Soil—Refers to the physical constitution of the soil including such characteristics as the color, texture, structure, and consistence of the various horizons, their thickness and arrangement in the soil profile.

Mottled—Spots or splotches, usually of rust and gray color. Mottling, in most of the soils in central and southern Wisconsin, is an indication of restricted drainage, or a fluctuating water table.

Muck—Organic soil material that is partially decomposed. Usually dark colored.

Organic soil—Soils formed from organic materials. Peats and mucks. Organic soils are classified in the Bog great soil group.

Parent Material—The sediments from which a soil is formed. For example, calcareous sandy loam glacial till, deep sands, sedge peat.

Peat—Organic soil material that is relatively undecomposed. This material may be broken up (disintegrated); however, plant parts may still be recognized. When peat undergoes decomposition it becomes muck.

pH—A notation used to designate the acidity or alkalinity of a soil. A pH of 7.0 indicates neutrality, lower values indicate acidity and higher values alkalinity. Agricultural soils should be limed so as to have a pH of about 6.5 for the common farm crops of southern Wisconsin.

Phase, Soil—A subdivision of a soil unit based on features significant to man's use of a soil. For example, sloping phase, stony phase, etc.

Prairie soils—Soils having thick dark brown or black surface horizons and brown, somewhat clayey illuvial subsoils. These soils are formed under prairie grasses and forbs in central and southern Wisconsin. Also called Brunizems.

Profile, Soil—A vertical section of a soil, through all of its horizons, including the parent material.

Regosol—A shallow soil consisting of an A horizon over unweathered parent material that is unconsolidated.

Sand—Mineral grains having diameters ranging from 2 to 0.05 mm.

Sand (texture)—Soil consisting of 85 percent or more of sand, percent silt, plus 1½ times percent of clay shall not exceed 15. Coarse sand, sand, fine sand, and very fine sand subclasses are recognized.

Sandy clay loam—Soil that consists of 20 to 35 percent clay, less than 28 percent silt, and 45 percent or more sand.

Sandy loam—Soil consisting of either 20 percent clay or less, and the percentage of silt plus twice the percentage of clay exceeds 30, and 52 percent or more sand; or less than 7 percent clay, less than 50 percent silt, and between 43 and 52 percent sand.

Sedimentary peat—Finely divided organic materials often found in lake bottoms and below herbaceous peat deposits. Sedimentary peat becomes very hard when dry.

Sequum—A sequence of an eluvial horizon and its related illuvial horizon.

Silt—Mineral grains ranging in size from 0.05 to 0.002 mm diameter. Soil material containing more than 80 percent silt and less than 12 percent clay is included in the silt class.

Silty clay—Soil that contains 40 percent or more of clay and 40 percent or more of silt.

Silty clay loam—Soil consisting of 27 to 40 percent clay and less than 20 percent sand.

Sol Brun Acide—A group of soils formed under forest vegetation from moderately acid parent materials in the podzolic soil region. These soils display little or no eluviation and illuviation of oxides and clays. Some formation of clay may have occurred.

Silt loam—Soil consisting of 50 percent or more of silt and 12 to 27 percent of clay (or) 50 to 80 percent silt and less than 12 percent clay.

Structure, Soil—Refers to the aggregation of primary soil particles into compound particles such as granules, blocks, prisms, or plates.

Swamp—A wet area supporting woody vegetation, usually tamarack.

Texture, Soil—Refers to the relative proportions of the various size groups of individual soil grains.

Variant, Soil—Soils of limited or unknown extent but having characteristics unique enough to set them apart from a related series. The term variant is usually used temporarily, until the soil can be studied further. Phase is sometimes used in the same sense.

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APPENDIX

ALPHABETICAL LIST OF SOILS

Alluvial soils (series undifferentiated)
*Astico (dark colored variant)[1]
Berrien
Boone
Boyer
*Briggsville[1]
*Briggsville (dark colored variant)[1]
Casco
*Delton
Dresden
*Fall River
Fox
Gotham
Granby
Hennepin
*Horicon
*Keowns
Lapeer
Lapeer (shallow substratum variant)[1]
*Lost Lake (dark colored variant)[1]
Lorenzo
Maumee
*Mecan
Meridian
Morocco
Nekoosa
*Neshkoro[1]
*Oshkosh
Oshtemo
Ottawa
*Packwaukee[1]
*Pardeeville[1]
*Pardeeville (shallow substratum variant)[1]
Plainfield
Plainfield (dune phase)
*Pleasant Lake[1]
*Poy
Poygan
*Puchyan (dark colored variant)[1]
*Puckaway[1]
Rimer
Rodman
Seward
*Shiocton
Sparta
Tuscola
*Tustin
Wauseon
*Winneconne[1]
*Wyocena

* Tentative or proposed series.
[1] Series or other unit newly proposed in Marquette County.

LIST OF SOIL ASSOCIATIONS AND THEIR TOTAL AREA[1]

Number	*Name*	*Percent of Total*	*Acres*
1	Lapeer–*Pardeeville–Boyer	4.4	13,063
2	*Mecan–Gotham	5.5	16,329
3	*Wyocena–Plainfield	10.0	29,689
4	*Packwaukee–*Wyocena–Plainfield	2.3	6,828
5	Boyer–Fox–Dresden	1.7	5,047
6	Oshtemo–Boyer	2.8	8,313
7	Oshtemo–Gotham	10.3	30,579
8	Gotham–*Pleasant Lake	0.9	2,672
9	Gotham–Meridian	0.5	1,485
10	Gotham–Plainfield	8.0	23,751
11	Nekoosa–Morocco	7.2	21,376
12	Granby–Maumee	2.5	7,422
13	*Oshkosh–*Briggsville–*Tustin	9.6	28,501
14	Ottawa–*Tustin	2.5	7,422
15	Ottawa–*Neshkoro	1.1	3,266
16	*Neshkoro–Wauseon	0.5	1,485
17	Gotham–Ottawa	0.6	1,781
18	Nekoosa–Ottawa	0.4	1,188
19	Nekoosa–*Shiocton–*Neshkoro	3.1	9,204
20	Morocco–*Keowns–Wauseon	0.8	2,375
21	Peat, muck, and associated poorly drained mineral soils	1.9	5,641
22	Peat and muck	21.3	63,237
	Rockland (OD and OG)[2]	0.2	590
	Lakes and streams	1.9	5,641
	Total	100.0	296,885

[1] Percentages were obtained by cutting up and weighing the various parts of a soil map.
[2] Miscellaneous land units composed of dolomite or crystalline rock outcrops and associated soils.

LABORATORY DATA

Laboratory analyses have been carried out on a number of soil parent material samples, and several soil profiles. The following methods of analysis were employed.

Bulk samples were air-dried and passed through standard square mesh screens. The screens used were 3 inch, 2 inch, 1½ inch, 1 inch, ¾ inch, ½ inch, 5mm, and 2 mm. The material retained on each screen was weighed, and the types of rock, with the exception of the material held on the 2 mm screen, identified, and counted.

Particle size distribution of the less than 2 mm fraction was determined on 40 gram samples by the method described by Day (see Bibliography). Samples were dispersed with a 1% "Calgon" solution.

Percent calcium carbonate equivalent was determined on a 2 gram sample. Twenty-five ml of 1N HCl was added to each sample followed by a half hour digestion on a steam hot plate. Samples were then cooled and back-titrated with 1N NaOH. The neutralizing value was calculated from the difference between the amount of HCl added and the NaOH titrated.

Acid soluble calcium and magnesium were determined on 2 gram samples digested with an excess of 1N HCl on a steam hot plate for half an hour. Samples were then filtered and the acidity adjusted to pH 4.5 so as to precipitate iron, aluminum, and phosphorus. The resultant solutions were analyzed for calcium and magnesium on a Beckman flame photometer and the amounts determined from a standard curve.

Available phosphorus was determined by the Bray procedure on samples above pH 7.0, and by the Wisconsin State Soils Testing Laboratory procedure on samples below pH 7.0.

pH was determined on a soil paste with a Beckman pH meter. A 30 minute equilibration was employed.

Table 12 shows the six kinds of parent materials analyzed and the number of samples of each. The analytical data have been compiled in Tables 13a through 13d. These data are averages of the various samples of each kind of material.

Table 14 shows the particle size distribution of the various horizons in several soil profiles.

TABLE 12. KINDS OF PARENT MATERIALS ANALYZED AND NUMBER OF SAMPLES OF EACH

Kind of Parent Material	Number of Samples
1 Calcareous light brown sandy loam till (Lapeer—Pardeeville)	5
2 Calcareous reddish-brown loamy fine sand till (Mecan)	14
3 Acid or slightly calcareous sandy till (Wyocena)	5
4 Calcareous gravel and sand (Casco—Lorenzo)	8
5 Acid sands (Plainfield—Gotham)	15
6 Calcareous reddish-brown silts and clays (Briggsville—Oshkosh)	5

TABLE 13a. MECHANICAL COMPOSITION OF THE BULK SAMPLES

Kind of Parent Material	Percent by Weight					
	3–1½″	1½–¾″	¾″–5mm	5–2mm	Total Gravel	Less than 2mm dia.
1	1.5	5.0	8.5	3.5	18.5	81.5
2	2.0	4.0	6.0	2.0	14.0	86.0
3	0.3	0.7	2.0	1.0	4.0	96.0
4	15.5	16.0	21.0	8.5	61.0	39.0
5	0.0	0.5	1.0	0.5	2.0	98.0
6	0.0	0.0	0.0	0.0	0.0	100.0

TABLE 13b. LITHOLOGY OF THE COARSE (3″–2MM) FRACTION

Kind of Parent Material	Percent by Pebble Count					
	Dolomite	Chert	Sandstone	Shale	Crystalline	Total
1	75.0	5.0	4.0	0.5	15.5	100
2	73.5	6.0	4.5	1.0	15.0	100
3	1.0	23.0	11.0	4.5	60.5	100
4	77.4	4.4	2.5	0.2	15.5	100
5	2.5	31.0	4.0	2.5	60.0	100
6	0.0	0.0	0.0	0.0	0.0	0

TABLE 13c. PARTICLE SIZE DISTRIBUTION OF THE LESS THAN 2MM DIAMETER FRACTIONS

Kind of Parent Material	Percent Sand					Total Sand	% Silt .05–.002 mm	% Clay <.002 mm	Textural Class
	VCS 2–1 mm	CS 1–.5 mm	MS .5–.25 mm	FS .25–.1 mm	VFS .1–.05 mm				
1	2.5	11.0	21.5	32.5	10.0	77.5	15.0	7.5	fine sandy loam
2	1.5	11.5	21.0	38.0	7.0	79.0	14.5	6.5	loamy fine sand
3	1.0	14.5	26.5	41.5	5.0	88.5	6.5	5.0	fine sand
4	10.5	41.0	25.0	14.5	3.5	94.5	5.0	0.5	coarse sand
5	1.2	17.3	31.5	43.0	3.0	96.0	3.5	0.5	fine sand
6	0.2	0.8	1.5	9.5	9.5	21.5	55.0	23.5	silt loam

TABLE 13d. SOME CHEMICAL CHARACTERISTICS OF THE LESS THAN 2MM DIAMETER FRACTIONS

Kind of Parent Material	% $CaCO_3$ Equivalent	pH	% Acid Soluble Ca	% Acid Soluble Mg	Ca/Mg Ratio	ppm P
1	18	8.0	3.0	1.6	1.9	5.3
2	14	8.0	2.8	1.5	1.9	4.6
3	0	6.1	0.07	0.05	1.5 (variable)	8.3 (variable)
4	17	8.1	3.6	1.9	1.9	4.2
5	0	5.8	0.08	0.05	1.6 (variable)	12.4 (variable)
6	29	7.7	4.8	2.6	1.8	2.8

TABLE 14. PARTICLE SIZE DISTRIBUTION OF SELECTED PROFILES

Soil	Horizon	Depth inches	Percent sand					Total sand	Percent silt .05–.002 mm	Percent clay <.002 mm	Textural class
			VCS 2–1 mm	CS 1–.5 mm	MS .5–.25 mm	FS .25–.1 mm	VFS .1–.05 mm				
Briggsville	A_1	0–3	0	8	20	31	4	37	28	9	fine sandy loam
	A_2	3–7	0	6	25	38	4	73	20	7	fine sandy loam
	A_3	7–16	0	7	27	43	4	81	12	7	loamy fine sand
	B_1	16–18	0	5	17	27	4	53	25	22	sandy clay loam
	B_{21}	18–32	0	0	3	4	8	15	43	42	silty clay
	B_{22}	32–38	0	0	3	3	8	14	47	39	silty clay loam
	B_3	38–46	0	0	2	2	9	13	53	34	silty clay loam
	C_1	46+	0	0	0	1	8	9	66	25	silt loam
Lapeer	A_p	0–7	0	4	27	42	10	83	11	6	loamy fine sand
	B_{21}	7–18	0	3	24	37	12	76	15	9	fine sandy loam
	B_{22}	18–28	0	3	26	33	13	75	15	10	sandy loam
	B_3	28–32	0	8	22	36	7	73	17	10	sandy loam
	C	32+	0	5	26	30	16	77	17	6	loamy sand
Puckaway	A_1	0–3	0	18	29	28	5	80	12	8	loamy fine sand
	A_3B_1	3–7	0	12	30	32	8	82	10	8	loamy fine sand
	B_{21}	7–21	0	12	25	36	8	81	6	13	fine sandy loam
	B_{22}	21–39	0	20	24	27	7	78	7	15	fine sandy loam
	B_3	39–48	0	20	29	30	4	83	5	12	loamy fine sand
	C	48+	0	17	31	41	7	96	2	2	fine sand

TABLE 14. PARTICLE SIZE DISTRIBUTION OF SELECTED PROFILES—Continued

Soil	Horizon	Depth inches	Percent Sand VCS 2–1 mm	CS 1–.5 mm	MS .5–.25 mm	FS .25–.1 mm	VFS .1–.05 mm	Total sand	Percent silt .05–.002 mm	Percent clay <.002 mm	Textural class
Plainfield	A_p	0–6	1	11	49	28	2	91	4	5	sand
	B_2	6–11	2	10	47	36	2	96	2	2	sand
	B_3	11–16	2	10	46	38	1	97	1	3	sand
	B_3	16–23	2	8	47	39	2	98	0	3	sand
	B_3	23–29	2	7	46	41	3	98	0	2	sand
	C	29–34	2	8	47	41	1	98	0	2	sand
	C	34–39	1	7	47	42	2	100	0	0	sand
Meridian	A_p	0–6	4	17	44	29	1	86	11	3	sand
	A_3	6–9	1	15	36	24	6	82	11	7	loamy sand
	B_1	9–13	1	10	30	20	10	71	16	13	sandy loam
	B_{21}	13–16	2	8	30	24	10	74	14	12	sandy loam
	B_{22}	16–21	2	17	36	18	7	80	8	12	loamy sand
	B_3	21–25	2	18	50	14	6	90	2	8	sand
	B_3	25–30	2	35	42	10	3	92	2	6	sand
	C	30–35	2	24	57	10	1	94	5	1	sand
	C	35–40	1	11	36	47	3	98	0	2	sand
Gotham	A_p	0–7	0	2	29	49	8	88	5	7	sand
	B_1	7–15	3	6	32	37	4	82	11	7	loamy sand
	B_2	15–20	1	7	30	34	10	82	6	12	loamy sand
	B_3	20–26	2	6	30	36	13	87	3	10	loamy sand
	B_3	26–34	0	6	34	39	9	88	5	7	loamy sand
	C	34–40	0	11	67	12	2	92	3	5	sand
	C	40–46	1	18	59	12	3	93	2	5	sand

SOIL MAP OF MARQUETTE COUNTY, WISCONSIN

THE SOIL SURVEY DIVISION, WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY,

UNIVERSITY OF WISCONSIN. G. F. HANSON, DIRECTOR

SOILS LEGEND

GLACIAL TILL UPLANDS

SOILS FORMED FROM LOAMY TO SANDY GLACIAL DRIFT (MAINLY CALCAREOUS TILL). LOAMY OR SANDY SURFACE COVERINGS OCCUR IN MANY PLACES.

- 1 Lapeer-*Pardeeville-Boyer loams and sandy loams.
- 2 *Mecan-Gotham sandy loams and loamy sands.
- 3 *Wyocena-Plainfield sandy loams and sands.
- 4 *Packwaukee-*Wyocena-Plainfield sandy loams and sands.

GLACIO-FLUVIAL TERRACES AND HILLS

SOILS FORMED FROM GRAVELLY OR SANDY GLACIO-FLUVIAL DEPOSITS. GRAVELS ARE CALCAREOUS AND HAVE LOAMY OR SANDY SURFACE COVERINGS IN MANY PLACES.

- 5 Boyer-Fox-Dresden sandy loams.
- 6 Oshtemo-Boyer loamy sands and sandy loams.
- 7 Oshtemo-Gotham loamy sands.
- 8 Gotham-*Pleasant Lake loamy sands and sandy loams.
- 9 Gotham-Meridian loamy sands and sandy loams.
- 10 Gotham-Plainfield loamy sands and sands.
- 11 Nekoosa-Morocco loamy sands and sands (restricted drainage).
- 12 Granby-Maumee loamy sands and sands (poor drainage).

GLACIO-LACUSTRINE BASINS AND SLOPES

SOILS FORMED FROM CLAYEY, SILTY, OR SANDY GLACIO-LACUSTRINE SEDIMENTS. MANY DEPOSITS ARE TWO-STORIED OR STRATIFIED.

- 13 *Oshkosh-*Briggsville-*Tustin silt loams and loamy fine sands.
- 14 Ottawa-*Tustin fine sandy loams or loamy fine sands.
- 15 Ottawa-*Neshkoro fine sandy loams or loamy fine sands (restricted drainage).
- 16 *Neshkoro-Wauseon fine sandy loams or loamy fine sands (restricted drainage).
- 17 Gotham-Ottawa loamy fine sands and fine sandy loams.
- 18 Nekoosa-Ottawa loamy fine sands and fine sandy loams.
- 19 Nekoosa-*Shiocton-*Neshkoro loamy fine sands and loams (restricted drainage).
- 20 Morocco-*Keowns-Wauseon loamy fine sands and loams (poor drainage).

MARSHES, SWAMPS AND BOGS

ORGANIC SOILS FORMED MAINLY FROM SEDGES, RUSHES, AND GRASSES. DEPOSITS VARY IN DEPTH AND ARE UNDERLAIN BY SANDS, SILTS AND CLAYS, OR MARL. VERY POOR NATURAL DRAINAGE.

- 21 Peat, muck, and associated poorly drained mineral soils.
- 22 Peat and muck.

* Tentative or proposed soil series

ROCK OUTCROPS

- OD Dolomitic Limestone
- OG "Granite"

MAP SIGNS

Steep slopes

Natural pit ("kettle")

Permanent stream

Lake

Soil boundary

Gravel pit or quarry

County boundary

Section line

Town line

Railroad

City

Village

Roads and Highways

U.S. highway

State highway

County highway

City road

Soil Survey, 1957-58 by the Soil Survey Division, Wisconsin Geological and Natural History Survey, University of Wisconsin in cooperation with the Soils Department, College of Agriculture, University of Wisconsin, and the Soil Conservation Service of the United States Department of Agriculture. Publication by the Soil Survey Division, Wisconsin Geological and Natural History Survey.

Soil Survey by T. R. Peck and G. B. Lee, with the assistance of M. Shivers. The Land Form map used during field operations was compiled by A. Peckham under the direction of F. D. Hole. Cartography by R. D. Sale with the assistance of Rodney Helgeland and William Kuepper.

Land forms, lakes, and streams delineated from aerial photographs. Road network taken from 1960 County Highway map. Some soil data were adapted from detailed soil maps of the Soil Conservation Service.

SCALE IN MILES

1 .5 0 1 2 3 4 5

WISCONSIN SOIL MAPS AND REPORTS

------ Leaflet colored soil map (state) ------ Free

------ Technical bulletin on "Preliminary Study of the Profiles of the Principal Soil Types of Wisconsin" ---------- 25¢

------ Introduction to the Soils of Wisconsin 10¢

------ What's in that soil map? ----------- 5¢

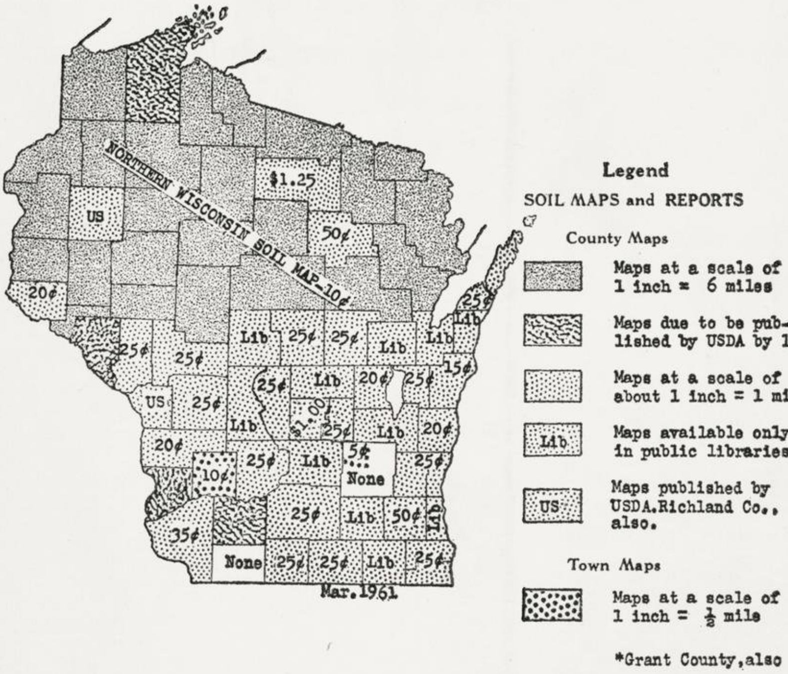

Figure 37. Index maps to soil survey publications by the Wisconsin Geological and Natural History Survey as of 1961. Requisitions and payments for the publications are handled by: the Soil Survey Division, 203 Soils Building, University of Wisconsin, Madison, 6, Wisconsin.