WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

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SOIL SURVEY IN COOPERATION WITH THE COLLEGE OF AGRICULTURE
H. L. RUSSELL, Dean

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SOIL SURVEY

OF

Washington and Ozaukee Counties

WISCONSIN

BY

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INTRODUCTION

The State of Wisconsin, working in cooperation with the United States Department of Agriculture, is making a careful study of soils and agricultural conditions throughout Wisconsin, and is preparing soil maps and soil reports of all counties in the state. A soil map shows the location and extent of the different kinds of soil. Tracts of 10 acres and over are mapped, but often areas of even smaller extent are shown. The soil map is prepared by trained men, who go over a county thoroughly, and examine the soil by making a sufficient number of borings to a depth of 36 inches to keep account of all variations. A report is also made, to accompany and explain the map, and this is based upon a careful study of the soils within the region surveyed and upon such other features as have a direct bearing upon the agriculture of the area.

It is the object of this survey to make an inventory of the soils of the state, and to be of practical help to farmers by locating and describing the different soils, by determining their physical character and chemical composition, and by offering suggestions for their management, based upon the work of the Soil Survey within the area, covered in the report, and upon the results of field tests made by the Experiment Station.

Soil fertility depends upon two factors: First, upon the physical characteristics of the soil, such as water holding capacity, workability, etc., and second, upon the chemical composition of the material composing the soil. The chemical composition depends upon the mode of origin of the soil, and the source of material from which the soil is derived.

Water holding capacity and other physical properties of soil all depend chiefly upon texture, which refers to the size of the individual soil grains, or particles. A coarse sandy soil, for example, will not retain moisture so long as a loam soil, or clay loam, because the finer the soil grains, the greater will be the total soil grain surface area to which moisture may adhere.

Texture is determined in the field by rubbing the soil between the thumb and fingers and with experience one soon becomes expert at judging the size of soil grains. This field judgment is verified in the laboratory by a mechanical analysis, which is made by a simple method of separating soil grains into different groups, of which there are seven. These are known as clay, silt, very find sand, fine sand, medium sand, coarse sand and fine gravel.

A chemical analysis is also made of the soil to determine the amounts of various essential plant-food elements which are present. A chemical analysis shows whether the soil contains a large store of plant food or only a small quantity, and it indicates which kinds of plant food will probably be needed first. The amount of organic matter in the soil is also determined, and tests are made to show conditions relative to soil acidity.

SOIL CLASSIFICATION

Soils are grouped according to texture into soil classes, a soil class being made up of soils having the same texture, though differing in other respects. A fine sand, for example, may be light colored and of alluvial origin, while another fine sand may be dark in color and of residual origin, while a third fine sand may have been blown into sand dunes by the wind, yet all of these soils would belong to the same class, because the greater proportion of the soil grains have the same size or texture. Thus we may have different kinds of clays, loams, sands, etc., and the class to which any soil will belong depends upon the size of the individual soil grains of which it is composed, and not upon its color, origin, topographic position, or agricultural value.

SOIL CLASSES

Soils Containing Less Than 20% Silt and Clay

1. Sand.—Over 25% fine gravel, coarse and medium sand, and less than 50% fine sand.
2. Fine sand.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.

Soils Containing Between 20–50% of Silt and Clay

3. Sandy loam.—Over 25% fine gravel, coarse and medium sand.
4. Fine sandy loam.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.

Soils Containing More Than 50% of Silt and Clay

5. Loam.—Less than 20% clay, and less than 50% silt.
6. Silt loam.—Less than 20% clay, and over 50% silt.
7. Clay loam.—Between 20 and 30% clay, and less than 50% silt.
8. Clay.—Over 30% clay.

Soils may be grouped in another way. Where soils are closely related through similar sources of the material from which derived, mode of origin, topographic position, etc., so that the different soils constitute merely a graduation in texture of otherwise uniform material, such a group is called a "soil series." It corresponds to the family which is made up of different individuals having the same parentage. The Miami series, for example, includes light colored, glacial material where the soils have been derived largely from the underlying limestone, and the soils in the series range in texture from a clay loam to sand and gravel with heavy types pedominating. The Plainfield series includes light colored soils in regions where no limestone is present, and where the material occurs at outwashed plains or stream terraces. The soils in this series also have a wide range in texture but sandy types predominate. The name used for a soil series usually indicates the locality where that particular series was first recognized and mapped by the Soil Survey.

By uniting the name of the *soil class,* which refers to texture, with the name of the *soil series,* which refers chiefly to origin, we get the *soil type,* which is the basis or unit of classifying and mapping soils. A *soil type,* thus, is a soil which is uniform throughout its entire extent in texture, color, topographic position, and other physical properties, and having a distinct agricultural unity, that is, being adapted to the same crops, and requiring the same treatment. It is also uniform in the source of material from which it is derived, and the mode of origin which, taken together, determine the chemical composition. Since the soil type is the unit in classifying and mapping soils, and the basis upon which experimental work should be conducted, every farmer should be familiar with the soil types on his farm, and their leading characteristics.

SOIL SURVEY OF WASHINGTON AND OZAUKEE COUNTIES

CHAPTER I.

DESCRIPTION OF THE AREA

The area covered by this survey includes Washington and Ozaukee Counties. Lake Michigan is on the eastern border and its southern edge is about 10 miles north of Milwaukee. This

Fig. I. Sketch map showing progress of the soil survey.

area has a total length east and west of thirty miles, and north and south of twenty-four miles. Washington County covers an area of 423 square miles and Ozaukee of 226 square miles, making a total of 649 square miles.

The territory covered by Washington and Ozaukee Counties was entirely in possession of the Indians prior to 1831. The territory north and east of the Milwaukee River was in the possession of the Menomonee Indians, while the territory west and south of the Milwaukee River was controlled by the Potawatamis. By 1838 all of the Indian lands had been ceded by the Indians, and the Indians had been removed to regions west of the Mississippi River.

The first road into the region was known as the Decorah Road, and passed through what is now West Bend and Saukville, and extended to Port Washington. This was laid out from 1832 to 1833. A road from Green Bay to Chicago was completed as far as Port Washington and Milwaukee in 1839. The original land surveys were made in 1834 to 1836, and the first land entered in this region was Port Washington in 1835. The population of this region in 1840 was 343, and by 1850 it had increased to 19,485.

The first settlements were made in Washington County from 1836 to 1842, and in Ozaukee County in 1835. The town of Belgium in Ozaukee county was settled largely by people directly from Belgium. In Washington County the town of Erin was settled chiefly by people from Southern Ireland, who came to Wisconsin about 1842. There was a considerable German influence in both of these counties shortly after the Civil War, and at the present time, the bulk of the population in both counties is of German descent, although many nationalities are represented, and the majority of the population is native born. Washington county was created from parts of Milwaukee and Brown counties in 1836. Ozaukee was created from Washington in 1853. At present the population of both counties is well distributed; Ozaukee county is somewhat more thickly populated than Washington. In 1920 Washington county had a population of 25,713, which is 41.3 per square mile. Ozaukee had a population of 16,335, which is 55.8 per square mile.

In studying the recent statistics, it is interesting to note that there has been a gradual reduction in the rural population of several towns in both counties during the last twenty years. In Ozaukee county between 1910 and 1920 this amounted to 2.5 percent. In Ozaukee County there was also a reduction of urban population at the same time of 11.9 percent. In Washington County there was a reduction of rural population be-

tween 1910 and 1920 of 14.3 percent., and an increase of the urban population 164.7 percent. at the same time. This has meant chiefly shifting of population from the farms to the cities, and it has caused great difficulty in securing farm labor. The greatest increase in population has been in the city of Hartford where there is a large automobile concern which employs considerable labor. Aside from this manufacturing establishment there are in the county a number of brick and tile plants, several knitting mills, a shoe factory, a farm implement manufacturing concern, and an aluminum factory, and several other establishments which employ labor. There has been a gradual increase during recent years of manufacturing in small towns, and the labor supply for this manufacturing has been drawn in part from the surrounding agricultural sections.

West Bend with a population of 3,378, is the County Seat of Washington County. Hartford is the largest city in the county, with a population of 4,515. Schleisingerville, Kewaskum, Jackson, Richfield, Allenton are other towns within the county. Port Washington with a population of 3,340 is the County Seat of Ozaukee County, and Cedarburg, Grafton, Saukville, Thiensville, Belgium, Fredonia are other smaller cities and villages within the county.

This region is well supplied with transportation facilities, the area being traversed by branches of the Chicago, Milwaukee & St. Paul, the Chicago and Northwestern, and the Soo Line. It is also crossed from north to south by the Milwaukee and Northern Electric Railway, which runs from Milwaukee to Sheboygan. These lines provide excellent transportation facilities for both passenger and freight. The public roads within the area are mostly well improved, and a number of concrete roads are being constructed along the main trunk highways. There is an abundant supply of excellent gravel for road building material, and some of the trunk highways, and many of the secondary roads are being surfaced with the material, which makes an excellent roadway. In time there will be a well surfaced highway within comparative easy reach of each farm within the area; so marketing of farm produce by truck will be greatly simplified. A large proportion of the farm homes in the county are supplied with telephones and rural mail service.

Milwaukee is the principal market for the farm products of this area. Marketing facilities are excellent, there being a popu-

lation of 1,000,000 people within a radius of fifty miles from the center of the area covered by this survey. With the good shipping facilities and system of trunk highways, the farm products can readily reach markets and shipping points. A large part of the milk which is produced is shipped to Milwaukee and delivered as whole milk. There are also some butter and cheese factories through which some of the dairy products are marketed. The marketing and transportation facilities are such at the present time that they could readily serve a much more highly developed system of agriculture than has been developed up to the present time. Because of this excellent service, agriculture is becoming more intensified. Farms are gradually being divided up into smaller units, and this will encourage larger acre production.

SOILS

The area included in Washington and Ozaukee counties, in common with the greater part of eastern Wisconsin, owes the general character of its surface soil to several methods of accumulation. They are glacial, alluvial, and lacustrine or lake-laid, in origin. In addition, the accumulation of organic matter in low places has resulted in the formation of large areas of peat soils. In the geological classification, which takes into consideration the underlying rocks, the area falls into several divisions, although one is much more extensive than all the rest.

The youngest rock formation is the Devonian, which forms the surface rock over a very small area along the shore of Lake Michigan, extending north from Port Washington for a distance of about eight miles, and having a width of one mile or less. This formation is frequently called the Milwaukee cement rock, and consists of a black to bluish shale, or buff to gray, clayey magnesia limestone.

The next formation older than this is the Niagara limestone, which forms the surface rock over ninety per cent of Washington and Ozaukee counties. Along the extreme western part of Washington County, there occurs as surface rock a small area of the Cincinnati shale. This covers a total area of about one township, and is of such small extent that it does not influence to any marked degree the overlying soils. The next oldest rock is the Trenton and Galena limestone formations, which occur

to a limited extent in the town of Erin, in the extreme southwestern corner of Washington County.

The original soil of the region was derived by weathering of these rocks but the ice of the glacial period mixed it with limestone ground from the rocks. Since the Niagara limestone is the most extensive, this is the formation which has contributed most to the formation of the soils, and the material which we now find making up the body of the soil has been derived largely from the Niagara limestone.

This region was traversed by two distinct glaciers, one known as the Lake Michigan lobe, and the other as the Green Bay lobe of the Late Wisconsin ice sheet. Where these two glaciers came in contact, there was formed a very pronounced moraine, which has been called the "Kettle" Range or interlobate moraine. This range of morainic hills now forms the most conspicuous feature of the landscape. It extends across the area from northeast to southwest, and is found extensively developed in the towns of Erin, Richfield, Polk, West Bend, Kewaskum, and Farmington. The development of the moraine is less marked in Trenton township. The elevation of the highest hills in this moraine is from two to four hundred feet above the adjacent country.

The elevation of the region, as implied, varies to a considerable degree, the range being from the level of Lake Michigan, which is 581 feet above sea level, to 1,361 feet, which is the elevation marked on Holy Hill by the United States Geological Survey. This is the highest point in the area. The elevation of a number of intervening points is given herewith, and these elevations are usually the elevation of the railroad station in each town.

Port Washington	671	Fredonia	795
Belgium	737	West Bend	896
Cedarburg	798	Kewaskum	951
Cedar Lake	1,030	Hartford	984
Germantown	858		

As indicated above, the soils of the regions fall into four distinct classes. Since the first deposition of the soil forming material, it has all been modified to a greater or less degree, so at the present time there is a wide variation in the surface of the soils of the two counties. In the work of the Soil Survey, this surface material has been classified into 11 soil series, and each

soil series has been further separated into individual soil types and type phases of which there are 44 in the area. The classification of these soils into types and phases is based chiefly on texture, topography, origin, chemical composition, and native vegetation.

The soils which are lacustrine or lakelaid in origin belong chiefly to the Superior, and Poygan series. These are found for the most part, lying between the Milwaukee river and Lake Michigan, and are characterized by heavy, compact, pinkish-red subsoils. The material forming these series was all deposited in Lake Michigan when this body of water stood at a much higher level than at present, and since then, the depositions have been modified more or less by glacial action.

The Superior series as typically developed, is level to gently undulating, and is characterized by heavy, red clay subsoil. The surface varies from fine sandy loam to a heavy clay loam. Three types were mapped as belonging to the Superior series,—clay loam, silt loam, and fine sandy loam. The rolling phases are similar to the typical Superior, but differ in the surface being undulating to gently rolling, which makes the natural surface drainage good.

The Poygan series occupies level, low, or slightly depressed areas associated with the Superior soils, and because of poor drainage, there has accumulated large amounts of organic matter, giving the surface soil a dark color. Poygan clay loam was the only type mapped in this area.

The soils which have been derived from glaciated material without otherwise being modified to any great degree are as follows: The Miami series includes light colored, upland timbered soils of the glaciated limestone country where the surface of the soil is gray or light brown, and the subsoil is clay loam of a yellowish or reddish brown color containing some stony and coarse material. The types of the Miami series which have been mapped are clay loam, clay loam light phase, silt loam, silt loam deep phase, silt loam hilly phase, silt loam level phase, loam, gravelly loam, fine sandy loam, sandy loam and gravelly sandy loam.

The Rodman series includes extremely rough and broken morainic country where the soil consists almost entirely of gravel with only a very shallow covering of soil. This gravel is usually stratified and occurs chiefly in the form of kames and eskers.

The gravel is over 95 per cent limestone. There were two types of this soil mapped; gravelly loam and gravel.

The Coloma series includes glaciated material, which is of a very sandy nature. In this area the sandy material has doubtless been carried for a considerable distance, and has included with it some limestone as well as sandstone material. The types, Coloma fine sand and sand were mapped in this area.

The Fox series includes light colored soils found occupying outwash plains or level terraces where the subsoil below a depth of two feet consists of stratified material. The soil of this section has been derived from glaciated limestone and redeposited as outwash material. The types mapped are: Fox silt loam, silt loam, poorly drained phase, loam, loam gravelly phase, loam heavy subsoil phase, fine sandy loam, and sandy loam.

The Plainfield series includes sandy soils which occur as outwash plains or stream terraces where the material has been derived chiefly from sandstone rocks, or where the sandy material has been eroded from other formations and deposited in the form of sand. The Plainfield sand and fine sand were mapped in this area.

The Waukesha series consists of dark-colored terrace soils which occur above the present flood plains and are naturally well drained and are underlain by a stratified sand and gravel to about two or three feet. The surface soil is usually acid, but the subsoil is high in lime carbonates. The fine sandy loam and silt loam were mapped.

The Clyde series consists of low, poorly drained land occurring as depressions in the upland and composed chiefly of grayish till with which there has been a large accumulation of organic matter, giving it a dark color. It also includes some alluvial soils. The subsoil is very calcareous, and the soil is seldom acid. Silty clay loam, clay loam, silt loam, loam, fine sandy loam, and sand were mapped.

The Wabash series includes dark colored alluvial soils occurring as first bottom land which is subject to the annual overflow. Wabash silt loam and a light-colored phase were mapped.

The peat soil consists of decaying vegetable matter in various stages of decomposition with which there has been incorporated a small amount of mineral matter. Two phases of this type were mapped; deep peat and shallow peat.

On the soil map, each one of the above names soil types has

been indicated by a distinct color so that its area and exent can be readily observed by making a careful study of the soil map.

Footnote to Chapter on Soils

In comparing this issue of the soil survey report of Washington and Ozaukee Counties with the edititon published by the United States Bureau of Soils, it will be noted that there is some difference in the naming of some of the soil types. In the State report the types have been correlated with the soils as previously mapped in the State while in the report issued by the United States Bureau of Soils the types have been correlated with the soils as they occur in adjoining states. The following table gives the various soils to which different names have been applied in the two reports.

TYPE NAME AS PUBLISHED IN THE STATE REPORT	TYPE NAME IN REPORT OF U. S. BUREAU OF SOILS
Miami silt loam, deep phase.	Miami silt loam.
Miami clay loam.	Miami silty clay loam.
Miami clay loam, light phase.	Miami silty clay loam, light phase.
Miami gravelly sandy loam.	Bellefontaine gravelly sandy loam.
Miami gravelly loam.	Bellefontaine gravelly loam.
Miami sandy loam.	Bellefontaine sandy loam.
Miami fine sandy loam	Bellefontaine fine sandy loam.
Miami loam.	Bellefontaine loam.
Miami silt loam.	Bellefontaine silt loam.
Miami silt loam, hilly phase.	Bellefontaine silt loam, hilly phase.
Superior fine sandy loam, rolling phase.	Kewaunee fine sandy loam.
Superior silt loam, rolling phase.	Kewaunee silt loam.
Superior silt loam, gravelly rolling phase.	Kewaunee silt loam, gravelly phase.
Miami Silt loam, level phase.	Conover silt loam.
Clyde clay loam.	Clyde silty clay loam.
Clyde fine sandy loam.	Maumee fine sandy loam.
Clyde loam	Maumee loam.
Clyde clay loam.	Maumee silty clay loam.
Clyde sand.	Newton sand.
Poygan clay loam.	Poygan silty clay loam.
Superior clay loam, rolling phase.	Kewaunee silty clay loam.
Fox silt loam, poorly drained phase.	Newton silt loam.
Clyde clay loam, alluvial phase.	Maumee silty clay loam.

WASHINGTON–OZAUKEE COUNTIES

Areas of Different Soils

	Acres	Per-cent
	Acres	Per-cent
Miami silt loam	75,620	21.5
Miami, silt loam, hilly phase	15,552	
Superior clay loam, rolling phase	45,632	10.7
Peat	38,784	10.3
Peat, shallow phase	5,056	
Miami clay loam	18,752	8.9
Miami clay loam, light phase	19,200	
Miami gravelly loam	36,544	8.6
Miami loam	21,568	5.1
Clyde silt loam	17,152	4.1
Clyde clay loam	12,800	3.0
Superior silt loam, rolling phase	11,200	2.9
Superior silt loam, rolling gravelly phase	1,216	
Miami silt loam, deep phase	10,496	2.5
Fox loam	1,792	2.5
Heavy subsoil phase	7,232	
Gravelly phase	1,728	
Rodman gravelly loam	10,048	2.4
Miami fine sandy loam	8,512	2.0
Miami silt loam—level phase	8,576	2.0
Poygan clay loam	6,976	1.6
Wabash silt loam	5,184	1.3
Wabash silt loam, light colored phase	192	
Fox fine sandy loam	4,416	1.0
Clyde loam	4,160	1.0
Miami gravelly sandy loam	4,032	0.9
Clyde clay loam, alluvial phase	3,776	0.9
Waukesha fine sandy loam	3,584	0.8
Fox silt loam	3,392	0.8
Superior clay loam	3,328	0.8
Waukesha silt loam	2,624	0.6
Coloma fine sand	2,500	0.6
Superior silt loam	2,500	0.6
Coloma sand	2,432	0.6
Fox silt loam, poorly drained phase	1,280	0.3
Plainfield sand	1.152	0.3
Clyde fine sandy loam	1,088	0.3
Rodman gravel	1,088	0.3
Fox sandy loam	960	0.2
Superior fine sandy loam, rolling phase	896	0.2
Miami sandy loam	576	.1
Clyde sand	512	0.1
Plainfield fine sand	448	0.1
Superior fine sandy loam	384	0.1

CHAPTER II.

GROUP OF HEAVY SOILS.

Miami Clay Loam

Description: The surface soil of this type to an average depth of 8 inches consists of a brown or light brown clay loam which is a grayish-brown when dry. The subsurface is a yellowish clay loam which has a brownish color in places. With depth the material becomes heavier and below 12 to 16 inches it is quite uniformly a brown clay. This heavy material extends to a depth of 3 to 4 feet, and in the deep subsoil some gravel and coarse material is frequently found. The gravel consists chiefly of limestone.

As a whole, the type is quite uniform, but there are several variations worthy of note. In places the subsoil has a suggestion of pink or red which is characteristic of the Superior soils. As mapped, therefore, the Miami clay loam includes small tracts of Superior clay loam rolling phase. Another variation is when the subsoil is of lighter color than typical. A grayish color or light drab is sometimes found and it is associated with this condition that the pinkish shade is usually seen.

In texture there is a variation which is important enough for a place distinction and that is where the surface soil is a light brown silt loam for from 4 to 6 inches before passing into the compact clay loam subsoil. Under this phase the upper subsoil appears to be more compact than typical and the lower subsoil is more gravelly than typical and frequently of a lighter color. This silty phase appears to be a gradation from the heavy clay loam to the silt loam, but it partakes more of the nature of a clay loam. The distinction of this silty phase is shown on the soil map as the light phase of the clay loam. Pockets or lenses of fine sand in the subsoil are not uncommon over all of the soil. On knolls, the stony material is nearer the surface than typical and the heavy subsoil is often exposed.

Extent and Distribution: The Miami clay loam is confined to the eastern half of the area and extends in a northeast and south-

west direction nearly parallel with the shore of the lake. Its most common occurrence is in eastern Richfield and Polk townships in the towns of Germantown west half of Mequen, Jackson, Cedarburg, Saukville, and Fredonia. In only a few cases is the clay loam found either east or west of this belt. Within this belt the silty phase is found mostly to the west where it grades into Miami silt loam and the typical clay loam is confined largely to the eastern part where it grades into and is closely associated with the Superior clay loam, rolling phase. The Miami clay loam is one of the important types in the area and occupies a total of 37,952 acres.

Topography and Drainage: The surface varies from undulating to gently rolling with but few areas included which could be classed as rolling. The natural surface drainage is in most cases good and the underdrainage is usually fair to good. Over some of the more nearly level tracts, however when the subsoil is very heavy and compact, the underdrainage is somewhat deficient and till drains could be used to advantage.

Origin: This soil is of glacial origin, having been derived largely from limestone through weathering and the movements of ice. While most of the material is of limestone origin, the surface has been leached to such an extent that most of the lime corbonate has been leached out and in places an acid condition has developed. The subsoil, however, is usually quite calcareous.

Native Vegetation: The original timber growth consisted of oak, maple, elm, ash, beech, hickory and some walnut. Most of the merchantable timber has been removed, and the land placed under cultivation.

Present Agricultural Development: This is one of the extensive and important types of soil in the area. It is strong and productive, and is nearly all under cultivation in highly improved farms. General farming and dairying are the chief lines of farming. The chief crops are corn, oats, hay, barley, some wheat and potatoes. Some cabbage, sugar beets, alfalfa, and peas are also grown, and in a few places more intensive farming in the form of trucking is carried on. This is chiefly in the regions nearest to Milwaukee and along good roads. Stable manure is the chief fertilizer used, but on some farms this is being supplemented by commercial fertilizers.

Miami Clay Loam, Light Phase.

The Miami clay loam, light phase, consists of a light-brown silt loam surface soil from 4 to 6 inches deep which passes into a compact clay loam subsoil. In this phase the upper subsoil appears to be more compact and the lower subsoil more stony than typical and is frequently of a lighter color. The light phase represents a gradation from a clay loam to a silt loam, but it partakes more of the nature of the clay loam.

The Miami clay loam, light phase, occurs in close association with the typical soil, largely along the west side of the belt of occurrence of the type, where it grades into the Miami silt loam. It is used for the same crops and is handled by the same methods as the typical soil.

Miami Silt Loam

Description: The surface soil of this type to a depth of 8–10 inches consists of a light textured, light brown silt loam. Below the surface soil is a yellowish-brown to slightly reddish-brown silt loam somewhat heavier than the surface soil and extending to a depth of 14–18 inches, where it grades into the subsoil proper which consists of reddish-brown compact silty clay loam. At about 2 feet the subsoil changes into a friable gravelly loam or clay loam, somewhat calcareous. This in turn grades into a mass of unweathered stony gravelly glacial till, composed largely of limestone material. Many areas are slightly gravelly at the surface. The soil itself may be a little gravelly in places and often carries enough sand of the different grades to make it slightly gritty, though there are numerous areas where the surface soil section is nearly as free from gritty material as the Miami silt loam, deep phase.

The degree of stoniness varies greatly, some places being entirely stone free, while others were originally covered with many bowlders. Most of these bowlders have been removed from cultivated fields, and placed in piles or built into stone fences, which are quite common in places on this soil. The stones present are largely crystalline rocks with some limestone. The gravel is made up largely of limestone pebbles. As is the case

with the Miami silt loam, deep phase, this soil is also deficient in organic matter or humus.

This type as maped includes numerous variations and also spots of other types especially Miami silt loam, deep phase, and Miami loam, gravelly loam, and fine sandy loam. The more gravelly areas usually occupy the rougher parts while the more silty areas occur where the slopes are gentle or the surface nearly level and little erosion takes place. On many of the hillsides and slopes the surface soil has been removed, leaving exposed the reddish subsoil which is characteristic of the Mimai series. Rolling fields under cultivation therefore have a spotted appearance, there being a marked contrast in color between the grayish brown surface soil and the reddish color of the exposed subsoil. The characteristics distinguishing this soil from the Miami silt loam, deep phase, are the browner color of the surface soil, the reddish tinge of the subsoil, and the shallow depth to the porous mass of highly calcareous material. The native vegetation and the experience of farmers would indicate that the soil is less acid than the deep phase. Alfalfa can be more easily grown and clover is a surer crop.

Extent and Distribution: Miami silt loam is the most extensive soil in the area. It is found most extensively in the towns of Wayne, Addison, Hartford, Erin, Kewashkum, Cedarburg, Richland, and Germantown. Other smaller tracts are scattered in every town within the area. Where most extensive the continuity of the type is broken by numerous areas of loam, gravelly and sandy loam of the same series, as well as by some low-lying types of the Clyde and Wabash series. Areas of peat are also associated with the soil.

Topography and Drainage: The topography ranges from gently undulating to rolling. As a whole, the natural drainage is good, though there are some areas where the surface is undulating or where there are long gentle slopes that would be benefited by tile drainage. Such tracts, however, are the exception. The subsoil contains sufficient sand and fine gravel to make the internal drainage good, so that wherever there is an outlet the land will drain out in a satisfactory manner. The question of artificial drainage is one which need seldom be considered on this soil.

Origin: Miami silt loam has been derived largely from glaciated limestone material which has been ground from the un-

derlying Niagara limestone by glacial ice. With this material there has been mixed a small amount of glacial debris which was carried from the north, as is evidenced by the presence of a large number of crystalline bowlders. Doubtless some fine earth was also transported or some of these rocks reduced to dust and mixed with the soil from limestone. The lower subsoil is calcareous and alfalfa appears to do better in this type than on the deep phase. This would seem to indicate for one thing, a larger amount of lime present. Where the surface of this soil is extremely silty it is possible that there has been a mantle of loessial material deposited over the glacial debris. This surface soil is sometimes slightly acid, though more often no reaction is secured by the use of litmus paper in the field.

Native Vegetation: The native timber growth on this class of land consisted of oak, maple, hickory, basswood, and in places there were originally some walnut and butternut trees. At present about 75 per cent of the type is cleared and under cultivation, and the woods that remain are in the form of small farm woodlots. Towards the eastern part of the area some of the areas of this soil have some beech timber, but there is little of this in the western part.

Present Agricultural Development: This land is used chiefly for the production of general farm crops and for dairying. The chief crops grown are corn, oats, hay, with some wheat, rye, and barley. The hay is mostly mixed clover and timothy but there is also an increasing acreage of alfalfa, which does better on this soil than on almost any other type in the region. Irish potatoes are grown to some extent and beans, peas, sugar beets, and some garden truck near the cities may be classed as special crops. Apples do well where the site is suitable. There are many home orchards, but no large commercial orchards.

The yields of most farm crops are better than on the deep phase of Miami silt loam, alfalfa in particular giving better results. But the surface of the land is more irregular and the appearance is therefore not always as attractive to some as the smoother land of the deep phase. As a whole, this land is fairly well farmed.

For the most part Miami silt loam will produce clover and alfalfa without the use of lime, when other conditions have been favorable. Inoculation of course is necessary where alfalfa has not been grown before. Where there is trouble in getting a

stand of either clover or alfalfa, tests should be made to see if the soil may be acid and in need of lime. While the survey was in progress, spots were found which were acid, but the condition is not uniform for the type and for this reason tests on every farm are necessary.

This land has a selling value of from $100 to $200 per acre, depending upon the location, roads, topography, character of the soil, and how the land has been worked.

Miami Silt Loam, Deep Phase

Description: The surface soil of this phase to an average depth of 12 or 14 inches consists of a grayish brown very smooth, friable silt loam, having a rather low content of organic matter or humus. The subsoil consists of a yellow silt loam somewhat heavier than the surface soil and grading at about 16–18 inches into a silty loam which, as the soil, is quite free from coarse material such as coarse sand and fine gravel. At about 28 inches the color becomes in most cases a slightly reddish chocolate brown and there is sufficient coarse material present to make the deep subsoil quite gritty to the feel. This material grades into, or rather is a part of, the unassorted glacial till. As a rule the soil is nearly or quite stone free but in places there were some stones when the land was first cleared. Most of these have been removed. The color of the soil varies slightly with the topography, being darkest in the slight depressions. The content of coarse material in the soil and subsoil may vary slightly, but as a rule the type is free from gritty material except in the deep subsoil, and the soil is quite uniform in texture, structure, and color. This soil differs from typical Miami silt loam chiefly by having a deeper covering over the unassorted drift. The subsoil material is also less well oxidized, and has less of the red color present in the lower depths than the typical Miami soils.

Extent and Distribution: The deep phase is not extensive. It is confined chiefly to Hartford town, where there are about 6 square miles, and to the towns of Germantown and Mequon where the area is much smaller. A few small patches occur in other parts of the area, but they are of minor importance. The total area of this phase is 10,496 acres.

Topography and Drainage: The surface of the soil varies from nearly level to gently rolling with most of the type gently

undulating. The natural drainage is for the most part good, but on the nearly level tracts, it is sometimes slightly deficient, and in such places tile drains might be installed with profit. The subsoil seldom shows signs of deficient internal drainage.

Origin: The material forming this soil is largely of glacial origin having been derived from the underlying Niagara limestone by the action of the glacial ice. It is possible that the deep layer of silty material on the surface may be in part of loessial origin, or has been influenced to a limited extent by wind blown material. It is quite similar to sections of the state where wind blown material is thought to have entered into the formation of the soils. Tests show that the material below a depth of 3 feet is usually calcareous, but frequently the surface soil is slightly acid, though not uniformly so.

Native Vegetation: The native vegetation consisted largely of oak, maple, hickory, elm, with some basswood and a limited amount of ash over the more poorly drained parts. Very nearly all of the timber has been cut, and what is left is now in the form of small wood lots, of a few acres each.

Present Agricultural Development: Probably 90 per cent of this type is cleared, under cultivation and in highly improved farms. It is excellent land, and is considered among the best in the area. The chief crops grown are corn, oats, barley, wheat, clover, timothy, and some alfalfa. The chief type of farming is dairying in conjunction with general farming. Hogs are raised quite extensively. Of the special crops grown, sugar beets, and white clover for seed may be mentioned. The yields secured compare favorably with the highest secured in the region, and this may be considered one of the most productive types of land in the area.

This land is mostly owned by progressive farmers and the methods followed are somewhat above the average for the region as a whole. Because of the smooth topography, and freedom from stones, and the extreme silty nature of the soil, it is not difficult to secure an excellent seed bed, and this land is usually kept in good tilth. The chief fertilizer used on this land is stable manure, though the question of the use of commercial fertilizer is each year receiving more consideration. Limited amounts of lime have been used, but the practice is not at all common.

Land values are high. Farms on this type of soil and well lo-

cated usually command a somewhat higher price than on most of the other types of the county. This is because of the smooth topography, freedom from stones, the fact that most of the land can be readily improved with the minimum of effort, and also because of the location, most of this land being well located as regards towns and shipping points as well as on good roads. Values of from $150 to $250 per acre are not uncommon and some land is held at higher prices.

Miami Silt Loam—Hilly Phase

The soil section of this phase is quite similar to that of the typical Miami silt loam, except that possibly there is not as much of the reddish color present in the subsoil. The surface is a brown to light brown silt loam, very smooth, friable and free in most places from coarse material. This is quite variable in depth due to the steep slopes, but usually ranges from 6 to 14 inches. The underlying material is a yellowish, heavy silt loam or silty clay loam, which takes on a reddish brown color and gradually becomes heavier with depth. At 2 feet the material is usually a heavy clay loam or silty clay loam, containing some gritty material below this depth, but often not as much as is found in the typical soil. The material forming the subsoil is more thoroughly oxidized than in the deep phase of Miami silt loam.

The rolling or hilly phase is confined almost entirely to the northwestern part of the area and over 90% of it is in Wayne Township. A small amount extends into Addison Town to the south and there are a few small scattered tracts in several other towns, but the total area outside of this large tract is of a minor importance.

The surface is rolling to hilly, and is usually steep enough so that erosion is a factor in farm management. Away from the main body of this soil some areas have been included which are less steep than herein described, but are somewhat different from the typical soil—an example would be a pronounced hill in the midst of a comparatively smooth area. Because of the surface features, the natural surface drainage is very good, and most too free, since too much of the surface water escapes. While the slopes are steep enough to cause erosion, there are comparatively few fields where destructive erosion was seen. This steep

land is used more for hay and pasture, and cultivated crops are not grown as much as on areas having smoother topography.

There appears to be more difference in the geology of this phase and the typical soil. The typical soil appears to be made up of glacial material, and the hills are for the most part composed entirely of glacial debris, being largely morainic in character. Stones and bowlders are common. This steep phase in the northwestern part of the county appears to be glacial material over a floor which was badly eroded before the glacial covering was laid down. The slopes are more regular in appearance, and do not have the bumpy characteristics common in much of the other country. While some stones are found, they are not as plentiful as on the typical soil. Rock outcrops were not seen but the draft appears to be thinner than where the typical soil is found.

From an agricultural standpoint this is good land, but the steeper portions are more difficult to work than the typical soil, and more care must be exercised in planning the farm practices. Cultivated crops like corn, beets, etc., should be grown with caution, and land should be kept in pasture as much of the time as possible to prevent washing.

Because of the topography this land has a lower value than the typical soil.

Miama Silt Loam, Level Phase

Description: The surface soil of this phase to an average depth of 8 inches consists of a grayish-brown, smooth silt loam, or heavy silt loam which may be somewhat darker than associated light-colored soils, owing to its lower position and the accumulation of organic matter. The upper subsoil is a yellow to drab silt loam gradually becoming heavier with depth, and at about 14–16 inches becoming a silty clay loam of a yellowish color which usually is mottled below 2 feet. The subsoil is quite compact and quite retentive of moisture. When dry, the surface often has an ashen appearance. In a few places this phase approaches a clay loam in texture.

Extent and Distribution: This soil is of limited extent, there being but 8,576 acres. It is associated with the Miami silt loam. The largest areas are in the vicinity of Hartford in the northern part of Hartford township where it is associated with Miami silt loam, deep phase. Numerous areas are also found in Addison

VIEW OF MIAMI CLAY LOAM IN OZAUKEE COUNTY.
This is a good soil and is highly improved. This soil with its light phase makes up about 9 per cent of the area of the two counties.

Bank of red clay along the shore of Lake Michigan in Ozaukee County.

Tractor operating on the Superior clay loam in Ozaukee County.

CONSTRUCTING A VERTICAL DRAIN IN A DEPRESSION IN MIAMI CLAY LOAM

This hole is 14 feet long, 5 feet wide and 7 feet deep and the bottom is sandy. It is to be filled to within 18 inches of the top with stones and then covered over with soil. The stones and the sandy bottom will form an outlet for the drainage waters. A vertical tile drain would be more effective.

township, and small patches occur in most of the towns in Washington county. But little of the type is found in Ozaukee county.

The chief difference between this soil and the Miami silt loam, deep phase, is that this phase has a mottled subsoil, showing poor under drainage and is more nearly level.

Topography and Drainage: The surface of this type is level to very gently sloping, and because of this and the heavy subsoil, the natural drainage is somewhat deficient.

Present Agricultural Development: The native timber was hickory, oak, and maple, most of which has been cut. Over fifty per cent of this soil is under cultivation and in improved farms. Some is kept in scattered timber and is used for grazing, especially where the drainage is most deficient.

Where cultivated, most crops common to the region are grown, but this soil is rather cold and backward in the spring, and for this reason it is not so well suited to corn as more rolling, better drained land. It may be classed as fair to good soil, but one which should be tiled before best results can be received from its cultivation.

Superior Clay Loam

Description: The Superior clay loam, to an average depth of 6 inches consists of a light grayish brown clay loam, grading quite abruptly into heavy, compact red clay which extends to undetermined depth. The light colored material over the red clay varies from 2 to 8 inches deep. In the heavy clay subsoil, especially in the lower depths, it is not uncommon to find thin beds or lenses of fine sand. Within 3 feet of the surface there may also be a few fine rock fragments, chiefly limestone. The surface soil is free from stones and the type as a whole is quite uniform.

Extent and Distribution: This soil is confined to the eastern side of the area within 8 to 9 miles of the lake. Within this belt the soil occurs in scattered tracts of from a few acres to a square mile or more in extent. It is closely associated with the Superior clay loam, rolling phase. The largest tracts are in Port Washington, Fredonia, and Belgium townships with smaller patches in the southern portion of the red clay belt.

Origin: During the time that Wisconsin was passing through the glacial period, Lake Michigan for long periods of time was

much larger than it is now. While this lake was in existence, a great amount of fine soil material, mostly silt and clay was deposited by the water. After the glaciers receded, Lake Michigan diminished to its present size and left behind it a vast area of soil which has been classified as the Superior soils. The rolling phases of the Superior types are those areas of this water-laid soil that was disturbed or reworked by the direct action of the glacial ice. In this process of reworking, the topography was changed to an undulating to rolling condition and a small amount of limestone fragments and stones was intermixed with the soil. These limestone rock fragments came from the Niagara limestone which is the bedrock underlying all of the eastern part of Wisconsin. The low amount of or lack of acidity in the soils of this area is due in part to the presence of this limestone.

Topography and Drainage: The surface of this soil is level to very gently undulating and it differs only in this respect from the rolling phase of Superior clay loam. Because of the level surface and heavy subsoil, the surface drainage is somewhat deficient and the under drainage is slow.

Present Agricultural Development This land is practically all in improved farms and is a good soil. It is rather cold and slow in the spring because of the drainage conditions, but small grains and grasses and clover do well. Corn does not do so well because the proximity of the lake makes the springs backward and the soil warms up slowly.

Superior Clay Loam, Rolling Phase

Description: The Superior clay loam, rolling phase, to a depth of three to four inches consists of a compact slit loam of a brown or grayish-brown color. This is underlain by a reddish brown or pinkish red clay loam which quickly becomes a clay and extends to a depth of over 3 feet. Road cuts and stream banks show it to extend to a depth of 40 to 50 feet. Along the shore exposures of over 100 feet can be seen in places where there is an abrupt drop to the water's edge.

The surface is somewhat patchy, for in places the thin silt loam covering is absent and the heavy reddish brown clay loam forms the surface soil. Usually the knoll tops and ridge tops and some slopes have had the surface soil washed off, while along lower slopes or over fairly level areas the silty covering is still in place.

The soil is practically stone free.

This type, with the exception noted above, is quite uniform.

Extent and Distribution: This soil is confined to the eastern part of the area bordering Lake Michigan. The greatest portion is found between the lake and the Milwaukee river. This makes the area from 5 to 10 miles wide and extending the full length of Ozaukee county. There is but little of this soil in Washington county. It is one of the important soils of the area and occupies 45,632 acres.

Topography and Drainage. The surface varies from undulating to rolling. The surface drainage is fair to good, but on account of the heavy subsoil the underdrainage is slow and water does not move through the soil readily. This soil is similar to the Superior clay loam, except in topography, the typical Superior soils being level or nearly so.

Present Agricultural Development: The original forest growth on the soil was maple, beech, birch, hickory, basswood, and oak, with some elm. Nearly all merchantable timber has been cut and probably over 90 per cent of the type is under cultivation and in highly improved farms. This is an excellent soil, well adapted to general farming and dairying, and all of the farm crops common to this region are grown. The soil is very heavy and somewhat difficult to cultivate.

Superior Silt Loam

The surface soil of this type to an average depth of about eight inches consists of a brown to grayish brown silt loam, which has a smooth feel and is free from all coarse particles and stones. The subsoil consists of a heavy, compact, purplish-red clay loam to clay, which extends to a depth of more than three feet.

There is some variation in the depth of this silty covering over the red clay, and this ranges from four to sixteen inches, the greatest being on lower slopes where wash from higher land has accumulated. On knolls and slopes, the surface soil has been eroded in some small spots, and the heavy subsoil exposed.

Superior silt loam is of limited extent and of minor importance. It covers a total area of 2,560 acres, and is confined chiefly to the northeastern part of the area in Belgium, Fredonia, Port Washington and Saukville Towns. The surface is level to very gently undulating, and the natural surface drain-

age is somewhat deficient, as is also the under drainage on account of the heavy subsoil.

The native growth on this soil was chiefly maple, beech, oak, pine, hickory, and basswood, with some elm and ash in the most poorly drained places.

Most of the timber has been removed, and the land is in well improved farms. It is devoted to general farming, to which it is well suited. It is classed as good land, and has a basic soil value as high as any other type in the area.

Superior Silt Loam, Rolling Phase

Description: The surface soil of this type to an average depth of about eight inches consists of a brown, rather compact silt loam containing a rather small amount of organic matter. The surface soil is practically free from stones, and as a whole, the texture is quite uniform.

The subsoil consists of heavy, red clay which is characteristic of the Superior series of soil. It is compact and stiff, and water moves through it slowly. However, the under drainage of this soil is not so deficient as some of the other heavy soils of the state. On drying, this soil cracks, and when heavy rains come, these cracks aid in carrying off the surplus water. While the subsoil contains a few stones, chiefly limestone, it is comparatively free from coarse material, and is very uniform in texture, color, and structure. In the deep subsoil there is frequently found more stones than near the surface. When this is the case, such material may represent an early gravel deposit.

This type has some variations worthy of note. On hill tops and on slopes the silty surface has frequently been washed off, leaving the heavy subsoil exposed. Such places are quite common, and they give cultivated fields a spotted appearance,—the red spots being Superior clay loam, rolling phase and the light colored areas being the silt loam. These red spots, while often numerous, are usually individually too small to be indicated. Where the sufficient size, they are shown on the map as the Superior clay loam, rolling phase.

Topography and Drainage. The surface of the type ranges from undulating to gently rolling, with a few areas which are rolling. The surface drainage, for the most part, is good, but the heavy compact subsoil does not allow the water to move

through it readily. On the most gentle slopes and in depressions between hills, some tile drains could be installed to advantage.

Extent and Distribution. This soil is found most extensively in Ozaukee county within five or six miles of Lake Michigan, chiefly in Belgium and Port Washington and Saukville townships. Most of it is between the lake and the Milwaukee river, although there are some areas west of this stream. The silt loam is associated with Superior clay loam and also with the Miami clay loam, to which it is quite similar. The total area of the Superior silt loam, rolling phase is 11,200 acres.

Present Agricultural Development. The original timber on this soil was maple, beech, birch, oak, basswood and some hickory, pine, and elm. Most of the merchantable timber has been cut and probably over eighty percent of this land is under cultivation in highly improved farms. It is one of the best soils in this area for general farming, and all crops common to the region are successfully grown upon it. It is not so difficult to cultivate as the clay loam.

Superior Gravelly Silt Loam, Rolling Phase

Description: The surface of this soil to a depth of 8 to 10 inches consists of a brown or light friable loam containing varying amounts of stones both in the subsoil and scattered over the surface. The subsoil consists of a reddish brown or nearly red clay loam containing an abundance of stones. The subsoil material is similar to the subsoil of Superior loam, rolling phase, but contains much more gravel and is not quite as red. It is heavier than the subsoil of the Miami gravelly loam, but in other respects is quite similar to it and may be considered as a phase of the Miami gravelly loam.

Extent and Distribution: This soil is found in the eastern half of the area, chiefly in the belt north and south where the Miami soils are associated with the Superior types. The total area is very limited, there being only two square miles. It occurs in very small patches of from 10 to 40 acres or less.

Topography and Drainage: The surface is gently rolling to rolling and the natural drainage is good. In places the surface soil has been eroded and the subsoil exposed.

Present Agricultural Development: Most of this land is cleared and cultivated. As the land is high in lime and well

drained, it is quite well suited to alfalfa, but it is used chiefly for general farm crops and pasture.

Fox Silt Loam

The Fox silt loam to a depth of ten inches consists of a light brown, friable silt loam, which has a light grayish appearance upon drying, owing to the low content of organic matter. The surface soil is practically free from sand and stones, and has a very smooth feel. The upper subsoil is a brownish yellow, silt loam, grading into a yellow, silty clay loam at sixteen to twenty inches. This heavy material extends to a depth of from two to three feet where beds of stratified sand, or sand and gravel are found.

This soil occurs in limited areas of from a few acres to 160 acres, although there are but few which exceed one hundred acres in extent. The total area of this type is 3,392 acres. The Fox silt loam occurs as well-drained benches or terrace lands along streams in Jackson, Farmington, and West Bend Townships, with a few small tracts in other parts of the area.

The Fox silt loam has a level surface, and because of the underlying gravel and sand, the drainage is good. In places where the silt loam covering is over three feet, the drainage is slightly deficient, but such areas are of small extent. In a few places, the surface is gently undulating, but all of the type is confined to terrace formations or outwashed plains, and occupies a position along the flood waters of adjoining streams.

This type is a good general farming soil, and is highly improved at the present time. Because of the small areas, but few, if any, farms are located entirely upon it. In its crop yields, the methods of farming followed upon it, and in the things that can be suggested for its improvement, it is practically the same as the Miami silt loam.

Waukesha Silt Loam

The surface soil of this type to an average depth of ten inches consists of a black, smooth silt loam carrying a large amount of organic matter, and being entirely free from stones on or in the surface soil. The upper subsoil is a brownish silt loam gradually becoming yellowish and at about eighteen inches, the material becomes brownish-yellow silty clay loam which con-

tinues to about twenty-four to thirty inches when it is underlain by stratified beds of sand and gravel. The lower portion of the heavy layer is gritty, but the change to sand is usually quite abrupt. The depth to the sand is variable, ranging from sixteen to thirty inches, but otherwise, the type is quite uniform.

The Waukesha silt loam is of limited extent, covering only 2624 acres in this area. It is confined chiefly to the terraces along the Milwaukee River, although a few patches are found along other streams. The type may also occur as outwash plains, but such places where the soil is black, are of very limited extent in this area.

The surface of this type is level to very gently sloping, and the natural drainage is usually good. The type is usually well above present flood flow, but in a few places it is found low enough so that the watertable is close to the surface in the spring, and the drainage somewhat deficient. Such areas are of limited extent, and the type as a whole is not in need of artificial drainage.

This soil as found in other areas is usually a prairie soil, but here it was mostly timbered, and may not be quite typical. In color it is not quite so black as the type in some other areas, but it is darker than our typical timbered soils, and otherwise answers the description of a Waukesha soil. Practically all of the type is cleared and under cultivation. It is a good soil and well suited to general farming. It is somewhat acid, and will respond to the use of lime and also phosphate fertilizers. It is better suited to corn, hay, and root crops than to small grains, as the grain is apt to lodge and does not fill so well as grain on the light colored soils.

Fox Loam, Heavy Subsoil Phase

Description: The surface soil of the Fox loam, heavy-subsoil phase, to an average depth of 8 inches consists of a brown to light-brown smooth silt loam containing somewhat more organic matter than other light-colored soils. The subsurface material is a grayish-brown or yellowish silt loam, which at 14 to 18 inches grades into a yellowish-brown silty clay loam, which is quite free from coarse material and extends to a depth of 3 to 5 feet, where it rests on sand or gravel. This phase is similar to the typical Fox loam in every respect except in the thickness of the heavy layer over the sand. In a few places the surface

soil is a clay loam, but such areas are too small to be mapped separately.

This phase is very widely distributed and is found in most of the towns in Washington County but is much less extensive in Ozaukee County. It is most extensive in the southern part of Richfield Town. In sections 29 and 32, Trenton Town, the subsoil is heavier and more compact than typical. This variation is also found in several smaller areas, but as a whole the phase is fairly uniform.

Topography and Drainage: The Fox loam, heavy subsoil phase, is level to very gently sloping. It occurs as terrace or bench lands tributary to streams, or as outwash plains. The natural drainage is fair, but not as thorough as on typical soil. In places tile drains would be helpful.

Most of this land is cleared, cultivated, and in highly improved farms. It is a strong, productive soil and well suited to general farming and dairying, for which it is most extensively used at present. With respect to crop yields, methods of cultivation, fertilization, crop rotation followed, and methods best suited for its improvement, this phase is similar to the Miami silt loam.

Chemical Composition and Improvement of Heavy Soils in Washington and Ozaukee Counties

The soils of this group vary somewhat in texture and color but from the point of view of their chemical composition and the methods of improvement, they are similar. The clay loam types are more difficult to handle especially after rains, due to their tendency to "puddle" and upon drying, form hard clods or "bake". The level phases of these heavier types have deficient drainage due to the compactness of the subsoil and the lack of surface slope to carry off the surface water. Tile drainage in such cases would be beneficial.

The Waukesha silt loam is the only dark colored soil in this group. The high content of organic matter gives this soil better tilth, larger water holding capacity and a greater supply of nitrogen than the other soils. The four elements of plant food with which the farmer is most concerned in his farming operations, and the ones which are the most apt to be deficient are nitrogen, phosphorus, potassium and lime or calcium. He should

know the part which each plays in the development of the plant and what are the best methods of maintaining an adequate supply in the soil.

The soil has been leaching for a large number of years and has lost much of the lime which it may have contained. Varying degrees of acidity have developed in places. The loss of lime from the soils is caused by two distinct factors, both of which are important. Crops require lime in their growth. A 5 ton crop of alfalfa requires 185 pounds of lime and 2 tons of red clover remove 61.6 pounds. A much larger amount is removed by leaching each year and these losses must be made up by the application of lime in order to maintain the fertility of these soils.

Tests show that the subsoil, especially of the deep phase of Miami silt loam, is frequently deficient in lime to a depth of 32 inches or more. The deficiency frequently extends down to where fine gravel and coarse sand is found in the subsoil.

While it will be seen from tests that part of this land shows some degree of acidity, it does not mean that all the land is in immediate need of lime. There are many areas where tests show that the application of lime is unnecessary. Where such crops as alfalfa, sugarbeets, tobacco, peas, cabbage and other garden crops are grown and where the acidity is medium, from 2 to 3 tons per acre of ground limestone may be used with profit. Where a liberal supply of manure is available the need for lime will not be so great. The second application which may be needed after 4 or 5 years will be less than the first.

Where such crops as corn, clover and oats are grown with manure once during each rotation, a smaller amount of lime will be needed. On parts of the farm where manure cannot be applied, the lime can be used with profit, and may be actually necessary for economic production. The greater need will usually be on the higher places, rather than on the lower slopes.

Phosphorus exists in all soils in small amounts. Many of the best types in the state contain only 1,200 pounds to the acre eight inches deep, and this is in a form which becomes available to crops very slowly. Phosphorus is constantly being lost from the farm in crops, milk, and in the bones of animals sold. It is well understood that when grain, hay, potatoes or other cash crops are sold, this element is removed from the farm. Phosphorus cannot be supplied from the air, thus in the long run

the loss must be made up through additions of phosphorus fertilizer in some form.

Several samples of clay loam and silt loam soils, when analyzed, varied from 420 pounds to 1640 pounds of phosphorus, the average being about 825 pounds. The lowest amounts were on a farm that had been cropped for many years and had not been manured very much. The number of pounds of phosphorus in the soil, however, cannot be taken to indicate the immediate need for phosphate fertilizer. The system of farming followed, crops grown, type of soil, and conditions relative to the need for lime are all important factors in determining the need for phosphorus. It should also be kept in mind that where soils are acid, the amount of phosphorus which they contain is not so readily available to plants as in soils which are not acid.

On good upland soil where dairying or general farming is practiced, the use of 200 to 300 pounds of 16 per cent acid phosphate or 75 to 100 pounds or 44 per cent super-phosphate to the acre every four or five years will maintain the phosphorus supply. If much grain, potatoes, or other crops are sold, more phosphate should be used.

On a farm in the eastern part of Wisconsin on one of the heavy soils, an application of 100 pounds per acre of treble superphosphate (44 per cent) on corn gave a yield of 15,570 pounds of silage while on the untreated plot the yield was 13,335 pounds per acre. In a test on the Station Farm at Madison, on the Miami silt loam soil, a phosphate fertilizer applied at the rate of 200 pounds per acre on oats gave a yield of 93.8 bushels while the untreated yield was 70.4 bushels. This was on land where the fertility was quite high. In another case where 500 pounds of 16 per cent acid phosphate per acre was applied to prairie land which received manure and limestone, the yield of alfalfa was nearly doubled. In some of these cases the increase is small but it should be kept in mind that the fertilizer left over in the soil will be of considerable value to the following crop, especially clover.

On soils relatively low in fertility, somewhat more phosphate should be used at first. This is especially true of the dark prairie soils which have grown corn or small grain a long time without the use of manure or other fertilizer.

In a study of the loss of phosphorus from the farms of Sheboygan County, it was found that approximately 180 pounds of

phosphorus per average farm was being completely lost. In other words, in order to maintain the phosphorus content of the soil, the average farmer would have to apply 1100 pounds of 16 per cent acid phosphate or its equivalent each year. If considerable amounts of bran or cottonseed meal are fed, which are relatively high in phosphorus, the supply of this element may be maintained. It would usually be necessary to feed at least one-half ton of bran or cotton-seed meal to each cow on a dairy farm per year to maintain the phosphorus supply of the soil. Since comparatively few farmers do that, some phosphate fertilizer should be used.

Postassium exists in these soils in large amounts, but in relatively unavailable form. Chemical analysis shows that they often contain from 30,000 to 40,000 pounds an acre 8 inches, while these same soils will contain only 1/18th as much phosphorus. On most soils of fairly heavy texture, when livestock is maintained, and the manure carefully used so there is considerably actively decomposing organic matter in the soil, a sufficient amount of potassium will become available from year to year to supply the needs of general farm crops. There are some crops that need relatively large amounts of potassium such as potatoes, tobacco, and cabbage and they will often be benefited by some addition of potash in the form of commercial fertilizer.

Nitrogen is chiefly responsible for the dark green, healthy color and rapid growth of corn or other crops on well manured land. It is important to have sufficient amounts in the soil, but when in excess it is detrimental for some crops. The quality of the grain may be injured by too much nitrogen. When the grain lodges, the kernels do not fully mature.

Virgin soils contain large amounts of nitrogen, but if they are cropped continuously to such crops as corn, oats and timothy without the addition of fertilizer material containing nitrogen, the nitrogen supply is gradually used and the yields are reduced.

The supply of organic matter and nitrogen in the prairie soils is considerably higher than in the light colored timber soils. Seven samples tested of Superior clay loam and Superior clay loam, rolling phase, contained an average of 3,500 pounds of nitrogen. This amount is considered a fair suppy where a crop rotation including a legume is used. Clover, alfalfa, peas and beans have bacteria on their roots that take the free nitro-

gen from the air and store it in the plant roots. This is the cheapest method of obtaining nitrogen and one which the farmers should use to the fullest extent. On the ordinary dairy farm at least ¼ of the land under cultivation should be seeded to clover or alfalfa. This should be fed to stock or plowed under as green manure to insure keeping up the supply of nitrogen and organic matter.

A rotation with a legume plowed under will secure nitrogen and reduce danger from diseases and when supplemented with phosphorus and potassium fertilizers, the legumes thus treated will take the place of manure, which can then be used for other crops on the farm.

Certain crops such as tobacco, potatoes and vegetables are grown by farmers who do not keep much livestock and who do not rotate these crops with legumes. This is not a good practice. See chapter on Agriculture for more information on farm practices and types of farming.

CHAPTER III.

GROUP OF LOAMS AND FINE SANDY LOAMS

Miami Loam

Description: The surface soil of the Miami loan is a brown loam 8–10 inches deep, usually somewhat stony on the surface. The amount of organic matter is rather low, as is indicated by the color, but it is probably somewhat higher than the Miami silt loam. The subsoil consists of a brown to reddish brown clay loam which is frequently quite heavy and which contains some stones and coarse sand, but is quite compact. At from 20–24 inches there is usually a larger amount of gravel present, the material is lighter in color, and also lighter in texture, being a gravelly clay loam or a loam, usually of a yellowish color. At about 30 inches there is found a mass of stony till, composed very largely of limestone material. A highly calcareous substratum lying within the three foot section is an almost constant characteristic of the type. The depth varies from place to place, and when it comes near the surface the soil approaches a gravelly loam or gravelly sandy loam. Occasional crystalline rock bowlders are to be found upon the surface, and mixed through the soil section. In places these were sufficiently numerous to interfere with cultivation but in most cases they have been removed from the fields.

Extent and Distribution: The Miami loam is not one of the major types of the area from the standpoint of acreage. It is, however, a good agricultural soil and is important in the localities where it occurs. It is found widely distributed throughout both counties, but usually in small tracts of from 40 acres to half a section. The most important tracts are found in Jackson, Saukville, Trenton, and Cedarburg towns. It is found in nearly all of the other towns also but in smaller and more scattered patches. The total area is approximately 21,568 acres.

There are some variations in the type worthy of note. Most of the soil in the central and western portions of the area is

quite typical, but as the lake is approached there is a tendency for the subsoil to become somewhat heavier, and also to be of a more reddish color. In other words it gradually approaches the soils of the Superior series.

Topography and Drainage: The surface of this soil varies from undulating to gently rolling and the natural drainage is good. The surface is characterized by minor irregularities in the form of small bumps or hillocks of a morainic nature. Knolls, ridges and depressions often appear in rapid succession, and give the type a varied topography which is frequently sufficiently marked to detract from its agricultural value.

Origin: The material forming this soil has been derived from glaciated limestone material, and consists of deep morainal debris belonging to the late Wisconsin stage of glaciation. It is for the most part highly calcareous, especially in the subsoil, and it is seldom that an acid condition is found in the surface soil.

Native Vegetation: The native timber growth consisted of oak, hickory, and maple. The greater portion of the timber has been cut and the land placed under cultivation. The timber now remaining is chiefly in the form of farm woodlots.

Agricultural Development: This soil is devoted to general farming and all of the crops common to this region are grown with success. The land is especially well adapted to alfalfa because of its high lime content and good drainage, together with the porous nature of the subsoil, which merits good root development. Clover also does well on this soil and there is less difficulty with securing a stand and less winter-killing than on many of the other types.

Miami Fine Sandy Loam

Description: The surface soil of this type to an average depth of 12 inches consists of a brown fine sandy loam which is practically free from coarser particles and quite uniform in its texture. Below this depth the material is lighter in color, being a grayish brown fine sandy loam somewhat heavier than the surface. At from 20 to 24 inches it usually becomes a reddish brown to yellowish brown sandy clay loam. At about 30 inches this grades into a porous mass of gravelly and stony material, only slightly weathered and quite highly calcareous. It is also lighter in color than the subsoil proper. In road cuts there is a

marked contrast plainly seen between the brown to reddish brown subsoil and this deeper material of unassorted till.

Small quantities of stones frequently occur on the surface and mixed with the soil, and glacial bowlders are not uncommon, though most of these have been removed from cultivated fields.

Extent and Distribution: The fine sandy loam is of only limited area but is widely distributed as small tracts ranging from a few acres to about 160 acres. The most numerous patches of this soil are found in the towns of Saukville, Trenton, Grafton, Addison, Farmington, and Fredonia. Nearly every town in the area has some of this soil, but no single area covers as much as a square mile.

Topography and Drainage: The surface of this soil ranges from gently undulating to gently rolling with some small areas which are rolling. On account of the surface features and the open nature of the subsoil, the natural surface and internal drainage is good. During extended dry spells the soil suffers from drought to some extent.

Origin: The material forming this soil comes from the Late Wisconsin Drift and is made up almost entirely of glaciated limestone from the Niagara formation. The lower portion of the soil section is very calcareous, but the surface is sometimes found to be acid.

Native Vegetation: The native timber growth consisted chiefly of oak, maple, hickory and beech. Most of the timber has been removed and the land placed under cultivation.

Present Agricultural Development: Probably over 75 per cent of the type is in farms, and well improved. It is good agricultural soil, though not quite as desirable as the silt loam. Because of its scattered nature there are but few farms located entirely upon it, and specific types of farming suited to this particular soil have not been developed. The crops grown are those commonly raised in the region, and fair yields are usually secured. It is an early soil and for this reason has some advantages over such types as Miami clay loam, and Superior clay loam. It also responds well to special fertilization. It is better suited to truck crops than to general farming and where suitably located should be devoted to this type of farming.

Its selling value is a little less than that of the silt loam, but where it is favorably located so that it can be devoted to the kind

of farming for which it is best suited, it might have a somewhat higher value.

Miami Sandy Loam

Description: The surface soil of this type is a brown sandy loam of medium texture extending to a depth of 12 inches. Below this depth the color becomes somewhat lighter and at about 18 inches a yellowish brown somewhat sticky sand or sandy clay is usually found. The subsoil is quite variable and in a few places is a gritty clay loam while in others it is quite sandy.

The type is quite similar to the gravelly sandy loam but differs by being free or nearly so from gravel. It might be described briefly as a gravel free phase of the gravelly sandy loam. It differs from the fine sandy loam only in texture, being somewhat coarser and less retentive of moisture.

Extent and Distribution: This type is of limited extent and of minor importance. It is found as small patches from a few acres to about 80 acres in extent and scattered chiefly through the towns of Trenton, Saukville, West Bend and Farmington. It is confined chiefly to the morainic region and the surface is rolling with good draingae, which in places becomes excessive.

Present Agricultural Development: Probably over 75% of this soil is cleared and under cultivation. It is devoted to production of general farm crops, but because of its limited extent no farms are located entirely upon this class of land. Yields are somewhat lower than on the heavier types of the same series and the soil requires more careful management. The type as a whole is better suited to truck farming than to general farm crops and where suitably located should be devoted to this type of farming.

Superior Fine Sandy Loam

This soil to a depth of eight to ten inches consists of a loose, friable loam or fine sandy loam of a brown color. It usually becomes somewhat lighter in color with depth, and frequently somewhat coarser also. At a depth of from twelve to twenty inches, it grades quite abruptly into heavy, compact, pinkish red clay subsoil which extends to a great depth below three feet. Some small limestone fragments are frequently found in the subsoil, and there may be also thin beds of fine sand, but as a

whole, the subsoil is quite uniform. The chief variation in the surface is the depth of the sandy covering over the clay.

This class of land is very limited, and is confined to a few small patches in the eastern portion of the area. It is associated with the superior silt and clay loams. The surface is level and the natural drainage is usually fair to good, though in a few places tile drains could be used to advantage.

The Superior fine sandy loam is a very desirable soil, being easy to cultivate, and retaining moisture and fertilizers well. It is devoted to general farming, but is better suited to truck crops and intensive farming where marketing facilities are favorable.

Superior Fine Sandy Loam, Rolling Phase

The surface soil of the Superior fine sandy loam, rolling phase, is a brown to dark brown, mellow, fine sandy loam, having an average depth of 8 inches. Below this the material becomes somewhat lighter in color, in places gray or pale yellow; it may also become a little finer in texture, and in a few places it contains a small proportion of small stones. At about 18 inches the subsoil is heavy red clay, which extends below the 3 foot depth.

The chief variation is in the depth of the sandy subsoil, which ranges from 8 to 24 inches. The texture varies somewhat, ranging from a sandy loam to loam. On some knolls and slopes the surface layers have been washed off, exposing the heavy red clay subsoil. This gives fields a spotted appearance. Stones are not common, but there are a few bowlders.

The soil is of small extent and minor importance. It is confined to the eastern part of the area where soils of the Miami series come in contact with the Superior types. Practically all of this type lies within 10 miles of the lake. The surface is undulating to gently rolling and the natural drainage is good.

The type originally supported a forest of maple, oak, beech, and basswood. Most of it has been cleared and brought under cultivation. This is a good soil, adapted to both general farming and trucking. The surface soil works easily and the heavy subsoil retains moisture well. It is better suited to truck crops than the heavy types with which it is associated. It can be improved by increasing the content of organic matter and phosphorus in which the soil is deficient.

Fox Loam

Description: The surface soil of this type to an average of ten inches consists of a brown, medium-textured loam, which is quite friable, but which contains only a moderate amount of organic matter. The upper subsoil is often a little lighter in color, and a sandy loam in texture. At about 14–18 inches, this becomes a yellowish brown silty or gritty loam, which at 20–30 inches grades into beds of sand, or sand and gravel. The surface is sometimes a sandy loam, and may vary to a silty loam in spots.

Extent and Distribution: Fox loam is found principally in the morainic belt, which crosses Washington county from northeast to southwest. Fair sized areas are found in Farmington, Mequon and West Bend towns. The type as a whole is limited, the total area being 3,520 acres.

Topography and Drainage: The surface is level to gently undulating, and the natural drainage is good. It occurs as terraces or outwashed plains above present flood flows. Practically all of this is cleared and under cultivation at present.

Present Agricultural Development: It is a good soil, but because of its limited area, but few farms are located entirely upon it. In its crop adaptation, methods of cultivation, fertilization, yields and improvements needed, it is similar to Miami loam.

Fox Fine Sandy Loam

The surface of this soil to a depth of eight to twelve inches consists of a brown, fine, sandy loam. The upper subsoil is a grayish, fine sandy loam which grades into a loam or gritty light clay loam, and then at about twenty to twenty-four inches passes into beds of sand and gravelly material. In places the layer of heavy material in the subsoil is very thin, and in other places, it is from a foot to a foot and a half thick, but the surface material is always of a fine sandy loam or a loam texture.

This type is of rather limited extent, covering about 4,416 acres, but is quite widely distributed through most of the towns in Washington county. It is much less extensive, and in fact, there is very little of this soil in Ozaukee county. The type occurs in small tracts usually less than half a section, and frequently only a few acres in extent.

The surface of Fox fine sandy loam is level to gently undulating, and the natural drainage is good. The land is a terrace formation or outwash plain. This soil is especially well suited for truck farming when favorably located, and when not can best be devoted to general farming. It is a good soil and one which responds well to commercial fertilization. It warms up early in the spring, and this makes it especially desirable for all crops which should reach market early such as sweet corn, potatoes, garden truck, etc.

The type is all cleared and in improved farms; it is classed as good agricultural land. In its improvement, the same methods should be used as are suggested for Miami fine, sandy loam and loam.

Fox Sandy Loam

The surface soil of this type consists of a brown medium sandy loam to a depth of ten inches, underlain by a grayish brown sandy loam which grades at about fourteen inches into a friable loam, usually somewhat gritty and of a yellowish brown color. Frequently, it becomes a silty clay loam, but always at a depth of from twenty to thirty inches, the material passes into stratified beds of sand and gravel.

The type varies somewhat, and frequently the heavy layer in the subsoil is lacking or is only very thin. The surface, however, is quite uniformly a sandy loam or heavier.

This type is of limited extent, and minor importance, covering only 960 acres. It is found chiefly on the terraces along Milwaukee River and in the morainic belt in Washington county. There are few areas over 160 acres in extent, and few, if any, farms are located entirely upon this soil.

The surface is level to gently undulating, and the natural drainage is, for the most part, good. Most of the type is cleared and under cultivation at present. It is a fair soil, but better suited to truck crops than to general farming. It is somewhat deficient in organic matter and will respond well to commercial fertilizers high in phosphorus.

Waukesha Fine Sandy Loam

This soil is a black or very dark brown loam, or fine sandy loam to a depth of eight to twelve inches, underlain by a chocolate colored sandy loam or loam, and grading at fourteen to six-

teen inches into a gritty, clay loam of brownish-yellow color. Below twenty-four to thirty inches is usually found a bed of stratified sand or sand and gravel.

The type is limited to small areas of ten to one hundred acres, and is confined chiefly to the terraces along the Milwaukee River, although some small patches are found along other water courses.

The surface is level, the soil occupies a terrace above present flood flows, and the natural drainage of most of the soil is good. A few spots are low enough to need tile drains, but these are not typical.

Most of this land is in improved farms, and it is considered good general farming soil, although more sandy parts are well suited to truck where favorably located. The total area is so limited and the areas are so scattered that such an industry could not be developed on this soil alone. The areas are so small that few, if any, farms are located entirely on this soil.

In its improvement, it needs some lime, and phosphate fertilizers give good returns. The crops grown and methods followed are those common to the region.

Chemical Composition and Methods of Improvement of Loams and Fine Sandy Loams

In this group there are nine types which with the exception of Miami loam, are individually of minor importance. As a group, however, they comprise about 10 per cent of the total area of the 2 counties and are important agriculturally, being well adapted to general farming and especially to alfalfa, potatoes, and most truck crops. These soils are lighter in texture than the clay loams and silt loams. Where general farming is carried on, practically the same methods of improvement can be followed except perhaps with the Miami sandy loam and Fox sandy loam. These latter types are more subject to droughtiness and should be handled especially with the aim in view of increasing this organic matter content either with green manure crops or barnyard manure. With a little care, alfalfa will do satisfactorily for as a rule, these two soils have a good supply of lime.

While there is some variation in the texture, structure, and color of the types of soil in this group, there is sufficient similarity so that general methods of improvement discussed here will apply to the entire group.

Tests and observations which have been made on these soils indicate that in practically all cases lime is present in sufficient quantities for crop production. The dark colored soil (Waukesha fine sandy loam) would be benefited by it however.

The supply of organic matter in the Waukesha fine sandy loam is somewhat greater than in the light colored types, but in older cultivated areas, this organic matter is in an inactive form so that the introduction of decaying vegetable matter will greatly aid in the improvement of this type regardless of color.

The supply of phosphorus in the loams and fine sandy loams is lower than in the heavier types and these soils show a marked deficiency in this element. The actual number of pounds of phosphorus which these soils contain, however, is not a true index of the actual need of this element. Some of the soils which show a small total amount do not respond as well to an application of the phosphorus fertilizer as do the types which have a large amount present. The behavior of a crop fertilized with phosphate is a more important indication of the need of phosphate than the chemical analysis.

Regarding the supply of potassium in the soil, the total amount is approximately 25,000 pounds per acre or fully 20 times as much as the supply of phosphorus. Where general farming is conducted and where there is maintained a good supply of vegetable matter in the soil, this will doubtless be sufficient. Where special crops are raised which require a large amount of potassium this element may be supplied to advantage in the form of a commercial fertilizer.

The principal characteristics of these types is that they hold somewhat less water than the heavier soils, especially the gravelly phases, and they warm up more quickly in the spring. This together with the readiness with which they can be worked adapts them to truck and special crops, better than the growing of staple crops. It is necessary to give them somewhat more attention to maintain fertility partly because of the fact that they are lower in fertility than the heavier soils but more because of the fact that these special crops require a higher degree of fertility to produce satisfactory yields. When these soils are used for the production of special crops their fertility can be maintained either by the use of barnyard manure through the use of rotation in which a legume is grown as the means of securing the necessary nitrogen and organic matter while the

other elements, chiefly phosphorus and potassium, are supplied in commercial fertilizers. When this latter system is followed, ⅓ or ¼ of the land should be sown to a legume such as clover or soybeans which have large powers of gathering nitrogen from the air, and a part of the phosphorus and potassium should be used for the growth of different green manuring crops. The fertility used in this way will become available for the succeeding crops through the decomposition of the legume when plowed under and the remainder of the fertilizer to be used should be applied on this ground at the time of fitting it for the succeeding crops.

CHAPTER IV

GROUP OF SANDY AND GRAVELLY SOILS

Miami Gravelly Loam

Description: The surface soil of this type to an average depth of 8–10 inches consists of a brown to light brown loam carrying a large number of stones both upon the surface and mixed with the soil material. The upper subsoil is usually a yellowish brown friable gravelly loam which changes at about 14–16 inches to a reddish brown gravelly clay loam. This stony subsoil extends to a depth of over 3 feet. In the lower subsoil the amount of stony material is frequently greater and in some places gravel beds are found.

There is considerable variation in the type. The yellowish portion of the upper subsoil may be thicker or thinner than here described and on slopes where there has been some erosion it may be entirly lacking. Included with this soil are numerous small areas of Miami fine sandy loam, loam and silt loam, too small to be indicated on the soil map. There are also some areas, especially in Ozaukee County, where the subsoil is heavier and of a deeper red color than typical where the soil approaches the Superior series.

Erosion is often a factor of importance on this soil and in many fields the surface soil has been washed away from the steeper slopes and the reddish brown subsoil exposed, giving the fields where cultivated a spotted appearance.

Extent and Distribution: The Miami gravelly loam is quite widely distributed in many small areas but its most extensive occurence is within the kettle moraine in the towns of Farmington, Kewaskum, West Bend, Polk, and Saukville.

Topography and Drainage: The surface features are quite irregular and a rolling choppy topography is characteristic of the type. Hummocks, kettle basins and ridges are common. Because of the uneven surface and open subsoil, the natural drainage is excellent and sometimes excessive.

Origin: This soil has been derived from glacial debris which was ground from the underlying limestone by the action of glacial ice. Because of the abundance of limestone present in the soil, acidity has not developed in this type. On the average, 90 per cent of the stones present consists of limestone.

Present Agricultural Development: Probably not over 25 per cent of this soil is cleared and under cultivation at present. The uncleared portion is covered with oak, hickory, maple, and some beech. A considerable part of this type is used for pasture, for which purpose it can best be utilized.

Corn, clover, alfalfa and small grains are grown on this soil. Clover and alfalfa do especially well and this is one of the best alfalfa soils in the county because of its high content of limestone.

The yields and methods of farming are about the same as on the loam and fine sandy loam types of the same series.

Miami Gravelly Sandy Loam

Description: The surface soil of this type to an average depth of 10 inches consists of a brown sandy loam of medium texture, which contains varying amounts of stones in the soil section and upon the surface of the ground. The supply of organic matter is typically low and the soil has a loose open structure. The upper soil is a light sandy loam both in color and texture, being a grayish brown color. At about 18 inches this material becomes a yellowish brown sticky or clayey sand. In the lower depths of subsoil a gritty clay loam is frequently found. In places there is an abundance of stones in the subsoil and in a few instances gravel beds were found.

Miami gravelly sandy loam is quite variable, especially in the subsoil. In places the surface is a sandy loam with gravel and the subsoil is a sand, while in some instances the surface is a sand and the subsoil a sticky or clayey sand. The two main features are that the land is sandy and gravelly. Stones and bowlders are found upon the surface in places but where cultivated most of these have been picked up and put in piles.

Extent and Distribution: This soil is not extensive but is quite widely distributed in small areas. It occurs associated with the Miami gravelly loam. The most numerous areas of this type of land are found in the towns of Farmington, West Bend,

Addison, and Erin, where it occurs in patches of from a few acres to about 160 acres.

Topography and Drainage: This soil is confined largely to the morainic belt and the surface is gently rolling to rolling. In some places it is quite irregular in surface features with pot holes, kames and eskers associated with it. Small marsh areas are also numerous in this region. Because of the surface features and stony soil and subsoil, the natural drainage is good and at times somewhat excessive.

Native Vegetation: The native timber which consisted largely of oak, poplar, and maple has mostly been cut and the larger proportion of the land is now under cultivation.

Present Agricultural Development: It is devoted chiefly to general farming with dairying as the most important feature. Corn always starts well but dry weather in July or August frequently causes reduction in the yield. Small grain is the second crop of importance. Potatoes are grown for home use but seldom on a commercial scale. Rye is grown to better advantage than other grains. Clover usually does fairly well and alfalfa will usually grow without lime. The general farm practices followed are similar to those in the other Miami soils.

Yields on this soil will average a little lower than on the loam or fine sandy loam, and because of its uneven surface and lighter soil, the type is not as desirable as the fine sandy loam type. Where favorably located, trucking could be developed, but at present it is not important on this soil.

Fox Loam, Gravelly Phase

The surface soil of this type to a depth of eight to ten inches consists of a brown loam or sandy loam which contains a considerable amount of very small stones. These stones usually range in size from one-sixteenth to one-half inch in diameter. The subsoil is gritty, yellowish-brown clay loam to a depth of eighteen to twenty-four inches where beds of stratified sand and gravel are found. For the most part, the soil is underlain by beds of gravel suitable for road material, and in a number of places pits have been opened for this purpose. In some places, the fine gravel is being used for making concrete work also.

This soil is of limited extent, and of minor importance from an agricultural standpoint. The largest areas are found in the

town of Mequon, parallel with the Milwaukee river, south of Theinsville and extending to the south county line. Most of the soil is on the west side of the river immediately along the public highway.

The surface of this soil is nearly level, but a part of it appears as a very low ridge which has a flat top in places. It is a little higher than the land on either side of it, and about fifteen to twenty feet above the surface of the river. Because of the loose character of the material in the subsoil, the natural drainage is good, and crops which are grown upon it sometimes suffer for lack of moisture.

Most of the soil at Theinsville is cleared and under cultivation, and is devoted chiefly to trucking crops. Probably twenty-five per cent of the type is not used for any agricultural purpose, being reserved for gravel pits which are being operated at the present time. Excavations of considerable extent have been made, and in such places the surface is now a bed of gravel which has no value for agriculture. The entire type in this part of the area seems to have greater value for construction work than for anything else, and in time, it will probably be used largely for this purpose.

There is sufficient covering of soil over most of the type so that crops can be grown successfully, and the use of the land for agriculture will continue until material is needed for construction purposes.

Rodman Gravelly Loam

The surface soil of this type consists of a loam, fine sandy loam, or silt loam of a light brown color containing varying amounts of stones mixed with the soil material and also scattered about the surface. The stones range from one-eighth to one inch in diameter, and in places some boulders are present. The soil proper extends to a depth of from eight to ten inches where a thin, grayish layer of silt loam or loam grades into yellowish-brown, grittly, gravelly loam or clay loam. This material extends from one and one-half to two feet or more in depth, and then becomes more stony and often rests upon a gravel bed. This gravelly loam is found most extensively in the moraine which crosses Washington county from north to south. The largest areas are found in the towns of Kewaskum, West

RODMAN GRAVEL AND GRAVELLY LOAM IN WASHINGTON COUNTY

This kind of land is of value for the pasture it affords, for some timber and also for road building material.

VERY LARGE GRAVEL PIT NEAR SCHLEISINGERVILLE.

This is within the kettle moraine and much of the surrounding country is quite rough and broken. This gravel makes good road material.

The steep gravelly areas can be utilized best for grazing, although where the soil is shallow the land is inclined to be droughty and pasture dries up early in the summer. This view was taken in Washington County.

MORAINIC TOPOGRAPHY BETWEEN KEWASKUM AND WEST BEND.

Within the moraine the surface is often rough, irregular and broken. Many places are too steep to be cultivated. Many of these hills should have been left in timber.

Bend, Polk, Erin, and Richfield. This type is closely associated with Rodman gravel and Miami gravelly loam, and the areas are very irregular in shape, and are broken up by other types of this and the Miami series.

The surface is rolling to hilly with many sharp, narrow ridges, bumps and potholes. The surface is irregular, and is typical of morainic topography. Many slopes are too steep to be cultivated. The natural drainage is excessive, and the soil suffers from drought. Probably fifty per cent of this soil is still in timber and brush land, and the timber consists chiefly of oak, hickory, and maple. When cleared, the land is cultivated to some extent, but is better suited to grazing, for which most of it is utilized. It affords excellent grazing in the spring and early summer, but dries out soon after hot weather begins.

When not too steep to cultivate, the soil produces good alfalfa since it is high in lime. The soil is better than the Rodman gravel, but not so good as Miami gravelly loam. It can be best utilized for pasture. Where not cleared, it should be allowed to remain in pasture and woodlots.

Rodman Gravel

This soil is of very limited extent, and of minor importance agriculturally. The soil section consists of from one to three inches of loam, silt loam or fine sandy loam of a brown to dark brown color resting upon beds of gravel, which is usually stratified. Stones occur scattered over the surface and mixed with the soil. The mass of stony material is limestone with a small percentage of crystalline rock stones and a few bowlders. Along lower slopes and between hills, the surface soil is deeper and may be two feet or more to gravel, but the steepness of the land precludes the development of cultivated crops.

This soil is of limited extent, and is confined to the kettle moraine which crosses Washington county from north to south. The total area is only 1,088 acres.

The surface consists of a series of kames, eskers, and kettle basins, and is extremely irregular and choppy. The gravelly nature of the soil and the steepness of the slopes make cultivation of the land impracticable, and the type is used for pasture and woodlots. The pasture dries up early in the season, and the type has but limited agricultural value.

The timber growth consists of oak, hickory, and some maple, but most of the good timber has been cut. The land still in timber should be allowed to remain so, and that cleared could well be allowed to reforest itself since it has little value for any type of farming.

Coloma Fine Sand

Description: The surface soil of this type to an average depth of six inches consists of a brown or yellowish brown fine sand which is loose and open in structure and contains only a small amount of organic matter. The subsoil is a yellow, fine sand which extends to a depth of over three feet. In a few places, there is a small amount of small stones in the surface, and mixed with the soil and subsoil, but as a whole, this type is quite uniform and free from stones.

Extent and Distribution: This soil is found chiefly in the towns of Farmington, Fredonia, Trenton, West Bend, Cedarburg and Jackson. It occurs in small patches of from a few acres to one-fourth of a square mile, and is associated with soils of the Miami series and confined largely to the morainic belt which crosses Washington county.

Topography and Drainage: The surface is gently rolling and because of the loose, open character of the soil, the natural drainage is excessive, and the type suffers from draught. The soil is somewhat more retentive of moisture than the Coloma sand because of the finer grains which make up the soil.

Present Agricultural Development: Most of this class of land is cleared and is being farmed. It is devoted chiefly to general farming, but is better suited to truck crops, and should be utilized for special crops when the location will permit ready marketing. Such crops as cucumbers, potatoes, sweet corn, soybeans, rye, and most garden vegetables can be grown with profit especially on the less rolling portions of the type. This soil responds readily to fertilization, and it also warms up early in the spring. Most of it is acid and is in need of lime.

Coloma Sand

The surface soil of Coloma sand to a depth of eight inches consists of a brown or yellowish brown loose sand of medium

texture, and containing only a small amount of organic matter. The subsoil is a yellow sand of medium texture which extends to a depth of over three feet. Upon the surface and frequently mixed with both soil and subsoil, there are a few stones, and in a few places this is sufficient to call the material a gravelly sand. However, such areas are too small to map. For the most part, the soil particles are quartz sand from sandstone rock, and the soil is acid. There are a few places, however, where the individual soil particles are broken up limestone. These effervesce when acid is applied to them. Such material should doubtless be classed as Miami sand, but owing to its limited extent and minor importance, it has been included with the Coloma sand.

The Coloma sand is of limited extent in this area, and is confined chiefly to the towns of Farmington, Kewaskum, Trenton, and West Bend in Washigton county. Small patches are also found in other towns, especially those traversed by the range of hills which crosses Washington county.

The surface of Coloma sand is gently rolling to rolling. A few small areas are nearly level. Because of the loose character of this soil and subsoil, the natural drainage is excessive and crops suffer from draught.

Most of this soil is cleared and has been cultivated, although some parts of it are not used for crops each year because of its droughty condition. Where the limestone phase occurs, some alfalfa is grown with fair success. This phase is better than the typical soil. The soil is best suited to truck crops and where favorably located should be developed along this line. It responds well to fertilization, and it warms up early in the spring, which is a decided advantage in this latitude. The soil is deficient in organic matter, and also in mineral plant foods, and these must be supplied before satisfactory crops can be grown from year to year.

Plainfield Fine Sand

The surface soil of this type to an average depth of six or eight inches consists of a light brown sand of fine texture. This is underlain by a yellow, fine sand, which extends to a depth of over three feet.

This soil is of limited extent and of minor importance. It is confined chiefly to river and lake terraces and to a few small

outwash plains. A small area is found in Belgium township bordering Lake Michigan, where it is associated with Plainfield sand. A number of other small areas occur along the Milwaukee river and some of its tributaries.

The surface of this soil is level or very slightly undulating, and the natural drainage is excessive. In a few places, the soil is so low-lying, however, that in the spring the water-table comes close to the surface; and in such places, the drainage for part of the year is slightly deficient. Such areas are very limited in extent, however.

A greater part of this soil is cleared and under cultivation, and is devoted chiefly to general farming. The crop yields secured are rather low, and the soil is better adapted to trucking than to general farming. However, it is so limited that few, if any, farms are located entirely upon it, and no systems of farming have developed which are best adapted to this particular soil. Where the land is so situated that it is near markets or shipping points, it should be utilized for trucking. In such a system of farming, commercial fertilizers could be liberally used with profit.

Plainfield Sand

Description: The surface soil of this type to an average depth of 6 inches consists of a light brown to yellowish brown sand, which contains only a small amount of organic matter. The subsoil consists of a medium yellow sand extending to a depth of over 3 feet. In the lower subsoil and sometimes below this depth, stratified sand and fine gravel may be found.

Extent and Distribution: This soil is of limited extent and minor importance in both Washington and Ozaukee counties. It is confined to stream and lake terraces and a few outwash plains. Some of the type is found in the valley of the Milwaukee river, but these areas are small. There is a small terrace bordering Lake Michigan in Belgium township, on which Plainfield sand is also found. This varies from ⅛ to ¼ miles in width, and extends for several miles. This lake terrace phase probably contains less organic matter than any other portion of the type, and in places it has been modified somewhat by the action of the wind. In a few places where the type is lower than typical, the color is somewhat dark owing to a larger accumulation of organic matter.

Topography and Drainage: The surface of the Plainfield sand is level or very slightly undulating, and the natural drainage is for the most part good. The only exception to this is where the type is lower than typical so that the water-table in the spring comes close to the surface. As indicated above, there is a slight topographic variation in the lake terrace phase of this type where the wind action has blown the sand into very low dunes.

Present Agricultural Development: Most of this soil is cleared and under cultivation at the present time, but because of its sandy nature and droughty condition, crop yields are small, and the soil has a rather low agricultural value. While most of the soil is devoted to general farming, it is better adapted to trucking and the growing of special crops, with which commercial fertilizers can be used extensively with profit. Much of the type, however, is so situated that it is not close to markets, and as it occurs in small areas, it is difficult to develop any extensive type of farming upon it.

Chemical Composition and Improvement of Fine Sands and Gravelly Soils

The sandy and gravelly soils are alike in that they are droughty and have a deficiency of plant food. The heavy substratum which retains the water so well in most of the other soils is entirely absent in the types of this group. The amount of nitrogen is low; about 1,500 pounds per acre 8 inches, as is also the supply of phosphorus; which is about 900 pounds. Postassium is in comparison with other soils, low in quantity but is not considered to be particularly deficient. The sandy soils are, on the whole, low in lime, but the gravelly types as a rule, have a sufficient quantity for crop production.

Where these soils lend themselves to cultivation, they should be given a rotation that includes a legume and a green manure crop, unless an abundance of barnyard manure is available. Acid phosphate, (16 per cent) applied at the rate of from 200–300 pounds per acre should be used as a supplement to the above about once in 4 years.

The sandy soils are adapted to truck or garden crops due to the ease with which they are handled and their ability to warm up quickly in the spring. For this type of farming they need to be heavily fertilized. A legume should be grown for green

manure and supplemented with a 2–10–4 fertilizer at the rate of from 200–400 pounds per acre. Lime is necessary on the sandy land except perhaps where it is underlain with gravel. Quite often in such cases, the soil has a sufficient supply of lime for good crop production, for nearly 90 per cent of the gravel is limestone. When general farming is practiced on sandy soils, a rotation of crops should be followed that is especially adapted to these soils. A good three year rotation that includes clover and corn is as follows:

First year—Rye or oats seeded to clover.

Second year—Clover for hay.

Third year—Corn or potatoes.

If the soil has been prepared properly for alfalfa, i. e., a good supply of organic matter, phosphorus and lime added, the following rotation will prove profitable:

Alfalfa, 2 to 4 years.

Corn or potatoes, 1 year and seeded to alfalfa again.

Sandy land that is capable of producing crops should not be sown to pasture crops. It is impossible to develop a good sod. The plants are easily uprooted, the growth of the pasture grasses is too slow, the ground is allowed to dry out more rapidly, than when cropped, and grass crops as a rule are too shallow rooted to get much moisture from sandy soils.

The best of the gravelly soils are satisfactory for general farm crops. Corn and small grain do fairly well but are limited in their growth due to the hot dry weather of mid-summer. Practically all the gravelly soils are calcareous. Alfalfa should be grown whenever the topography of the land and the depth of the surface soil will permit. It should be inoculated and given the treatment recommended above of 200–300 pounds of 16 per cent phosphate per acre once in a four year rotation.

Where these soils are extremely rough or gravelly they should be used for grazing or for growing timber. They serve well as pasture land until mid-summer when the dry weather stops the growth of the vegetation. They should not be grazed too early in the spring until the grass roots have a good chance to develop.

CHAPTER V.

GROUP OF POORLY DRAINED SOILS

Fox Silt Loam Poorly Drained Phase

The surface soil of Fox silt loam, poorly drained phase to an average depth of 8 to 10 inches consists of a brown to dark brown silt loam. The soil contains more organic matter than most of the light colored soil of the area. The subsurface soil is a grayish or drab silt loam to 14 to 16 inches where a silty clay loam is usually found and this usually has a yellowish brown color though it is frequently mottled with brown gray and yellow. At 2–3 ft beds of stratified sand are frequently found. This phase is like Fox silt loam only that it is poorly drained, the surface is somewhat darker, and the subsoil is mottled.

This soil is found quite widely distributed, areas being found in Section 7 and 8 of the town of Belgium, Section 8 of the town of Germantown, Section 4 of Richfield and Section 18 and 30 in the town of Erin. Numerous other patches are also found but they seldom exceed 160 acres in extent.

The surface is level and so lowlying that the natural drainage is deficient and tile drains are in most cases quite necessary to successful farming. When drained the land is productive and well suited to the general farm crops common to the region. Part of the type is cleared and cultivated, but as most of it is not tile drained, crops suffer from too much moisture and the land is cold and backward in the spring.

In the improvement of this soil, drainage is the first and most important step to be taken. With thorough drainage established good crops have been secured.

Clyde Clay Loam

Descriptions: The surface of this type to a depth of ten to twelve inches consists of a black, heavy, compact clay loam, which contains a considerable amount of organic matter. The

subsoil is usually a heavy, compact, bluish clay or silty clay, extending to a depth of over three feet. This soil is uniform in texture, and the surface is entirely free from gravel and stones. In the deep subsoil, very thin beds of fine sand are sometimes encountered, and frequently these occur within the 3 foot section. The depth to, and thickness of, these sandy layers is quite variable.

Extent and Distribution: This soil is widely distributed throughout the area, but is found chiefly to be associated with the Miami clay loam and Superior clay loam. The most extensive areas are found in the towns of Germantown, Mequon, Cedarburg and Farmington.

Topography and Drainage: This soil is all low-lying; the surface is level to very gently sloping, and the natural drainage is deficient. In fact, before cultivated crops can be grown, the installation of some system of drainage is necessary. In many places open ditches and tile drains have been installed, and the land thus improved. When kept in its natural state, this land is used mostly for pasture and cutting wild hay.

While some ditching has been done, only a part of it is actually under cultivation. Where drained, it makes an excellent corn soil, and is also adapted to root crops, hay, and grasses.

Agricultural Development: In the improvement of this type, drainage is the first and most important step. As the type frequently occurs bordering peat marshes, it is necessary in its drainage, to include the improvement of other soils, and thus it is frequently desirable to have it included within large drainage districts in order that its improvements may be along the most economical lines. There are a number of places, however, where the type occurs in small patches, and where the entire area is confined to one farm, in which case, the farmer, himself, would have complete control of the drainage, providing an outlet could be secured without crossing a neighbor's farm.

Clyde Clay Loam, Alluvial Phase

Description: The surface soil of this type to a depth of 8 to 12 inches consists of a black, heavy, compact silty clay loam with a bluish drab or mottled heavy clay loam subsoil, which extends to a depth of from 2 to 3 feet. Usually this heavy material is underlain at a depth of from 30 to 36 inches by lighter

material. Sometimes beds of sand are found beneath the soil. The type as a whole is quite uniform, but the depth to the sandy material may be somewhat variable.

Extent and Distribution: This class of land is quite limited in extent, and is confined chiefly to the low land adjoining some of the larger streams. It occurs along the valley of the Milwaukee river, largely in Trenton township. The largest area is found in Section 6, Germantown township, and in Section I, town of Richfield. This soil is very similar to the Clyde clay loam, but it occurs chiefly as water laid soil rather than glacial till material.

Topography and Drainage: The surface is low, and for the most part, level. The natural drainage is poor. In places there is a very gentle slope towards the stream along which it occurs, but this slope is never sufficient to drain off the surface water. Some of the type is subject to overflow, and in the spring, water may stand on the surface a large portion of the time.

Native Vegetation: The original timber growth on this soil was largely elm, ash, soft maple, willow, and other moisture-loving trees together with coarse grasses in the open places.

Present Agricultural Development: Probably 20 to 25 per cent of this soil is cleared and under cultivation, but drainage has not been sufficiently established and crops frequently suffer from excessive moisture. Where the land has been cleared and not cultivated, it is used chiefly for pasture and hay, and in its present condition it is best suited for such use. When thoroughly drained, this land is very well adapted to corn, sugar beets, other root crops, and hay and grasses. Small grains are inclined to lodge, and do not fill as well as on the upland soils.

Clyde Silt Loam

Description: The surface soil of the Clyde silt loam to an average depth of 12 to 14 inches consists of a black, smooth silt loam, very high in organic matter. The subsoil consists of a bluish-drab or mottled silt loam, grading into silty clay loam, and extending to a depth of over three feet. The surface soil is entirely free from stones and the type as a whole is uniform.

Included with the Clyde silt loam, as mapped, are small areas of somewhat coarser texture. These areas are Clyde loam, but on account of their small extent and minor importance have been included with the silt loam.

The surface soil of the Clyde loam consists of 10 to 12 inches of black loam which contains much organic matter and in some places is covered by a few inches of peaty material. The subsoil is variable, ranging from sandy loam to gritty clay loam, is usually drab or mottled in color, and locally in the lower part contains thin beds of sand. It is confined to small depressions in the upland and low areas bordering stream courses. It is rather widely distributed, but occurs mainly in those parts of the area where Miami soils occupy the uplands.

The Clyde silt loam is very widely distributed, and, with the exception of Belgium Town, it is found in every town in the area. It occupies small areas ranging from a few acres to about one-half square mile, so that few farms are located entirely upon it. Probably the most extensive developments of this soil are in the Towns of Wayne, Kewaskum, and Addison.

This soil occupies depressions in the upland where there has been a large accumulation of organic matter, and also occurs along stream drainage courses where the poor drainage has permitted the development of rank vegetation, the decay of which has produced the dark color of the soil. The surface of this type is always lower than the surrounding country. It is level or has a gradual slope towards the drainage course along which it occurs. The natural drainage is poor.

Clyde Loam

Description: The surface of the soil of the Clyde loam is a dark-brown to black loam, which contains a large proportion of organic matter. The subsoil is drab or bluish heavy loam or gritty clay loam, which is underlain by sandy material at two to three feet. The type is somewhat variable both in color and texture.

The type as mapped includes some variations. In some areas the surface soil to an average depth of 10 to 12 inches is a smooth black silt loam containing much organic matter, and in a few places there is very thin covering of Peat, which makes the soil somewhat more loamy. The subsoil consists of a heavy silt loam lighter in color than the surface soil, and gradually becoming bluish or drab silty clay loam which extends to a depth of two to three feet, where sandy material is frequently found. These areas really represent inclusions of the Clyde silt loam but

on account of their small extent have been included with the Clyde loam, in mapping. The silt loam areas are confined to the valley of the Milwaukee River in Trenton and Fredonia Town. A few areas are found away from this stream, chiefly in Richfield Town.

The Clyde loam, is confined chiefly to the low land bordering stream courses, or to low, poorly drained outwash plains where there has been a large accumulation of organic matter. The type is similar to the Waukesha loam, except that it is more poorly drained. Most if it in this area lies along the Milwaukee River in Trenton and Saukville Towns.

Topography and Drainage: The type is low-lying, level and poorly drained. It was originally covered with elm, ash, soft maple, and willow trees and coarse marsh grasses in the open places. Only a small part is under cultivation, and where it is not drained, there is considerable danger of the crops being damaged by an excessive supply of moisture.

When this soil is properly drained, it is one of the best soils of the region for corn, root crops and grasses.

Clyde Fine Sandy Loam

Description: The surface soil of the Clyde fine sandy loam is a dark-brown to black fine sandy loam, high in organic matter. The subsoil is a dark fine sandy loam in the upper part, grading into loam or light clay loam, which in places at depths of two or three feet gives way abruptly to a sandy material.

Extent and Distribution, Etc.: This type is of very small extent and is confined largely to the valley of the Milwaukee River in Trenton Town. The surface is level and low-lying, and the natural drainage is poor. In its present condition the soil is best suited to grazing and cutting wild hay, but when thoroughly drained it is best suited to a variety of crops, and especially to truck crops.

Clyde Sand

The surface soil of the Clyde sand consists of eight inches of dark brown to black sand of medium texture which contains considerable organic matter. The subsoil is light colored or grayish and extends to a depth of over three feet.

Distribution and Extent: This soil is of limited extent and minor importance. Small areas are mapped in section 19, Cedarburg Town, and section 19, Trenton Town. A few other areas are scattered in various parts of the area, chiefly in the region where the upland soils are sand or fine sand.

Topography and Drainage, Etc.: The surface of this type is level or depressed, and the natural drainage is poor. Because of its extremely sandy nature, the soil has a low value. When thoroughly drained, it could probably be used for trucking more profitably than for any other line of farming, provided it is located favorably. It would require rather heavy fertilization to keep it productive.

Poygan Clay Loam

The surface soil of this class of land consists of a dark brown to black, heavy loam or clay loam, high in organic matter and extending to a depth of from eight to eighteen inches. In places, there is a thin, peaty layer over this surface which imparts a loamy character to the land when plowed and mixed with the heavier subsoil. The subsoil consists of a brown or usually a bluish silty clay loam extending to a depth of from twenty-four to twenty-eight inches, where the material usually takes on a pinkish color. Frequently the pink color is lacking and sometimes thin beds of sand are found in the deep subsoil within the three foot section. Along streams the soil is more variable, and the subsoil frequently contains more coarse material indicating possible alluvial action. This course material consists of fine gravel and sand mixed with clay rather than stratified beds of sand, although in a few instances the bedded sand layers are also found.

The Poygan soils are confined entirely to the eastern part of the area in Ozaukee county, and for the most part, to the region between Lake Michigan and the Milwaukee River. The soil is confined to depressions in the upland or to low land along drainage ways, and it found in the region where the upland soils are of the Superior series with the characteristic red subsoils.

The surface of most areas is low and saucershaped in the upland, and it occurs as long, low, narrow bands along drainage ways. These drainage ways seldom contain large streams, but are simply the lowest land, and consequently poor drainage has

formed an accumulation of the organic matter, which imparts the black color to the soil.

The natural drainage is poor, and before cultivated crops can be safely grown, it is usually necessary to supplement the natural drainage with tile or open ditches. The undrained land is used chiefly for hay and pasture. Some is still in timber and supports a growth of elm, ash, willow, hickory, soft maple, etc.

A phase of the Poygan was recognized in the field and is partly alluvial, and in some instances is subject to overflow. It is thus not typical Poygan, but is included because of its limited extent.

When thoroughly drained, this makes excellent land, well-suited to hay and root crops, cabbages, etc. Small grains are apt to lodge, and the region is too close to Lake Michigan to be especially favorable for corn growing.

Wabash Silt Loam

The surface soil of this type to a depth of twelve to fourteen inches consists of a black or dark brown silt loam, which is underlain by a brown or yellowish, heavy silt loam, grading into a blue or mottled silty clay loam. The subsoil is quite variable, and in places thin beds of fine sand are found. The surface soil is also variable, and may range from a loam or a fine sandy loam, to a silt loam.

This soil is low, and poorly drained, and is confined to first bottom land immediately along stream courses. It is most extensive along the valley of the Milwaukee river and along the north branch of this river in Farmington township. Some of this soil is also found in Kewaskum and in about six or seven other townships within the area. It is quite widely distributed, but most of the areas are rather small, the most extensive being in Farmington township as before indicated.

This soil is of alluvial origin, and is practically all subject to overflow; so improvement by drainage is often very difficult. In its present form, the type is of value chiefly for grazing, and but little of it is utilized for cultivated crops. Some hay is being grown.

Inasmuch as draining this land is very difficult, it is doubtful whether it will be developed to any great extent for cultivated crops in the near future. Some of the largest areas might be

improved in part by the building of dikes to protect the land from overflow, and by draining the diked off area. This is expensive, however, and would not be justified at the present time. The land is of such a nature that when drained, it will make an excellent agricultural soil.

Wabash Silt Loam, Light Colored Phase

The surface soil of the light colored phase of the Wabash silt loam consists of a brownish loam or fine sandy loam extending to a depth of eight to twelve inches, and underlain by mottled yellowish and bluish clay loam, or heavy silt loam. Thin layers of fine sand are present locally in the subsoil, and both soil and subsoil are variable in texture and color.

Chemical Composition and Improvement of Poorly Drained Soils

Description and Composition: These types occupy a total of about 13.5 per cent of the county and form a substantial part of the best potential agricultural land in the region. They are characterized by having relatively large amounts of organic matter, accumulated as a result of poor drainage. The supply of organic matter is quite variable since the soil grades into muck and peat on the one hand and into upland mineral soils on the other. Chemical analyses of such soils show that the nitrogen content varies from 4,000 to 10,000 pounds per acre 8 inches. The supply of phosphorus runs from 1,000 to 2,460 pounds per acre while potassium usually runs from 25,000 to 40,000 pounds per acre or more. Where the soil has a thin covering of peat the phosphorus and potassium are present in the surface soil in considerable smaller amounts.

Drainage: The most important step and the first step in the improvement of these soils is to secure adequate drainage. Tile drains and some open ditches have been installed and a portion of the land is now devoted to cultivated crops. Considerable areas, however, are still undrained, and are used chiefly for pasture and hay. The drainage of these lands frequently requires the development of drainage districts, but there are numerous tracts which are so situated that they can be reclaimed by individual efforts.*

*Bul. No. 309 and 365.

Need for Lime: There are only occasional areas of these soils that need lime. Over most of the region these soils are not in need of it. They are so situated that they receive the wash from higher lands, which contain lime material, and this lime bearing water has prevented the development of an acid condition in these lands. Where acidity is found it is usually so slight that but little if any lime is needed.

Potash and Phosphate Needs: A condition which sometimes develops on this soil is shown when corn turns yellow on areas of small extent. In such cases the use of some form of potash or strawy horse manure is helpful. There is relatively a much larger supply of nitrogen than phosphorus and potassium. For this reason it is a good practice to use the manure on the upland soils which are deficient in nitrogen and apply mineral fertilizers to the low land when these are needed. In many cases which show a marked need of potassium during the first few years of cropping, usually where the soil is high in organic matter to a depth of a foot, this lack of potassium frequently disappears after a few years of cropping, as a result of the settling of the surface so that deep plowing brings up some of the soil high in potash.

In spite of their large content of both phosphorus and potassium, it is not infrequently true that these soils show low availability of these elements, especially of potassium. This is probably due to the inert condition of much of the organic matter which protects the earthly part of the soil. Where thoroughly good artificial drainage has been developed and nevertheless poor crops are secured, this result will usually be found to be due to lack of available potassium and in some cases also of phosphorus. A direct experiment should be made in these cases with potassium and phosphate fertilizers, as suggested in the bulletins of the Experiment Station.*

Adaptation: The soils are capable with thorough drainage and proper fertilization and cultivation, of being made among the most productive lands in the state. They are well adapted to some of the intensive field crops such as cabbage and sugar beets as well as practically all general farm crops, even including alfalfa when the drainage has been perfected. Corn does very well, although the frost hazard is greater on those low soils than

* Bulletin 376 and 383. Wis. Exp. Station.

on the upland types. Most small grains, however, lodge on these highly organic soils, especially during the first few years of cultivation. The Clyde loam and fine sandy loam, when drained, are very satisfactory soils for potatoes and truck crops. The lighter texture makes them better adapted to these crops than are the heavier soils of this particular group.

PEAT

(Including Shallow Peat)

Description: The type mapped as Peat consists of vegetable matter in various stages of decomposition. Much of the material is still in a very raw, fibrous condition, showing quite plainly the structure of the vegetable growth from which it is derived. In this condition the material is brown, but with decomposition it becomes darker, and where thoroughly decayed it is very dark brown or black. Mineral particles may be incorporated with the organic matter, but seldom in sufficient quantities to appreciably affect the texture. In the more extensive areas of Peat there is little mineral matter except about the margins, where the proportion is frequently sufficient to form muck.

The depth of the organic layer is variable. Areas in which it is less than 18 inches in depth are separated as a shallow peat. Deep peat is over 18 inches deep. In some places the organic depoists are more than 10 feet deep, and in practically all the swamps with an area of 1 square mile or more the depth is more than 3 feet. The peaty layer is generally deepest in the center of the areas, and shallowest about the margins.

In large swamps and marshes, where the material is still raw, there is very little difference in character between the surface material and that several feet below the surface. Where conditions have favored rapid decomposition, the material at the surface is frequently darker, but where the accumulation of vegetable matter on the surface has been rapid, that at the lower depths is more decomposed and darker in color. A vertical section may consist of 8 to 16 inches of slightly decomposed to well decomposed, brown to dark-brown vegetable matter, underlain by similar material which may be more decomposed, or may be in a raw condition.

The material underlying the peaty matter is variable, ranging from sand to silt loam or clay loam. In general, its texture is

determined largely by that of the surrounding upland soil. In the regions of silt loam soils the underlying material is usually heavy and of a grayish to dark-brown color. In the regions of sandy soils the peaty material in most cases is underlain by grayish to nearly white sand or very fine sand.

In some places small "islands" of muck, sand, or other soils are included with the peat, such areas being too small and unimportant to be separated on the map.

Extent and Distribution: Peat is one of the most extensive classes of land in this area. It is found in every town and is well distributed through each, except along the lake shore, where the amount is much less than it is ten or more miles back from the lake. The largest peat marshes are found in the towns of Germantown, Jackson, Erin, Saukville, Farmington, Fredonia, Wayne, and Addison.

Topography and Drainage: Practically all the peat areas are level, or have only a very gentle slope, nowhere sufficient to provide drainage without the aid of ditches. Most of the areas are wet the greater part of the year, and there is often a few inches of water over the surface in the spring, when heavy rains occur.

Most of the marshes in which peat occurs have sufficient slope so that they can be successfully drained. In several instances drainage districts are being organized, and a considerable acreage is now being prepared for cultivation through drainage. Aside from these projects which require a drainage district, there are a number of individuals who have reclaimed small tracts of marsh land, but the total acreage of these is still quite small. One farm on which considerable drainage has been done is in Section 34, town of Hartford. At the time of the survey, excellent corn was being raised on this reclaimed marsh land. The total amount of peat in the county which is under cultivation is small. This type of land offers a large opportunity for development, and because of the high price of the adjoining upland, it would seem that this development should be carried on quite rapidly in order to place these idle acres on a productive basis without delay.

Vegetable: The native trees on the peat areas were chiefly tamarack and cedar. On the well-decomposed peat some elm, ash, and soft maple are found. Some of the marshes support no trees, or at most only a scattered growth. In most places where trees are lacking the original growth has been destroyed

by fire, but a few marshes apparently have always been treeless. On some of the open marshes there is a growth of coarse grass which is cut for hay, but in most cases the vegetation consists of moss, willow, alder, and other moisture-loving plants.

Improvement of Peat Soils

Composition and Fertilizer Requirements: Owing to the peculiar composition of peat soils they are unbalanced in the elements of plant food. They are extremely high in nitrogen and relatively low in phosphorus and potash. Chemical analysis shows that the relative amounts of nitrogen, phosphorus and potassium per acre 8 inches is as follows: nitrogen 10,000; phosphorus 525; potassium 700 pounds. On account of this lack of mineral elements, it is practically always the experience in developing peat soils that while they may produce two or three good crops after thorough drainage without fertilization, they soon show marked need of fertilizers containing phosphoric acid and potash. Barnyard manure will supply these elements, but under prevailing conditions they can be more profitably supplied in their commercial forms. The amount of these fertilizers necessary will depend to a considerable extent on the crops to be grown. For crops that make a heavy rank growth such as sugar beets, cabbage and truck crops, 400 to 600 lbs. per acre of an 0–10–10 fertilizer will prove profitable. For hay and grain crops a somewhat smaller amount would be satisfactory. When it is desired to supply phosphorus alone 300–400 lbs. of 16% acid phosphate may be used. In fertilinzing with potash alone, 150 lbs. of muriate should be applied. In place of using a mixed fertilizer as previously mentioned, 300 lbs. of 16% acid phosphate may be mixed with 150 lbs. of muriate of potash.

Manure on Peat: Peat soils as mentioned above, have an abundant supply of nitrogen. Nitrogen is one of the main fertilizing elements in manure. In applying manure to peat therefor, this plant food is being applied where it is not needed. For this reason, it is more profitable to apply the manure to the upland soils where the nitrogen is needed and fertilizes the peat soils with commercial fertilizer containing only phosphorus or potash or both unless indeed there is plenty of manure for both the upland soils and the peat. In some cases however an application of manure to peat is warranted. If the peat is raw and

the nitrogen as a consequence is in an unavailable condition to be used by plants, a light application of manure will introduce bacteria into the peat that will break down or decompose the raw organic material thus making the nitrogen available to the plant roots.

Slight Acidity: The peat soils of this county are rarely acid on account of the percolation of lime-containing water from higher lands, though occasionally patches of acid peat are found on the larger marshes. This acidity, however, is not so detrimental in the case of marsh lands as in the case of sand and clay soils, since the chief objection to acidity is that it interferes with the growth of those legumes, such as clover and alfalfa, which are needed on higher lands to secure nitrogen but which are not needed on the marsh soils for this purpose, and to the growth of which, indeed, the marsh soils are not physically so well adapted.

Cultivation: The method of handling peat soils is important. On account of their very loose, spongy character, many crops do not get a good foothold, and the heat from the sun is not readily conducted downward from the surface. To improve this condition, thorough compacting by the use of a heavy roller is necessary to get good results.

Adaptation: The crops adapted to this land depend to a considerable extent on the degree of drainage and on the thoroughness with which the seed bed is prepared. A much less expensive drainage system would be necessary to fit this land for tame-hay crops, such as timothy and alsike clover, than would be needed to fit it for corn, sugar beets, and other cultivated crops. For its highest development agriculturally, a tile-drainage system in which the laterals are not more than 8 to 10 rods apart would be essential. With adequate drainage, fertilization, and compacting of the soil, this type should produce good crops of corn, sugar beets, cabbage, and onions, as well as hay and other crops generally grown in this section of the state. It is not so well adapted to small grains on account of their tendency to lodge. There is somewhat more danger from frost than on the higher ground, partly because heat is not conducted readily to the soil and is quickly lost by radiation at night.

Peat, Shallow Phase: The shallow phase is differentiated from the typical peat solely on the basis of thickness of the peaty deposit, the maximum depth in areas of the phase being 18

inches, and the range being 6 to 18 inches. The underlying material is variable, and usually corresponds quite closely to the soil of surrounding uplands, just as is the case with the typical peat. Small islands of other materials noted in the typical soil occur likewise in the shallow phase.

Though not very extensive, small patches of the phase are scattered throughout the area. The forest growth is practically the same as on the typical peat, except that tamarack is found in only a few places.

The production of marsh hay is the chief use made of this soil at present, though it is used to a small extent for grazing. In its present condition it has a low agricultural value, but when drained it will be adapted to the same crops and types of farming as the typical peat, and in most cases it is easier to improve the shallow phase, as it may be more easily drained and requires less compacting to make a good seed bed. After drainage, the peat settles to a considerable depth, so on the shallow phase, the underlying subsoil is often plowed up and mixed with the peaty covering, adding to the value of the land by the mixing of this fine earth.

CHAPTER VI.

GENERAL AGRICULTURE AND CLIMATE OF WASHINGTON AND OZAUKEE COUNTIES

Agriculture

Agriculture History: The early history of agriculture in this area dates back to 1835 when the first land was taken up in this region. As in other parts of the state of Wisconsin, the first efforts at farming were rather crude, and the most important crops grown were those upon which the farmer could live and which would supply feed for his stock. The early farms were hewn from forests, and at that early date there was but little demand for lumber; so many of the trees were burned as the land was cleared. After lumbering developed as an important industry, (the operation of lumbering always preceded agriculture), the early settlers grew potatoes, corn, root crops, and such crops as wheat, corn, and oats for market. The raising of grain did not at first assume large proportions, and as early as 1858 records indicate that considerable attention was being paid to the livestock industry. Market days were first established in this region about 1858, and these markets stimulated the raising of livestock, and afforded markets for all surplus stock. These market days or fairs rapidly spread to other portions of the state, and are still a factor in agricultural development.

Native timber: The original timber growth in this region consisted chiefly of maple, oak, elm, beech, basswood, ash, hickory, with some walnut and a scattering of pine. In the marsh lands, there was considerable tamarack, willow, and alder. Very nearly all of the merchantable timber has now been removed, but there are still a few wood lots where some original timber remains and where second growth trees are of sufficient size to be of value.

Crops and Present Agriculture: Practically all of the general farm crops which are now grown were produced in the early history of the county, but the relative imporatnce of a number

of them has materially changed. For example, in 1879 there were 47,300 acres of wheat in Washington County, whereas in 1910 there were only 3,120 acres. The acreage of corn in 1879 was 17,559 in Washington County; in 1910 it was 19,280. The amount of barley was 2,964 acres against over 30,000 acres in 1910. The growing of wheat, after declining to a crop of rather minor importance, rose again during the following period so that the acreage in 1920 was 14,163 acres. After the effects of the war had passed, however, the production fell off rapidly.

The agriculture of Washington and Ozaukee Counties at present consists chiefly of general or mixed farming, with dairying as the most important branch. The leading crops named according to their acreage are hay, oats, corn, wheat, barley, and potatoes and green peas. Crops of minor importance are buckwheat, flax, dry peas, sugar beets, beans, etc. Practically all of the crops are grown to some extent as sources of income, hay, corn, oats, rye, and barley, and sugar beets, etc., being sold to some extent direct from the farm. Potatoes are also grown partly for sale although they are one of the most important subsistence crops. By far the greater proportion of the corn, hay, and oats produced is used in feeding live stock, and reaches the market in the form of dairy products, beef, and pork.

Oats is grown throughout the county and on nearly all the soils, but better yields are obtained on soils of a fine sandy loam texture or heavier.

Hay is grown in all parts of the region, but gives the best yields on the types of land of heavy texture. Most of the hay consists of mixed timothy and clover, although considerable timothy is grown alone, and clover is also grown alone for hay, as well as for seed. In the vicinity of Hartford and in the western part of the area, the clover seed industry is quite extensive. Some marsh hay is also grown on the wetter areas, but this is of an inferior quality. Alfalfa is coming to be a very important crop. In 1924 there were over 6,000 acres in Washington, and over 2,000 acres in Ozaukee County. This is more than 30 times the acreage in 1910. Many of the soils of this region are especially well adapted to alfalfa because of the high lime content and also because of good drainage. The soils of the Miami series are especially well adapted to this crop.

Corn is grown in all parts of the area, but it is not so extensively grown along the lake shore as it is twenty or thirty miles

back from the lake. This is due to the fact that along the lake, the spring is rather late, and the nights are cool. The types of fine, sandy loam texture or heavier are best suited to corn, and there are also many tracts of poorly drained land which, when thoroughly reclaimed, will make excellent corn land. This is especially true of the types mapped as Clyde loam and silt loam. The peat soils when reclaimed can also produce corn with proper cultivation and fertilization.

Wheat is best suited to the heavy soils, such as the Superior clay loam, and fine sandy loam, and to Miami silt loam and clay loam. It was grown more extensively from 1916 to 1920 but declined considerably after that date. It should be grown more extensively on many of the farms.

The growth of barley has been well distributed over these counties in the past, but the acreage has been much reduced during the last ten years. In 1910 there were more than four times as much grown as at the present time.

The growing of peas for canning is rather an important industry, and there are several large canning factories within the area. Peas are grown on the fine sandy loam and on the heavier light-colored soils, and as a rule give good yields. Only a small proportion of the peas which are grown are allowed to mature.

Potatoes are grown on a commercial scale to a limited extent, and are confined largely to soils of a somewhat sandy nature, although for home use, they are grown on nearly all of the types. The average yields are low, in 1920 being 87.8 bushels an acre in Washington County, and 67.3 bushels an acre in Ozaukee County.

The raising of sugar beets receives some attention, there being about 500 acres in the 2 counties in 1920. In as much as there is a factory at Menomonee Falls in Waukesha County within hauling distance from part of the region, it would seem that this industry could be materially extended.

Because of the location of this area and its proximity to Milwaukee, some trucking is carried on, especially in Ozaukee County where the farms are somewhat smaller than in Washington County. Potatoes, cabbage, celery, some onions, lettuce, radishes, strawberries, and other vegetables and small fruits receive special attention. Some trucking is also carried on near the principal towns within the area.

Fruit growing receives comparatively little attention, although many farms have small apple orchards for home use, and during favorable seasons there are some apples to place upon the general market.

STATISTICS OF FARM CROPS

	Washington County		Ozaukee County	
	1923 Wis. Dept. of Ag.	1919 U. S. Census	1923 Wis. Dept. of Ag.	1919 U. S. Census
Corn,				
Acres,	12,935	17,739	6,067	5,872
Bu. per acre.	40	39.9	43	46.0
Oats,				
Acres,	47,362	38,107	27,796	23,258
Bu. per acre	47	32.1	46	28.5
Wheat, spring and winter				
Acres,	1,834	14,163	1,048	7,301
Bu. per acre	17	14.3	18.5	12.4
Barley,				
Acres,	6,642	8,186	2,821	2,968
Bu. per acre	33	23	33	22.5
Buckwheat,				
Acres,	28	76	54	20
Bu. per acre	13	14.3	14	6.8
Rye,				
Acres,	4,161	5,755	1,254	2,089
Bu. per acre	19	14.8	20	14.4
Flax,				
Acres,	39	16	395	209
Bu. per acre	----------	85.1	----------	14.8
Dry peas,				
Acres	11	139	195	590
Bu. per acre	15	15.9	15	20
Green peas,				
Acres,	3,927	2,537	3,510	2,658
Cwt. per acre	19.2	----------	19.2	----------
Clover and timothy (Mixed and alone)				
Acres	32,434	26,734	26,745	21,506
Tons per acre	1.6	1.6	1.7	1.4
Alfalfa,				
Acres,	6,859	2,015	2,617	1,100
Tons per acre	2.3	2.2	2.3	2.2
Clover seed,				
Acres,	5,717		2,076	
Bu. per acre	2.0) 1922		2.0) 1922	
Sugar Beets, Acres	110	295	556	238
Tons per acre	8.5	10.5	8.8	11.4

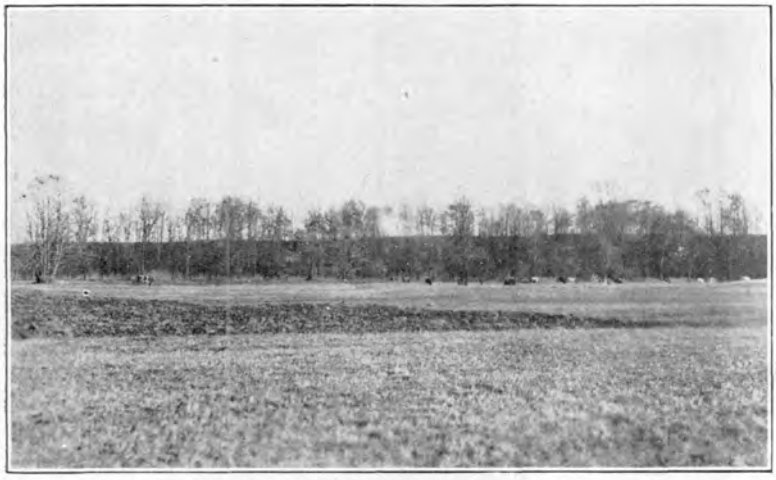
The raising of livestock is an important industry in this region, and dairying is the most important branch of the livestock industry. Some beef cattle are produced, and a large number of hogs are raised each year. In 1923 there were produced in

General birdseye view of the country, looking southeast from the top of Holy Hill in Washington County.

View in Fredonia Township, Ozaukee County, looking across the Milwaukee River. Miami silt loam and clay loam predominate here. The land is somewhat stony. A stone fence is seen in the background.

A FIELD OF CABBAGE IN OZAUKEE COUNTY NEAR THE MILWAUKEE COUNTY LINE.

This is on drained land and is mostly peat. There are numerous other peat areas in Washington and Ozaukee Counties which could be improved and utilized for special crops.



Terrace of Waukesha silt loam, along the Milwaukee River in Ozaukee County east of Cedarburg.

Washington County, 151,716,000 pounds of milk, and in Ozaukee County 96,288,000 lbs. of milk. The total receipts from both counties for milk alone amounted to over $5,494,603. The average production of milk per cow in pounds was approximately 5,400 pounds in 1923. In 1922 there were 73 cheese factories and 12 creameries, 4 condensaries and 10 receiving stations in these two counties. Twenty-eight of the cheese factories in Washington County produced brick cheese; all of the others made American. The majority of the dairy cows are pure bred or grade Holsteins. The number of pure breds is gradually increasing, and considerable improvement is being made in grading up stock as a whole. Hog raising is carried on in conjunction with dairying to a considerable extent, and where butter or cheese is produced, the whey or skimmed milk is used as feed for the hogs. However, hog raising is not carried on so extensively in this region as in some regions which are more remote from large centers because much of the milk is sold in Milwaukee as whole milk, thereby reducing the amount which can be used as feed for hogs.

Livestock Statistics

Wisconsin Department of Agriculture Estimates for 1924.

	Washington County	Ozaukee County
No. of Dairy Animals over 1 yr. old	32,400	20,800
No. of other cattle	8,500	3,700
Swine	31,600	15,200
Horses and Mules	8,600	4,800
Sheep	2,100	300

Adaptation of Crops to Soils

Differences in the character of the soils in various parts of the region have some influence on the distribution of crops. Oats and wheat are grown more extensively on the heavier soils while potatoes are grown with most profit on soils of a more sandy nature. Clover and timothy are grown best on heavy soils, and the dairy industry is most highly developed in the regions where the soils are a fine sandy loam or heavier. It is recognized in a general way that different soils are adapted to different types of farming and different crops. The rough, hilly types such as the Rodman Gravelly Loam and Miami Gravelly Loam are best adapted to grazing and some of the low, poorly drained lands

which are not sufficiently reclaimed are also best for pasture. It is also recognized that the types of a somewhat sandy nature are best suited to trucking, growing of rye and potatoes; alfalfa has been found to make its best growth on soils of the Miami Series such as silt loam, loam, and fine sandy loam. Since this soil is high in lime and is well drained. Peas make very good growth on such soils as Miami silt loam and fine sandy loam. They also do well on soils of Superior Series, but when raised on drained land where the soil is dark-colored, they grow too much to vines. Small grains do best on the heavy light-colored soils, and are apt to lodge when grown on dark, drained lands. Corn does especially well on drained clay soils and also grows very well on the upland heavy types. On the fine, sandy loam and sandy types it can get an earlier start and sometimes mature somewhat earlier with good fertilization. On the low ground corn is apt to suffer from frost.

Methods: The tendency throughout this region is towards better methods of cultivation, fertilization, and seed selection, and as a result, better yields are being secured than in the past. Where the soil is droughty but not subject to erosion, fall plowing has been found helpful in the conservation of moisture. Often the heavy soils are plowed in the fall, especially the Superior types. It is customary to apply stable manure to land that is to be plowed for corn, but after the land is plowed in the fall, the manure is often hauled during the winter and scattered over the plowed surface. Throughout this region most farmers plan to seed the land to grass or clover at least once every four or five years.

Equipment: The farm buildings, and the dwellings are generally large and substantial. The barns usually have a stone or concrete foundation, and most farms have one silo, and some have two or three. The fences are good, many of them being of woven wire. The work stock consists of draft horses, medium to heavy in weight. Modern farm machinery is in use throughout the county. There are a number of tractors used for plowing as well as for other farm work. Machines for threshing grain travel about the country, and there are also a number of co-operative threshing outfits owned by the farmers themselves.

Farm Tenure, Labor, Etc.: In 1920 there were 2,799 farms in Washington County and 1,727 in Ozaukee. Approximately 95 percent. of the land is in farms, and from 66 to 76 percent.

of this land is improved. In Washington County the average size of the farms is 94.4 acres, in Ozaukee County, 81.7 acres. Approximately 88 percent. of the farms are operated by the owners. There are fifty farms in Washington County and twenty-seven in Ozaukee operated by a manager. The renting system is divided equally between cash and share rentals. Ordinarily where the landlord supplies work stock and tools, he receives two-third of the crops; where the tenant supplies these in addition to labor, the landlord receives one-half of the crops.

Land Values: The selling price of the better farm land ranges from $125 to $250 an acre, depending on quality of soil, topography, improvements, and the accessibility to markets. There are a number of concrete roads traversing this region, and leading directly to Milwaukee, and land on such highways has a considerably greater value than land remote from them. The land of lowest value is found in the marshes, and the extremely rough region within the moraine. Some marsh land which is peat has been offered recently for as low as ten dollars an acre. Between these limits, all ranges in value can be found within the areas surveyed.

FARM AREAS

Value and Tenancy—Washington and Ozaukee Counties

	Washington County			Ozaukee County		
Population of County	1920 25,713	1910	1900	1920 16,335	1910	1900
Number of Farms	2,799	2,795	2,873	1,727	1,714	1,728
Average size of farms	94.4	94.0		81.7	84.0	
% of land in farms	95.8	95.3		94.6	94.0	
Valuation per acre (Land alone)	$96.82	$65.95	$54.34	$105.76	$74.51	$56.75
Percentage of farms operated by by owner	88.1	88.4	89.2	89.2	88.6	90.3
Value of property per farm	$16,019	$10,286		$14,861	$ 9,538	

SOIL IMPROVEMENT

There are a number of farmers within Washington and Ozaukee Counties who have had their farms examined by the State Soils Laboratory, and are now following instructions received for the improvement of their soils. This line of work has brought a soil expert to each farm, and careful examination has

been made of soil and subsoil. Samples have been collected for chemical analysis, and observations made as to cultivation and fertilization followed. Upon the completion of the chemical work, reports are made for each farm, outlining methods for the permanent improvement of the soil on each farm. As a result of this work, it has been found that on a large proportion of the soils, the supply of phosphorus is limited, and in the upland soils, the supply of organic matter is also deficient. The supply of lime in most soils is moderate to high, and the use of lime is seldom necessary.

Commercial Fertilizers and Manures

In applying fertilizing materials to the soil the most economical sources available should be drawn upon. The most common source of fertilizer for the farms is stable manure. The supply of this is greater in a dairy region than in a grain raising region, but even here the supply is not sufficient to meet the needs of the land.

The readily available plant foods in the form of commercial fertilizers are now being used to some extent in this region. In 1919 there were 82 farms reporting the use of commercial fertilizer and for this the sum of $7,452 was expended. In 1919 there were 3,469 farms reporting expenditures for feed, with a total cost of $824,405. Much of this money could be saved by the judicious use of fertilizers and the growing of such crops as alfalfa which have a high feeding value equal to wheat bran.

The analysis of the soil will give some indication as to the need of certain fertilizers, but the growth and behavior of the crop itself will be a more certain guide as to the needs of the soil.

Soil analysis, as mentioned above and crop tests show that one element in which many of the soils are deficient is phosphorus. This can best be supplied in the form of acid phosphate, in which the phosphorus is in a readily available form or it may be applied in the more slowly available forms of rawrock phosphate or bone meal. In the trucking region where crops are forced, and where large amounts of readily available plant food must be at hand the complete fertilizers are most commonly used, and applications run as high as 800 pounds per acre. Frequently liberal applications of mixed fertilizers are used to supplement

stable manure, and it is usually such combinations which produce the largest and most economical yields. In the improvement of the peat marshes, potash alone is required first, but after a number of years of cultivation, it is probable that phosphorus will be needed also. This is especially true of the marshes which do not need lime. Where lime is needed, usually potash and phosphorus are both required the first year.

For general farm crops the usual application of acid phosphate is from 300-400 pounds of 16% material per acre when sown broadcast. If applied in the row or hill about half this amount is sufficient. Subsequent applications should be at the rate of about 200 pounds every three or four years thereafter.

The most satisfactory way to apply commercial fertilizers is with a fertilizer spreader, or with a fertilizer attachment to a grain drill, or corn planter. If sown broadcast it should be put on the plowed ground, evenly distributed and worked well into the soil. Care should be taken that it does not come into contact with the seed. Commercial fertilizers may also be applied by spreading them over the top of a load of manure in the manure spreader. An application should be made at least once during each rotation, and preferably on the small grain crop, or on the corn. Frequently both of these crops are given an application.

In supplying nitrogen to the soil, the most economical form is through the growth of legumes.

For more information on the use of commercial fertilizers see bulletin No. 341, Wisconsin Experiment Station.

Through the work of the Wisconsin Experiment Association the importance of using good grains has been manifested, and farmers are now paying more attention to the selection of their seed grain with the result that yields and quality have gradually increased. There are a number of farmers within the region who make a business of raising pure bred pedigreed seed grains for the market.

Liming

This area is located within the glaciated limestone region of Wisconsin, and a considerable proportion of the soil forming material has been derived from limestone debris. The deep subsoil of many of the types is well supplied with lime and the surface

soil in many places is neutral or only very slightly acid. In fact, many tests have been made where the soil does not show any reaction whatever. The types which are most apt to show acid reaction and which seem to be in need of lime are soils of the Waukesha series. The soils of the Miami series also show slight acidity in places. The peat soils are also slightly acid in places but there is less acidity in the low lands of this region than in the central and northern parts of the state..

The degree of acidity on any farm may be quite variable. It is quite important therefore that before an expenditure is made for lime that the soil should be tested and the crops observed to determine the actual need for lime. The County Agent can be called upon for soil acidity tests or samples of soil may be sent to the Soils Department of the University for free acidity test.

It should be kept in mind that when a soil is acid according to a laboratory test, it does not necessarily mean that that soil will respond profitably to the use of lime. The story which the crop tells should also be considered. Failure of clover and alfalfa, or a growth of sorrel may be indications of acidity. When there appears to be a medium need for lime, from 2 to 3 tons of finely ground limestone should be applied per acre. The amount to be used will usually vary with the degree of acidity, the character of the soil and the crops to be grown. Such crops as alfalfa, sweet clover, peas, cabbage, onions, and lettuce have a high lime requirement. Clover, garden beans, barley, hemp, turnips, and radishes have a medium lime requirement, while vetch, white clover, oats, rye, blue grass, potatoes, sorghum, and others have a low requirement for lime.

Ground limestone appears to be the most economical form of lime which can be extensively utilized. Lime should be applied previous to planting the crop which is to be benefited. It should be applied to plowed land and thoroughly worked in by harrowing. Either fall, winter or spring applications may be made.

The best way to apply lime is with a regular spreader made for this purpose, and there are a number on the market. A manure spreader may also be used by first putting in a thin layer of manure and spreading the limestone evenly on top of the manure. Where several farmers are so situated that they can work together, a lime spreader may be secured jointly for

this purpose. The end-gate type of spreader has given good results in spreading dry or moist limestone.

After making a first application of two tons or three per acre, it is not likely that another application will be needed for four to six years. The need should be determined by the story which the crops themselves tell.

It should be remembered that most acid soils are also deficient in available phosphorus, but applying lime will not add to the total amount of phosphorus in the soil. The need of phosphorus may be so great that but little result will be secured from liming until phosphorus is also added. Frequently the application of phosphorus alone to an acid soil will result in larger increases than the use of lime alone, and for this reason it is important that both deficiencies should be corrected to secure the most economical production.

Drainage

Washington and Ozaukee counties have over 106,000 acres of land over which the natural drainage is deficient, according to the classification of the Soil Survey, and which must be provided with some form of drainage before cultivated crops can safely be grown from year to year. Of this poorly drained land, 40% consists of peat, while most of the remainder is low, poorly drained mineral soil which belongs chiefly to the Clyde series.

Both the peat and the Clyde soils are pretty well distributed throughout the county. There is very little peat, however, within 10 miles of Lake Michigan, but most of the Poygan soils are in this particular part of the county.

The following table taken from the 1920 census gives statistics covering the extent to which the development of drainage enterprises have been carried in this county.

Drainage Statistics for Washington and Ozaukee Counties

	Washington	Ozaukee
Land in operating drainage enterprises: acres	4,500	5,900
Open ditches completed, miles	20.5	23.7
Area drained by open ditches only, acres	4,300	4,238
Area drained by open ditches and tile, acres	200	1,700
Improved land in operating drainage enterprises, acres	330	4,462
Improved land prior to drainage, acres	40	278
Increase since drainage, acres	290	4,184
Total capital invested in and required for completion for operating enterprises	$64,500	$63,160

It is evident from these figures that per square mile of the two counties, more drainage work has been carried on in Ozaukee county than in Washington county. This table also shows that out of a total of 10,460 acres in operating drainage enterprises, 4,792 acres are already improved although only 1,900 acres are drained by both ditches and tile. Since 1920 considerable more drainage work has been done in these counties.

The types which offer the best opportunity for drainage from the standpoint of productivity are the soils of the Clyde series and the poorly drained phase of Fox silt loam and Poygan clay loam. When well drained, these soils make the best corn land in the state, and are also well suited to cabbage, sugar beets, and hay. On the lighter types of the Clyde series, onions will do very well, though they are not grown in the area to any great extent at present.

The drainage of the peat land offers opportunity for agricultural development, but the problems in the improvement of this type of land are more numerous and difficult than is the case with the Clyde soils. The peat requires the use of commercial fertilizers, as indicated elsewhere and special methods of cultivation are also called for, but with proper handling peat lands can be made to produce profitable crops, and their drainage will add materially to the productive acreage within the region.

If all of the poorly drained land of the county were improved so that the gross income would be but $10 per acre, there would be added over a million dollars to the farmers annual income. Such an important project is worthy of the most careful study by every public spirited citizen of the region. The best results can be secured only through co-operation of all parties concerned.

Where areas of low land include land owned by several people, the owners can readily form a drainage district and issue bonds for the improvement. This is the method which has been used and a number of drainage districts have already been formed in Washington and Ozaukee counties. In this way the cost can be spread over several years, and can actually be paid for from the products of the improved acres. Assistance for the development of such projects can, and in fact must, be secured from the State authorities, who pass upon the feasibility of the project before the courts will permit the organization of a dis-

trict. Where areas of marsh are small and confined to one farm from which there is an outlet, the drainage can be installed without the co-operation of the neighbors. This has been done in a number of places, and small tiling systems are not uncommon in Washington and Ozaukee counties. There are thousands of acres in small tracts which have not as yet been improved but which would make good productive land when drained.

Crop Rotations

It is of great importance in selecting crops to grow that careful consideration be given to the question of climate. This is about the only factor which the farmer absolutely cannot control. A poor soil may be improved, better markets may be found, and better laobr secured, but the farmer is powerless to change climatic conditions. He must, therefore, select such crops as are suited to his climate.

The soil is also a factor of great importance. As a general rule, small grain crops do better on heavy than on light soils, and the same is true of grasses grown for hay. On the other hand, the same variety of corn requires shorter season for maturity on light than on heavy soil. Rather light soils and those of intermediate texture are better adapted to potato growing and root crops. Therefore, on lighter soils the greater acreage should be devoted to cultivated crops than on heavy types.

Shipping and marketing facilities must also be considered in planning a rotation. The farmer located on a sandy loam farm close to a railroad station or home market will often find it profitable to include potatoes in his rotation. If he is located six or seven miles from a station, the profits from growing potatoes will be much lessened. It will then pay him better to raise more corn for stock feeding, and to convert his crops into dairy products which are less bulky, and which for the same bulk have a greater value.

Some of the other things which we should keep in mind regarding a good rotation are that it helps to control weeds. It also aids in controlling plant diseases, and serves to check insect pests. Following a good rotation increases the humus supply in the soil, and insures maintaining a good amount of available nitrogen in the soil. It helps to distribute the labor efficiently throughout the year. A good crop rotation means that the

proper crops will be grown at the proper time and in the proper place, and this will aid in keeping the soil in proper sanitary condition. It may also increase net returns from each acre, and improve the general appearance of the farm.

The rotation of crops which is most common probably consists of corn, followed by small grain, which is seeded to timothy and clover, after which hay is cut for one or two years. Corn may be grown on the same field for two years in succession, especially on the clyde soils, or the second year may be devoted to peas on the upland instead of corn, but usually on a much smaller acreage. Small grains may also be grown for two years in the rotation. The manure is most frequently applied to the corn ground and this is frequently plowed in the fall. The manure is sometimes spread on the plowed ground in the winter or on the land which is to be plowed in the spring. The question of rotations is receiving more careful attention now than in previous years, and most farmers follow some sort of a rotation, though not always the one most suited to their particular soils.

Potato raising when properly managed is a profitable industry in many parts of the state. Although good crops may be grown on heavy soils, the sandy loams are especially well adapted to potato production. For best results, this crop should be grown in rotation with other crops, and should always follow a legume of some kind. Potatoes should not follow corn or corn potatoes as both crops draw heavily on the fertility of the land. In the rotations which have been given, potatoes can be planted as one of the cultivated crops. It is better to apply manure to the clover crop rather than just before planting to potatoes, for scab is more common when potatoes are planted on freshly manured land. The three-year rotation just described is excellent for sections where potatoes are grown extensively. As a rule cropping to potatoes oftener than once in three years is not recommended.

The growing of peas for canning is important in some sections, and this crop may be introduced into the rotation very readily. A four-year rotation may consist of small grain, clover, a cultivated crop, followed by peas. This may be made a five-year rotation by adding timothy and cutting hay two years.

The growing of sugar beets is also an important industry,

and beets may also be introduced into the rotation without difficulty. It is best not to have the beets follow or precede the corn, but the crop may follow barley or other small grain. Beets may simply take the place of corn in a three or four year rotation. Cabbage may be substituted for beets without difficulty.

Hemp is coming to be an important crop in Wisconsin and could be grown with success in this area as it is now being grown in Racine and Kenosha counties. The most satisfactory place in the rotation for this crop is after corn. The corn should have been preceded by clover sod, well manured and plowed in the fall. Hemp may also follow potatoes, cabbage, or any other cultivated crop. Hemp should not follow timothy meadow, blue grass sod nor pasture in Wisconsin. Neither should hemp follow any small grain unless the soil is very well supplied with manure. Hemp will leave the soil in splendid physical condition for any spring sown small grain. It also leaves the land relatively free from weeds, and it is, therefore, a good crop to precede sugar beets, or canning peas. The following rotations with hemp have been found applicable to Wisconsin:

Small spring grain crop (seeded down to clover)
Clover for hay and pasture (manured and fall plowed)
Corn, potatoes or similar crops
Hemp (then back to small grain and clover)

Another rotation covering three instead of four years is as follow:

Small grain crop (seeded to clover)
Clover (manured and fall plowed)
Hemp (then back to small grain and clover)

Alfalfa is coming to be an important crop in this region and the question of how to grow it in rotation is becoming more important. Alfalfa is not ordinarily used in a short rotation in alfalfa districts. It is however well adapted to such a rotation where it can be easily started, and where it produces a profitable crop the first year, as it does in the South and the irrigated regions of the West. Whether alfalfa should be used instead of clover in a short rotation must be determined by the

relative yield of the two crops for the first one or two years. Ordinarily where alfalfa can be started from fall sowing it will outyield clover the next year. But in much of the clover country alfalfa is as yet too difficult to start to justify any general attempt to substitute it for clover in a short rotation.

In general, the rotations developed in the clover region have been based on the habits of the clover plant, which ordinarily does not produce profitable crops for more than two years. In sections where alfalfa becomes thoroughly established, it might be wise to revise the rotation so as to better utilize the possibilities of the alfalfa plant. Take for example such a rotation as that suggested by Joseph E. Wing from his experience with alfalfa in Ohio: Four years alfalfa; one year, corn; one year barley sown with alfalfa. The cultivated crop (corn) gives a chance to destroy weeds, which are apt to get a foothold in the alfalfa field in four years' time.

Climate

The climate of Washington and Ozaukee Counties is typical of the eastern portion of Wisconsin. The climatic conditions immediately along the lake are somewhat different from those ten or twenty miles back.

The region covered by this report is included in the Michigan Shore, which is one of the eight climatic provinces into which Wisconsin is divided by recent study on the climate of Wisconsin and its relation to agriculture, Bulletin 223 of the Wisconsin Experiment Station: "The Michigan shore possesses the most equable climate in Wisconsin. The winters are mild (22 degrees), and somewhat more moist than elsewhere in the state, resembling those of the coast of Maine, or eastern Michigan; the springs (42 degrees) are retarded and cool, like those along the coasts of New England and British Columbia; the summers (67 degrees) are mild and pleasant, averaging over 2 degrees cooler than the Wisconsin or Rock River Valleys and 4 degrees cooler than the Mississippi Valley; while the autumns (50 degrees) are warmer than farther west, the temperature being about the same as that of eastern Massachusetts, the Hudson Valley, or the Lake Ontario shore of New York. During the winters an average of five days shows a temperature lower than 10 degrees below zero, while on seven days in the year the ther-

mometer registers 90 degrees or more. The lake shore is not a distinctive corn region, but is splendid for pasture, peas, and hay, the growing season extending from about May 1 to October 10, thus resembling southern Ontario and northwestern New York. The average rainfall (30.3 inches) is slightly less than

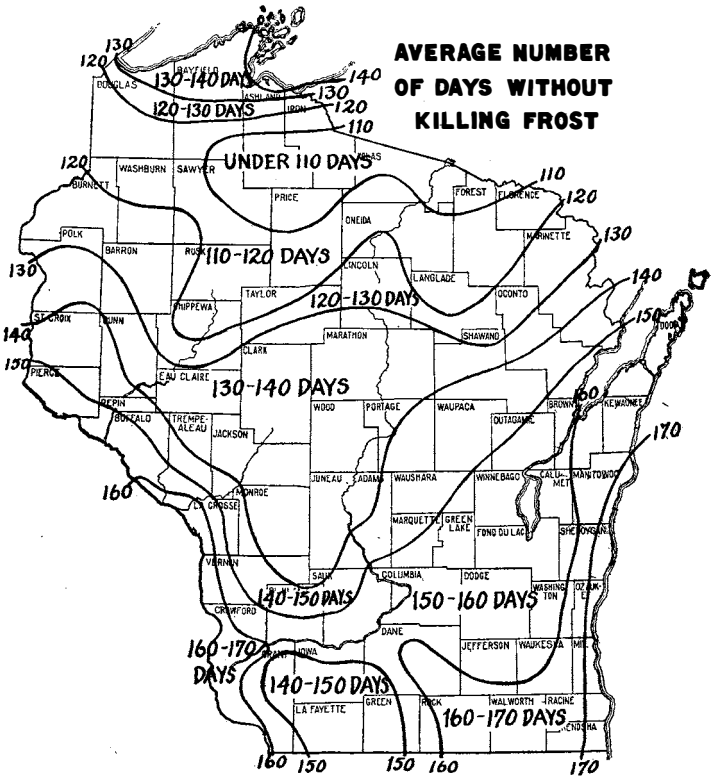


FIG. 2—SKETCH MAP OF WISCONSIN SHOWING THE AVERAGE NUMBER OF DAYS WITHOUT KILLING FROST

that of the state in general, and a larger proportion is precipitated in winter (8.2 inches), and less in summer (9.6 inches).

The following table shows the normal monthly, seasonal, and annual temperature and precipitation at Port Washington which is on the shore of Lake Michigan and at Fond du Lac which is some distance from the lake, and which represents the conditions as they exist in the western part of this area. On making a comparison of this table with the accompanying

sketched map of the state, it will be noticed that there are some differences. This is due to the fact that the map is based upon a much longer period of observation than are the figures given in the table, and of the two, the map must be considered more thoroughly representative of conditions as they are at present.

Months	Fond du Lac (800 ft. elevation)				Port Washington (713 ft. elevation)			
	Mean Precip.	Mean Temp.	Max. Precip.	Min. Temp.	Mean Precip.	Mean Temp.	Max. Temp.	Min. Temp.
December	1.48	21.8	57.0	—27	1.76	23.7	57	—22
January	1.30	17.0	54.0	—44	1.92	20.2	59	—31
February	1.13	17.9	56.0	—30	1.73	19.5	63	—29
March	1.63	31.0	75.0	—16	2.81	31.4	73	— 8
April	2.24	44.5	87.0	— 5	2.98	43.1	88	9
May	3.24	56.1	91.0	23	3.77	52.7	92	24
June	3.53	66.0	96.0	31	2.85	62.6	94	34
July	3.53	70.0	102.0	40	3.33	68.4	102	42
August	3.14	67.7	100.0	35	3.04	67.8	100	39
September	2.86	61.2	96.0	22	3.01	61.2	96	27
October	2.05	48.5	89.0	8	1.95	49.4	87	15
November	1.71	33.7	68.0	—14	1.96	36.1	74	— 3
Year	27.84	44.6	102.0	—44	31.11	44.7	102	—31

FROST DATES AVERAGE DATES

	Ave. date first killing frost in autumn	Ave. date last killing frost in spring	Earliest killing frost in autumn	Latest killing frost in spring
Fond du Lac	October 2	May 5	September 12	June 12
Port Washington	October 12	May 6	September 25	May 31

This gives an average growing season free from frost of 150 days at Fond du Lac and 159 days at Port Washington.

This is a healthful region, and it is not subject to as marked and sudden changes in temperature as parts of the state more remote from large bodies of water. There is a good supply of water available for use in homes and for stock, which is a factor of importance in the higher development of agriculture.

There is a large number of marshes in this region, and it should be kept in mind that as they are developed they will be in much more danger from frosts than the surrounding upland. It has been found that marshes in the southern part of the state will develop a frost about two weeks earlier than the uplands in the same latitude. The marshes in this region, however,

whenever thoroughly drained are reasonably safe in most cases for the growing of corn, except close to the lake. Here conditions even in the upland are not so favorable for corn as they are in the interior of the state, due to the effect of Lake Michigan.

Summary

The area included in Washington and Ozaukee Counties is situated in the eastern part of Wisconsin bordering Lake Michigan. It has a total area of 649 square miles, or 415,360 acres.

The first settlement was made in Washington County in 1835. Washington County was created from a part of Milwaukee and Brown Counties in 1836. Ozaukee was created from Washington in 1853. The population of Washington County in 1920 was 25,713, or 41.3 per square mile, and the population of Ozaukee County was 16,335, which is 55.8 per square mile. The drainage of the eastern part of this area is through the Milwaukee river into Lake Michigan. The western part of the county is drained chiefly to the west into the Rock river, through which it finds an outlet into the Mississippi river drainage basin. Some of the streams, especially those tributary to the Milwaukee river, have sufficient fall so that some power is developed from them. The region is very well supplied with railroad facilities, and the public highways are kept in good repair, many of them being crowned with cement or gravel.

Farm operations in this region were started before the lumber industry was extensively developed, and in the clearing of much of the land, valuable timber was burned in order to prepare for farming. Later on as timber became more valuable, it was cut off and sold before the land was placed in farms. All parts of the area are now well improved. The least developed portion is that within the extremely hilly belt crossing the county from northeast to southwest, and known as the kettle moraine.

The climate of this region is representative of a large area in eastern Wisconsin. The annual rainfall as recorded at Port Washington is 31.11 inches, and at this point there is a growing season free from frost of 159 days.

The agriculture of this county consists chiefly of general farming, with dairying as the most important branch. The chief crops grown are hay, oats, corn, barley, wheat, with smaller

acreages of potatoes, cabbage, sugar beets, buckwheat, peas, beans, etc. Dairy products are marketed chiefly in the form of whole milk, butter, and cheese. Cows of Holstein breeding are most plentiful, and the number of pure breeds is gradually increasing. In 1920 there were produced in Washington County 117,256,347 pounds of milk, in Ozaukee 72,632,659 pounds, which had a total value in both counties of approximately $5,000,000. In 1920 there were 2,799 farms in Washington County, and 1,727 in Ozaukee. Approximately 95 percent of the land is in farms, and from 66 to 76 per cent. of this is improved. The average size of farms is 94.4 acres in Washington County, and 81.7 acres in Ozaukee. Approximately 88 percent. of the farms are operated by the owner.

Well located and highly improved farms have a selling price at present of from $125 to $250 an acre, depending on the condition of the land and improvements. Farms located on trunk highways leading directly to Milwaukee, have a higher value than those more remote.

The soils of this region have been derived from glacial, lacustrine, and alluvial material, and in addition there are large deposits of peat consisting of partly decayed organic matter. The soils have been classified into 11 series and 44 types and phases, each one of which is fully described in the accompanying soil survey report. The Superior Series consists of lacustrine material that is characterized by heavy red clay subsoils. The surface is level, and the natural drainage is somewhat slow. The types mapped are Superior clay loam (rolling phase), Superior clay loam, and fine sandy loam. The rolling phase is similar to the typical Superior but differs in having a surface which is undulating to gently rolling, with good natural surface drainage. It has been influenced to some extent by glacial action. The Poygan Series occupies level, low, or depressed land, associated with the Superior Soils, and is characterized by a black surface soil, and heavy, red, clay subsoil. The natural drainage is poor.

The Miama series includes light-colored timbered soils of glaciated limestone origin. The subsoil consists of well weathered, rather reddish brown unstratified gravelly till. The deep phase and level phase of Miami silt loam both have a heavy subsoil that extends to a depth of 3 or 4 feet before gravelly material is encountered. They are less rolling than the typical types of Miami. The types mentioned in this series are clay

loam, silt loam, level phase of silt loam, deep phase of silt loam, loam phase, sandy loam and gravelly loam. The Rodman Series includes rough and broken country where the soils consist largely of stratified gravel with only a thin covering of soil. The gravel is over 95 percent. limestone material. Rodman gravel and gravelly loam were mapped. The Coloma Series includes glaciated material which is of a very sandy nature. It has come in part from sandstone, and in part from other formations, and has been moved considerable distances by the ice sheet. The types mapped were Coloma fine sand and sand. The Fox Series includes light-colored soils found occupying outwash plains or level terraces where the subsoil below two feet consist of stratified material. The parent material was glaciated limestone debris which has been reworked and redeposited as outwash or terrace material. The types mapped are silt loam, silt loam poorly drained phase, loam, fine sandy loam. The Plainfield Series includes sandy soils appearing as outwash or terrace formations. The material has been derived chiefly from sandstone rocks and redeposited by water. Plainfield sand and fine sand mere mapped in this area. The Waukesha Series consists of dark-colored terrace soils which occur above present flood plains. Waukesha silt loam and fine sandy loan were mapped. The Clyde Series consists of low, poorly drained land occupying depressions in the upland, and consists of poorly drained glaciated till where there is a large accumulation of organic matter and includes water laid material which occurs as poorly drained outwash plains or lake-beds. Clyde clay loam, silt loam, fine loam, sandy loam, and sand were mapped. The Wabash Series includes dark-colored alluvial soils which occur as first bottom land, and which are subject to overflow. It includes brown first bottom land also. The silt loam was mapped in this series. Peat soil consists of decaying vegetation in various stages of decomposition, with which there is a very small amount of mineral matter. Two phases of this type were mapped, deep peat, and shallow peat.

On the soil map, each one of the above named soil types has been indicated by a distinct color so that its area and extent can be observed by making a careful study of the map.