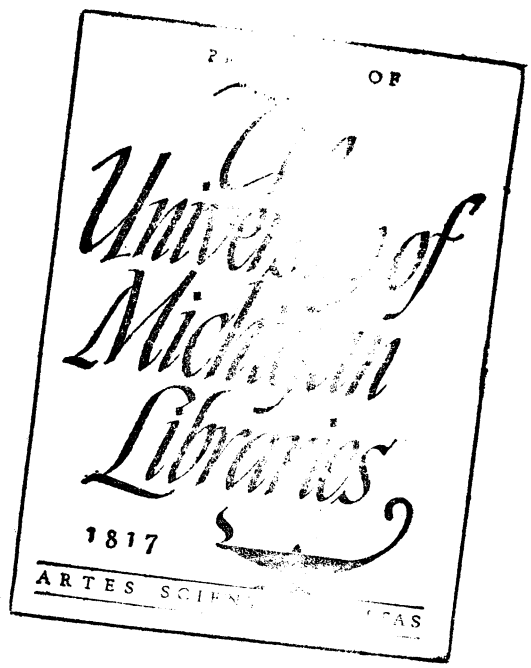

A REPORT ON MARL DEPOSITES OF OCEANA COUNTY MICHIGAN. 1927

by

Stanard Gustaf Bergquist

Submitted in partial fullfillment of the requirements for the degree of Master of Science in Geology at The University of Michigan. 1927.

MARL.

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Stanard G. Bergquist.
Michigan State College.

PART I.

THE GEOLOGY OF MARL.

THE GEOLOGY OF MARL.

Marl is a loosely consolidated, earthy material composed largely of calcium carbonate. It is essentially a form of limestone which has been but partially indurated and is somewhat variable in composition.

Marl is formed largely by the action of ground waters moving slowly thru soil containing fragments and nodules of limestone. Some of the more soluble lime material is taken into solution and carried along. When the lime charged waters flow out into open basins such as lakes and swamps, the calcium carbonate is precipitated out and deposited. The waters of the depressed areas thus become sites for the development of lime-secreting animals and plants which successively flourish and die off, eventually to accumulate on the floors of the basins and assist in sedimentation. That organic matter contributes extensively to the formation of marl is attested by the almost universal presence of their remains in the beds.

Marl is ordinarily found in regions which were at one time or are at present covered with water. It occurs not only in present existing water basins but is often found buried under muck and peat in dried up swamps and decadent lakes and also along old river channels. In places, it forms the upper terraces of lakes and streams and may there be exposed to the surface.

Deposits of marl are confined largely to the areas that have been glaciated and are quite common in the region of the Great Lakes. Unlike most sedimentary deposits, they are not continuous over large areas but are restricted to glacial

depressions and drainage lines. Hence they are generally only local in character but nevertheless quite widely scattered.

The development of marl deposits is of more or less recent occurrence. In all instances where formed in Michigan they are post-glacial and in many places are still in process of formation.

Because of their recent origin, the deposits of marl are as a rule found near the surface and seldom deeply buried. This fact, that the overburden is generally not very thick, is of decided import in the economic working of the commercial beds. At present the low price of marl makes it impossible to work profitably marl areas which have a cover of more than four or five feet of muck and peat. With a maximum thickness of five feet of overburden, the marl would necessarily have to be quite deep to warrant stripping the surface.

In the general run of deposits, a surface cover of more than two feet would present serious difficulties in the profitable removal of the marl below. It is necessary of course in commercial operation of marl beds to consider in addition such factors as quality, uniformity, availability and accessibility of the marl as well as the market conditions, etc..

The wide distribution and apparent accessibility of marl deposits thruout the state affords a potential source of almost unlimited supply of agricultural lime. This material when added to the soil plays the same important role as does commercial lime but owing to its impurities it must be applied more heavily to assure equal results.

When freshly dug from the lowland deposits, marl contains water to the extent of nearly half of its weight; is somewhat pasty in character and difficult to handle. Allowed to stand

exposed to the weather, it dries out and gradually crumbles. The upland marls, especially those which lie in dry beds thruout the entire year are as a rule very friable and readily worked. Regardless of their position with regard to the water table, however, marls are very often contaminated with undesirable and somewhat detrimental impurities. In many of the deposits tested during the past summer the odor of hydrogen sulfide was quite apparent.

To obtain the best results in liming, the marl should be allowed to remain in the open for several months after having been dug. It is advisable to pile it up in rather small heaps so as to insure thorough weathering. In this process, much of the excess water and harmful toxins are removed and at the same time the marl is broken up and made more friable thus insuring more effective results when applied to the soil. If the marl is left standing in large piles on the surface, it dries out very slowly. The outer surface disintegrates and soon becomes quite powdery but the inner portions retain the moisture and apparently change but very little.

Before working a marl bed, it is a good policy to determine by means of borings, the exact nature of the underlying materials. It has occasionally been noted that the lower portion of the marl merges rather gradually into a layer of light colored, plastic clay which resembles very much the marl itself. In digging marl with a clay substratum, extreme caution should be exercised not to remove the clay and spread it out over the surface of the excavated marl. The

clay has a tendency to harden as it dries out and forms a somewhat impervious shell which excludes the air and prevents complete weathering of the inner material.

The areas in which marl accumulates are generally so situated with reference to the surrounding lands as to provide natural drainage pockets for surface waters flowing from the higher surroundingareas. Clastic materials, such as sands, silts and clays are transported into the depressed basins and become intermixed with the lime deposits. Prolonged sedimentation ultimately results in the filling in of the basin to develop marshy conditions.

The growth and decay of organic life within the marshy areas often results in the formation of a layer of muck and peat which tends to seal up the surface of the area and thus prevent further accumulation of marl. The vegetal matter very often becomes intermixed with the marl in the process of sedimentation and tends to contaminate it.

The value of marl as a soil amendment depends largely upon its degree of purity. Many of the beds contain materials which are relatively free of impurities and test up very high in calcium carbonate content, in fact approach very closely the analysis af a commercial lime. In other cases however, there may be a great deal of foreign material present in the marl, with the result that there will be a corresponding decrease in the ratio of lime present. It is necessary in applying marl to the soil, to know the needs of the land and also the quality of the amendment. The best results cannot be expected if a low grade of marl is applied in small amounts to a highly acid soil.

PART II.

A REPORT ON
THE MARL DEPOSITS OF OCEANA COUNTY.

S.G. Bergquist,
Michigan State College.

Field work performed
in
summer of 1926.

June 1, 1927.

SOME ASPECTS OF MARL DEPOSITS IN OCEANA COUNTY.

Oceana County is typically an area of sandy soil, made up largely of outwash and till plains. Approximately eighty percent of the surface area is light and sandy in character and the remaining twenty percent about equally divided between lowland swampy areas including lakes, clayey till and gravelly loam.

The marl is quite widely distributed thru the county altho in some of the townships, especially those in which the soils are uniformly and persistently light in texture, no trace of marl is to be found.

The deposits of marl in the county are of two distinctively different types and for the sake of convenience I have tentatively classified them into two groups, based upon their relationship to the water table, namely, lowland and upland deposits.

LOWLAND MARLS.

The lowland types are by far the more common and make up the greater proportion of the deposits in Oceana County. They occur in beds of variable thickness in swamps and marshes, in river beds and as marginal deposits in lakes.

The marl in these areas is generally found below the normal water table and in such positions as to be constantly saturated with water. The thickness of the beds ranges from a few inches thru to twenty and more feet, depending to a large extent upon the size of the depression in which the material was allowed to accumulate.

The lowland marl beds are usually mantled with a layer of muck and peat which in many of the swamps and decadent lakes has accumulated to rather extensive depths, indicating that quite a long period has lapsed since the cessation of marl forming activities. In some areas however, marl is still in the process of formation and is accumulating more rapidly than is the encroaching vegetation, which in time will undoubtedly form a layer of organic matter to completely seal up the deposit and prevent further deposition of marl.

The marls of this type are extremely variable in color and in quality. The purer forms are as a rule grayish but, where intercalated with vegetal remains in the form of muck and peat, they generally assume a darker shade. The color of marl is not always an index of its quality, altho it is unquestionably true that those of lighter colors contain less organic matter of vegetable origin and hence would be

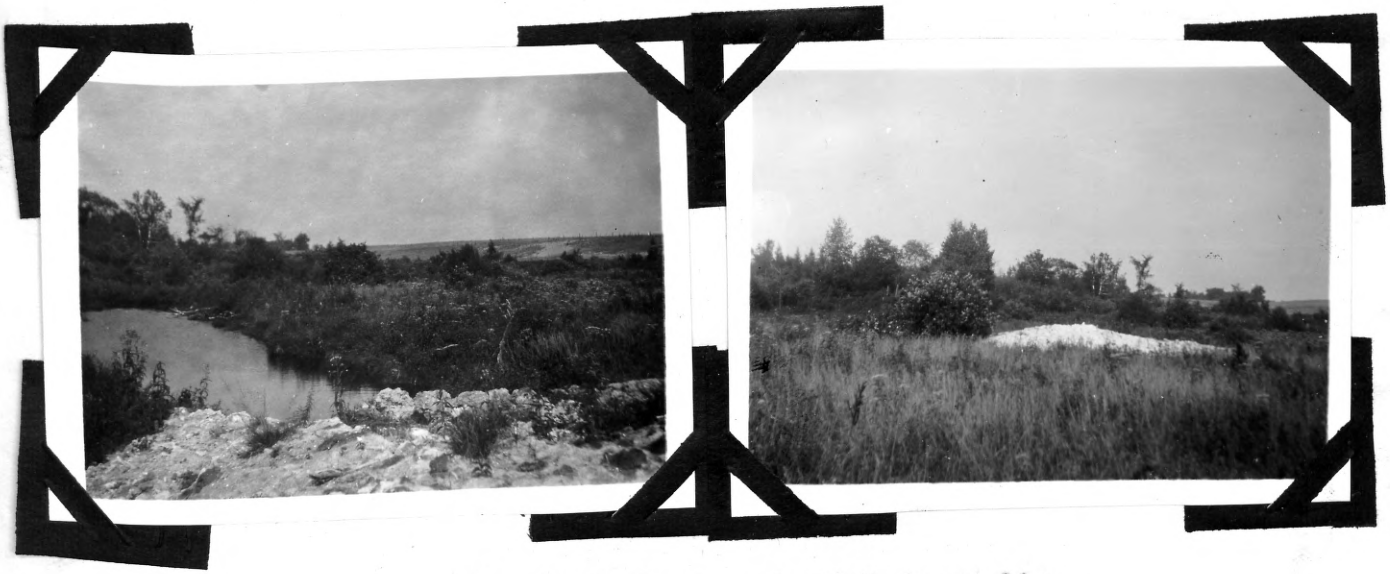
likely to have a higher a higher percentage of calcium carbonate than those that run darker. However, in some of the darker marls, those which apparently were contaminated with muck and peat, the final analysis showed a relatively high content of lime.

The waterlogged marls are heavy and difficult to handle. When freshly dug they contain water to approximately half of their weight and are frequently pasty or mushy in character. If intermixed with clayey material, they are plastic and sticky. Upon drying, a large amount of water is released and the color becomes considerably lighter, oftentimes pure white. A cubic ~~of~~ foot of marl taken from the borders of McLaren's Lake was weighed immediately after its removal from the water and found to weigh 104.8 pounds. A cubic yard of this material, completely saturated with water, would accordingly weigh 2829.6 pounds.

In the deeper layers of the saturated deposits and particularly where the marl is of a colloidal nature, the presence of hydrogen sulfide seems to be quite apparent, both in the lake and marsh deposits. This substance is readily detected by its odor when present in large quantities and will frequently produce a purplish tarnish on a brass rod even if only in limited association with the marl.

Marl which has formed and developed completely under water, is generally not fit to be applied directly to the soil immediately upon being dug. It should be piled up in small heaps and allowed to weather thoroughly. The process of drying tends to remove a large proportion of the water and allows the included toxins to escape. At the same time

the marl is rendered more friable and made easier to apply and also more useful as a soil builder. If piled up in large deposits on the surface, the material weathers very slowly, and ordinarily only in the outer portions. On the inside it remains quite unchanged as to moisture content and textural properties.



Lowland Areas of Marl Deposits.

Oceana County.

The marl in these beds has a thickness exceeding twenty feet and is covered with a mantle of twelve to sixteen inches of muck and peat. The water table is above the surface of the marl

UPLAND MARLS.

The upland areas of marl are somewhat more limited in their distribution, but nevertheless constitute beds of great importance in the county. They are found in the terraces of lakes, where the water level has subsided, and in the upper flats, terraces and old meander channels of streams and rivers.

The marl in these deposits is largely concentrated in beds that lie above the present normal water table. They are for the most part fairly dry as compared with the lowland types. In seasons of excessive rainfall however, the water table rises, very frequently to levels above the surface of the deposits. In general the beds are relatively shallow, scarcely if ever, attaining a thickness exceeding six or seven feet; they would probably average three to four feet thick for the county.

The surface cover ordinarily is so thin as to be practically negligible. It consists merely of a few inches of muck, more often up to six or eight inches of wind drifted sand. Occasionally, thin lenses of sand are found scattered thru the marl beds, but not in quantity sufficient to be of serious consequence in the economic handling of the deposits.

The upland marls are predominantly grayish to whitish in color. In deposits where clay forms the substratum and prevents proper drainage, they are frequently mottled with brown. As a general rule the marl of this type is fairly pure and runs high in calcium carbonate content. Very little muck or peat is inter-associated with it.

Inasmuch as the deposits lie above the normal level of the ground waters, the marl is comparatively light in weight. A cubic foot of the material was dug from the dry bed on Carlton Creek and found to weigh 56.8 pounds, that is, 1533.6 pounds per cubic yard. Another sample, taken from the flood plain terrace of Cushman Creek weighed 85.1 pounds per cubic foot or the equivalent of 2297.7 pounds to the cubic yard.

The upland marl is characteristically friable in texture and breaks readily into a crumb structure upon weathering. Because of its relatively porous nature and exposure to weathering activities, it is quite commonly completely aerated and requires little or no preliminary curing to be used on the soil. In several areas, especially where the marl was colloidal and the base of the deposit rested in the upper ground waters, the odor of hydrogen sulfide was very apparent.

Upland Areas of Marl Deposits.

Oceana County.

Terraces of marl a quarter of a mile back from the present stream. The beds contain marl to a depth of six feet and are covered with a few inches of wind drifted sand.

ECOLOGICAL CONSIDERATIONS.

There seems to be a rather definite relationship between marl deposits and plant associations. In the southern part of the state, a variety of Potentilla grows luxuriantly in areas where marl is present. In fact, the presence of this plant may be reliably used as a positive indicator of marl. In Oceana County not a single trace of the plant was found altho in the adjoining county of Newaygo it was present in merely one isolated area of the six townships surveyed.

If we are to differentiate between bog and marsh in reference to character of soil and type of vegetation present it will be quite necessary to make some changes in the nomenclature of marl deposits. If we define a marsh as an area of low lying, swampy land with soil of an alkaline character and supporting vegetation with alkaline requirements; then contrast the bog as having an acidic soil and favoring a growth of vegetation with acidic tendencies, it is no longer correct to classify marls in the category of bog limes as has been done in the past.

Marls do not form under bog conditions altho it would be possible for a bog to become the site for marl deposition thru a change in drainage conditions. If the ground waters, flowing thru the soil containing nodules and concretions of limestone, were diverted from their courses so as to carry lime carbonates into a bog, condition might then be made favorable to marl forming processes. With the neutralization of the heretofor acid waters of the bog, lime secreting plants and animals would undoubtedly come in

and assist further in marl accumulation.

Of the bog types of plants found in Oceana County, two are especially outstanding in their complete aversion to marl. Wherever Cassandra and Andromeda grow, marl will not be found even with depth. Bogs with these plant types are numerous in the sandy plains of the county and occasionally also in the areas where the heavier types of soil have developed under conditions of improper drainage. Soiltex test made in these bogs and also in the soils of the higher surrounding areas always revealed an acid character of soil.

It is natural, of course, to expect that acid bogs should be developed in regions where the ground waters flowing into them have their origin in glacial deposits containing soil of an acid nature. It seems probable that the environmental conditions are the factors which would determine whether lowland areas will develop into marshes or bogs. The type of vegetation which would come into the depression would be influenced largely by the conditions existing in the watershed area of the basin.

Cassandra Bog

Oceana County.

Sphagnum moss occurs in lowland habitats and almost always in acidic associations. Occasionally, thin beds of marl are present in the sphagnum floored depressions but generally below a thick mantle of muck and peat.

Tamaracks and cedars grow under variable conditions and their presence in the swamps is never a positive index to the occurrence of marl.

Along the lake borders, the growth of Chara and Potomogeton always seemm to indicate areas in which marl is in process of accumulation. On the other hand, in regions where lily pads and cat tails form the bulk of the vegetation, muck and peat with scarcely any marl characterizes the deposit.

From observations made in a large number of deposits during the past summer I am somewhat inclined to discount the importance of Chara as a factor in the formation of thick deposits of marl. It is obvious that Chara is a lime secreting plant and functions to a certain degree in the accumulation of marl but many other plants are of equal importance in this respect. Much of the marl, especially the extensive deposits, have formed thru the accumulation of animal remains and alsothru the process of precipitation of calcium carbonate carried into the depressions by surface and ground waters.

Stanard G. Bergquist.
Michigan State College.

PART III.

DESCRIPTIONS OF MARL DEPOSITS

BY TOWNSHIPS.

OCEANA COUNTY, MICHIGAN.

OCEANA COUNTY _____ PENTWATER TOWNSHIP.

T. 16 N. R. 18 W.

Marl Survey by S. G. Bergquist and A. W. Bergquist.

General Description.

Pentwater township lies in an area made up almost entirely of wind-drifted sand ridges. These ridges along the shore of Lake Michigan form a succession of fairly high dunes whereas farther inland they have been levelled down to form almost level plains. The soil thruout is sandy and of no agricultural value.

The drainage is well developed and very few marshes and swamps are found in the region. Pentwater Lake, occupying approximately the center of the township is the only lake of any importance. A very small tip of Bass Lake extends into section one on the north end.

The Pentwater River enters Pentwater Lake almost on the east township line. A rather extensive river marsh area has developed at this junction and extends eastwardly well into Weare township.

Marl Deposits.

Marl is found in only one area in the entire township and that is in the overflow flats of the Pentwater River at the head of Pentwater Lake. The sedgy bottoms run largely to muck, which along the river's edge is five to seven feet deep and underlaid with sand. The muck layer thins out towards the edges to three and four feet and is underlaid with three feet of a dark colored, poor grade of marl that runs only in patches.

The bottoms are rather low, just slightly above the river level and subject to extensive overflows during high water.

Sample # 1050. Analysis 72.52 %

S.E.¼ of S.E.¼ Sec. 24. Class C. deposit.

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OCEANA COUNTY ____ WEARE TOWNSHIP.

T. 16N. R. 17W.

Marl Survey by S.G.Bergquist and A. W. Bergquist

General Description.

Extending from east to west across the south half of Weare township is a morainic area made up of soils ranging from sands thru to sandy loams and clays. The topography is undulating except to the southeast where it assumes a fairly level attitude. A narrow strip of sandy moraine runs north and south along the west side of the township to a point half way down the township. It is somewhat level and merges into the wind drifted area to the west.

In the northeast corner of the township and occupying approximately eight square miles of area is a level sandy outwash plain that continues east into Crystal township.

To the west of the outwash area and confined between it and the narrow strip of moraine on the township line is a level sandy lake bed that extends south to about the middle of the township.

The county is drained by the westward flowing Cedar Creek and Pentwater River and their tributaries. For the most part, the creek and river bottoms are sandy or mucky with sand below.

There are no lakes in the township and relatively few swamps save those of shallow muck along the waterways.

Marl Deposits.

No commercial deposits of marl were located in the township. Only one area containing marl was found and that in the N.W.¼ of N.W.¼ Sec. 31 and extending into the S.W.¼ of S.W.¼ Sec. 30.

The marl in this deposit has a thickness of three to four feet and is covered with five feet of muck and peat. A dense tangle of undergrowth covers the area and is almost impenetrable.

OCEANA COUNTY ____ CRYSTAL TOWNSHIP

T. 16N. R. 16W.

Marl Survey by S. G. Bergquist and A. W. Bergquist

General Description.

The eastern half of Crystal township comprises an area of undulating to rolling moraines. The soil is mainly sandy altho locally it runs into sandy loam and light clay.

With the exception of a small area of moraine in the southwest corner, the western portion of the township is largely outwash with sandy and clayey soils intermixed. The topography in this section is relatively level ranging to somewhat gently undulating.

The drainage is almost entirely thru Crystal Creek which headwaters in the east half of the township and flows westwardly thru the middle of the region into Cedar Creek. A portion of Pentwater River cuts across the northwest corner and several small streams headwater in various sections.

Lakes are absent and swamps are relatively scarce.

Marl Deposits.

Only one deposit containing marl in commercial quantities was located in the township and half of it extends into Mason County.

Class A.

In the N.W.¼ of N.W.¼ Sec. 6 on the Mason County line is an upland deposit of dry marl. Three to five feet of muck forms the cover over a bed of marl ten feet in thickness. The deposit lies on either side of the county line road, is very accessible and could be easily worked.

Sample # 1077. Analysis 86.16 % Andrew Bahr.

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OCEANA COUNTY ___ COLFAX TOWNSHIP.

T. 16 N. R. 15 W.

Marl Survey by S. G. Bergquist and A. W. Bergquist.

General Description.

The surface of Colfax township is about equally divided as to morainic and outwash features.

The moraines comprise a relatively large area in the northwest quarter and a narrow belt extending from School Section Lake to the southeast corner of the township. The topography in the morainic belt is somewhat undulating with sandy soils predominating. Small patches of clay are distributed haphazardly over the area.

The outwash belt extends from the northeast corner thru the center of the township across to the southeast corner with local extensions projecting south into the till plain area of Leavitt township. The outwash plains are gently undulating and the soils characteristically sandy.

The drainage is fairly well developed. The streams for the most part are small and in places somewhat intermittent in character. They flow eastwardly from the middle of the township.

Lakes are not very numerous and wherever present are generally rimmed with muck. The swamps are largely confined to the water courses and relatively shallow.

Marl Deposits.

No marl deposits were located in the township of Colfax.

OCEANA COUNTY _____ GOLDEN TOWNSHIP

T. 15 N. R. 18 W.

Marl Survey by S. G. Bergquist and A. W. Bergquist.

General Description.

In the southeast corner of Golden township and extending north from Benona township is a small stretch of undulating sandy outwash plain. To the north this outwash area is bordered by a belt of till plain that continues eastwardly thru the village of Hart. A morainic ridge of somewhat hilly attitude and composed largely of sandy material traverses the township from northeast to southwest. This morainic belt lies between the outwash and till plains of the southeast portion and the level sandy plains and rolling dunes that skirt the shore of Lake Michigan to the west.

The drainage is mainly into Au Sable Creek which flows from Round Lake westwardly across the north end of the township thence south into Silver Lake. There are quite a large number of small swamps and bogs scattered thru the region but for the most part they are relatively shallow with a few inches to six and seven feet of muck and peat and with sandy bottoms. Marl is sometimes found in these undrained areas but not in large amounts, seldom exceeding a foot or two in thickness and then usually with a cover of several feet. Lakes are not abundant, Silver Lake in the southwest portion and Round Lake on the northeast being the only ones of any importance. Silver Lake has a margin and beach of sand except at the west end near the outlet where the border is marshy and underlaid in places with marl. Round Lake is rimmed with a wet, marshy margin of muck and peat except on the west side where sand prevails. Patches of marl are found at varying depths below

below the muck and peat around the borders of Round Lake but are not of much commercial importance. Several other mud bottom lakes either almost totally extinct or partially dried up are found in the southeast portion of the township but are of no significance from the standpoint of marl deposits.

Marl Deposits.

Marl is not found in extensive quantities in Golden township. Only a few areas worthy of classification were located.

Class A.

Along the banks of a small creek and near its headwaters in a spring fed swamp in the S. E. ¼ of the N. E. ¼ Sec. 28 is a somewhat extensive marliferous deposit. The region is decidedly wet and the water table almost up to the surface. A foot of muck covers a bed of marl that ranges from five to seven feet in thickness. A very dense undergrowth has grown up and would have to be removed in order to work out the marl. High ground to the north of the swamp would afford fairly good facilities for machine operation as well as for storage. The roads, however, are sandy and would be difficult of travel except possibly during the winter when sleigh hauling could be employed.

Sample # 1047 Analysis 88.36 % M. A. Davis

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Class B.

On the west end of Silver Lake and near its outlet, S.E.¼ of S.E.¼ Sec. 25 extending from the water's edge inland for several rods is a fairly dry sedgy marsh of some fifteen or twenty acres in extent. The marl in this deposit averages about four feet in thickness and is uniformly quite dark in color thruout. It is covered in places with a few inches to a foot of sand and comes up to the surf-

ace locally. The underlying material is sand. The area could be very easily worked but the absence of roads would make it almost impossible to get out except in winter over the ice of the lake. A small sandy knoll to the west of the marsh would afford ample storage facilities.

Sample # 1049 Analysis 63.08 %

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Class C.

Marl in varying amounts and at variable depths below the surface was found along the margin of Round Lake in Secs. 11 and 14.

In the swamp on the north end of the lake a foot of brownish marl on a sand bottom is overlaid with a layer of muck and peat averaging from five to seven feet in thickness.

On the east side of the lake and extending into the water is a deposit of rather dark colored marl ranging from five to six feet in thickness. On shore the marl is covered with two and three feet of muck and peat and thins down to three feet.

On the south end of the lake the marl seems to be of a better grade, being lighter in color especially with depth. This area is quite marshy and wet and has a surface cover ranging from three to six feet of muck and peat. The marl does not form a continuous bed but seems to run in patches. In places the marl is only a few feet thick and then again it may attain a depth of fourteen and more feet. This is the only portion of the Round Lake margin that would be commercially workable.

On the west side of the lake the shore and beach are sandy except where the lake has been filled in with mill refuse. A local

lens of pure white marl two to eight inches thick and interbedded with sand is the only evidence of the material on this shore.

Sample # 1046 Analysis 87.96 % E. Krantz
Elmer Wycoff

The sample was taken from borings taken at intervals around the lake.

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In the S.E.¼ of the N.W.¼ Sec. 36 (fraction) slightly to the south of the extreme west end of Silver Lake is a small isolated patch of upland, dry marl with three feet of sand cover. The marl varies in thickness from two to five feet. It is situated on a sand road with fairly good facilities for hauling. The marls thins out to the east of the area to a foot and less in thickness. The thick cover of sand and locally of muck would make this deposit of little consequence.

Sample # 1048 Analysis 64.88 %

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Unclassified

The following locations contain marliferous deposits but the areas are not extensive enough to warrant operations for removal. No samples were taken of the unclassified areas.

S.W.¼ of S.E.¼ of Sec. 21-- two to three feet of marl under three to seven feet of surface cover.

N.W.¼ of S.W.¼ Sec. 13 -- some marl below seven feet of cover.

S.W.¼ of S.W.¼ Sec. 16 -- six inches to three feet of marl with three to seven feet of surface cover.

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OCEANA COUNTY ____ HART TOWNSHIP

T. 15N. R. 17W.

Marl Survey by S. G. Bergquist and A. W. Bergquist.

General Description.

The southern third of Hart township lies largely in a rolling morainic area with sandy soil predominating. Cutting across the middle of the township with an east-west trend and centering about the village of Hart is a narrow till plain with a somewhat undulating relief and made up of a soil that ranges from sandy loam to a light phase of clay. This till plain terminates a few miles east of Hart in a belt of sandy outwash plain that extends through to the southwest corner of the township. Another similar belt of outwash has its origin in the central till plain a few miles south of Hart and continues south and east through the middle portion of the southern third of the township. Local pockets of gravel are found associated with the sand in the relatively level outwash plains and especially where the streams flow thru them. In the north part and extending from east to west across the township is a morainic belt with a slightly heavier soil than the similar area to the south. The soil in the northern moraine varies from sand to a sandy loam and locally runs into a light clay. The topography in this section ranges from undulating to gently rolling.

The drainage is somewhat haphazard and poorly developed.The township is dotted with numerous small bogs and undrained areas, some of which are situated on the higher slopes, the so-called creeping or climbing bogs. For the most part, these moist, undrained patches are fed by springs or represent the heads of the

springs themselves. As a rule, the muck that is found in them is relatively shallow, rarely exceeding a foot or two and invariably with a sandy bottom containing a hardpan layer; often times a clay substratum. A rank growth of swamp vegetation generally clothes the surface of these bogs giving to them the appearance of actual lowland areas. In no single instance was marl found in these shallow bogs. The numerous hillside springs are sources of a large network of small, shallow and narrow bottomed streams none of which were found to contain marl.

Most of the drainage is to the north and into the westward flowing Pentwater River that traverses the township in the north. Aside from the mill ponds of several dammed up rivers in the vicinity of Hart, there is only one lake, Crystal Lake, in the township. This lake is completely rimmed with a sandy shore and beach and has no marl assiciations.

Marl Deposits.

There are no commercially important marl deposits in the township of Hart and consequently none have been classified. Marl occurs in but a few places in the entire township and where found is relatively thin bedded and in no large quantities. The most extensive unclassified marl deposit is that found on the land of W. R. Roach and Company and is located in parts of three sections as follows:

S.W.portion Sec. 14.
N.E. portion Sec. 22.
N.W. portion Sec. 23.

The marl here has an average thickness of about a foot and is underlaid with sand. Peat covers the marl to a depth of three and four feet.

OCEANA COUNTY ____ ELBRIDGE TOWNSHIP.

T. 15 N. R. 16 W.

Marl Survey by S. G. Bergquist and A. W. Bergquist.

General Description.

Cutting across the northeast corner of Elbridge is the south end of the moraine that extends thru the east half of Crystal township. The topography in this area is quite rugged with fairly well defined hills scattered over the surface. The soil is predominantly light and sandy but is interspersed with local and small patches of sandy loam and light clay.

Bordering this morainic section to the south and west is a narrow strip of gently undulating, sandy outwash plain which extends from the northwest corner to the middle of the east edge of the township. Another area of outwash plain extending from Hart thru to Ferry traverse the southwest corner.

Between the two outwash plains lies a fairly extensive morainic belt that covers practically the entire southwest half of the township. The topography in this area is quite hilly in character and the soil essentially sandy.

The drainage is mainly into the Pentwater River which flows westward thru the outwash plain from the middle of the east margin to the northwest corner of the township. Numerous small tributaries enter the river at intervals but they are in many cases only intermittent and not important.

Lakes are scarce -- Cabmoosa and Evans Lakes in the southeast being the only significant ones.

Swamps are confined almost wholly to the river bottom and locally reach somewhat large proportions. The swamps are generally

quite shallow with only a few feet of muck and peat spread out over a floor of sand.

Marl Deposits.

The only beds of any importance in Elbridge township are found along the borders of Cabmoosa Lake in Section 26.

Class A.

On the south end of Cabmoosa Lake and along Swenton Creek near the outlet of the lake in the N.E ¼ of the S.W.¼ Sec. 26 marl is found in rather extensive beds with one to three feet of muck overlying eight to twelve feet of the material. A floating sedge mat on the lake margin would make it impossible almost to remove marl at this point but conditions along the creek are quite favorable for machine excavation. Some marl has already been taken out.

Sample # 1076 Analysis 87.04 % Edward Weirick. Henry Hovey.

Class B.

In the N.E.¼ of the S.W.¼ Sec. 26 and somewhat to the east of Cabmoosa Lake is a swampy area in a rather wet condition where marl is present to a thickness of five to six feet under a cover of two feet of muck and peat. This body of marl lies quite distant from any good road and would be difficult to get out.

Sample # 1074. Analysis 64.04 % Claude Aiken.

Class C.

In the N.E.¼ of the N.W.¼ Sec. 26 and extending into the N.E.¼ of the S.W.¼ of the same section is an area of marl with a thickness of eight to ten feet. The bed is covered with peat and muck to a

depth of three feet. The material is dark in color and apparently of rather poor quality. The marl occurs both on the land margin and in the water near shore but does not form a vary wide area.

Sample # 1075. Analysis 78.76 %.

OCEANA COUNTY ___ LEAVITT TOWNSHIP.

T. 16 N. R. 18 W.

Marl Survey by S. G. Bergquist and A. W. Bergquist.

General Description.

The greater portion of the east half of the township lies in a ground morainic or till plain section, The soil for the most part is here quite sandy but interspersed with local areas of sandy loam and patches of clay, also with isolated belts of bowldery deposits. The surface is fairly level altho in places gently undulating.

A narrow strip of level outwash borders the till plain on the west but is cut thru in the northwest and southwest corners of the township with finger like extensions from the Elbridge moraine.

A linited area of moraine running north from Newfield cuts across the southeast corner of the township with a rolling surface and made up mainly of sandy soil.

Small extensions of the Colfax outwash connect up with the north border of the till plain but like its northern representative is sandy and level.

The township is drained by a number of fairly large streams that flow across the area from the northwest to join the eastward flowing Beaver Creek on the east side of the township.

Several large lakes are found in the township but they are situated along the margins with extensions into other townships. East Lake in section 29 is the only lake within the interior. The lakes are rimmed entirely with muck or with muck and sand alternating. No marl was located in any of the lake basins.

There are numerous swampy areas within the township but they are generally quite shallow with only a few feet of muck and peat on a sandy substratum. An extensive expanse of swampy land is centered about East Lake. The muck and peat cover in this area ranges from a few feet to eight and ten feet thick and only in few places is marl present below it and then in very limited amounts.

Marl Deposits.

Altho marl is present in limited amounts in numerous swamps and under rather thick covers of peat and muck there are only a few deposits of commercial importance.

Class B.

In the S.W.¼ of the N.E.¼ Sec. 12 along the drain outlet from the swamp to the north is a fairly dry deposit of marl. The material is not very thick, ranging from one to three feet, and is overlaid with about two feet of muck. The upper foot of marl is quite light in color and filled with shells but below this it is dark gray to brownish and somewhat colloidal. The odor of hydrogen sulfide was very pronounced in the lower portion of the deposit.

Sample # 1073. Analysis 79,68 % W. S. Bettis.

Class C.

In a fairly well drained area near the main road in the S.W.¼ of the S.E.¼ Sec. 3 is found a bed of marl two to three feet thick underlaid with a heavy plastic blue clay. The deposit is covered with a layer of muck averaging from one to three feet thick. The surface of the area is grown up to a dense stand of brush which would make operations quite difficult.

Sample # 1072. Analysis 54.56 %. Ben S. Bond.

OCEANA COUNTY ___ BENONA TOWNSHIP

T. 14 N. R. 18 W.

Marl Survey by S. G. Bergquist and A. W. Bergquist.

General Description.

The central portion of Benona township comprises largely an area of sandy outwash plain. This plain is bordered to the north, east and west by margins of undulating to hilly moraines and to the south by a small belt of sandy to clayey lake plain, an extension of the plain that occupies the northwest corner of Claybanks township. In the southeast corner is a small, isolated patch of till plain with a fairly heavy, clayey soil.

With the exception of the morainic ridges that border the central plain and the line of low dunes in the southwest corner of the township, the relief is quite gentle and for the most part level.

The drainage is mainly thru Stony Creek which flows south thru the east edge of the township into Stony Lake on the south township line. Aside from Stony Lake and the rather extensive river bottom marsh at the head of the lake there are no lakes or swamps of any consequence in the township.

Marl Deposits.

All of the commercially important marl beds of Benona township are located either around the borders of Stony Lake or in the marshy bottoms of Stony Creek and its tributaries near the head of the lake.

Class A.

On the north shore of Stony Lake in N.W.¼ of S.W.¼ Section 33 is a rim of upland dry marl extending back several rods from the water's edge. In places the marl comes to the surface but in general has a cover of a foot to a foot and a half. The marl below varies in

thickness from three to seven feet, rarely exceeding six feet, and is underlaid with sand. The deposit extends into the lake as wet marl with a fairly constant depth of seven feet. Conditions in this area are excellent for removal and storage. Some marl already has been dug and taken away.

Sample # 1024 Analysis 90.64 % James A. Porter.

This same marl bed continues westwardly along the north shore of Stony Lake to about the center of Sec. 32 from which point west the margin and beach are sandy. A sample of marl was taken from the dry bed in the west central portion of the S.E.¼ of Sec. 32 which represents approximately the west end of the deposit. In this area the marl has no cover but comes out to the surface, and with a thickness not exceeding five feet. The bed is high and well drained, easily worked and with good facilities for handling the material. Some marl has been removed for local use. The upland bed extends down to the water's edge and is continuous with the eight to ten feet of deposit in the lake.

Sample # 1032 Analysis 88.88 % H.E.Huey.

On the west end of the lake along the mouth of Stony Creek in the S.E.¼ of N.E.¼ Sec. 33 is a bed of upland marl, well drained and dry with a cover not exceeding two feet. In some places the marl comes out to the surface and varies from two to six and eight feet in thickness. The marl continues out from the higher ground into the low, marshy bottom land and there reaches a depth of fourteen feet and more with only two or three feet of surface peat above. The upland marl is readily accessible and can be easily removed as it lies adjacent to

higher ground for storage. In the bottom lands, however, excavating operations would be more difficult on account of distance to high ground and also water conditions. The principal drawback in the operation of the bed as a whole lies in the lack of haulage facilities, the roads being quite distant. Several hundred yards of the upland marl have already been dug out and removed over winter roads.

Sample # 1026. Analysis 89.72 %. Munson Bros.

Adjoining the Munson bed and slightly to the south and west, in the N.W.¼ of S.E.¼ Sec. 33, is a similar deposit of upland marl with extensions into the creek bottoms where it becomes wet and undrained. On the higher ground the marl comes out to the surface and ranges from four to six feet in thickness while in the lowland borders the thickness increases to ten and twelve feet with a cover of muck and peat up to four feet. Conditions for operation in this bed are identical with those on the Munson farm and the same obstacles would have to be overcome.

Sample # 1027. Analysis 92.72 %. A. J. Sundell.

Class B.

In the west central portion of the N.W.¼ Sec. 34 along the north edge of the Stony Creek bottom is a narrow strip of upland marl somewhat poorly drained and on that account mottled with brown. The marl comes to the surface, varies from four to five feet in thickness and is underlaid with sand. Owing to the steep slopes of the hilly hinterland, the lack of any roads and the almost impossible prospects of getting a road into the marl area, the deposit is quite inaccessible and would be difficult of operation.

Sample # 1025B Analysis 93.72 %. Emil Wentsloff.

Class C,

Away from the upland where sample 1025B was taken and in apparently the same bed but in the marshy bottoms of Stony Creek adjoining, the peat cover is three to seven feet in thickness and the underlying marl seems to be present only in patches, ranging from zero to ten feet. This area of backwater and overflow marshy bottom land is subject to extensive floodings during the high water seasons and the marl could be worked out only during times when the water had receded to the natural channel.

This point, the W. central portion of the N.W.¼ Sec. 34, seems to mark the east edge of the marl deposit in the Stony Creek bottoms. From here on upstream, the creek flows over a sandy or clayey floor except occasionally where a widened marshy area has formed and small amounts of marl have concentrated into pockets.

Sample # 1025A Analysis 82.96 %. Emil Wentsloff.

At the confluence of Grover Creek with Stony Creek at the head of Stony Lake in the W. central portion of the N.W.¼ Sec. 34, the bottom lands widen out considerably. Here the surface is extremely wet and drainage poor all thru the year. Three to seven and more feet of wet, soggy peat covers a marl formation which varies from five to twelve and more feet in thickness. It would be difficult to operate the bed in this vicinity because of adverse conditions of drainage coupled with lack of storage ground and the entire absence of roads.

Sample # 1025C Analysis 83.56 %. Emil Wentsloff.

In the low bottom of Stony Creek in the W.C. portion of the S.E.¼ Sec. 27 is a rather extensive marshy area subject to overflows at certain times of the year. Marl to a thickness of four to ten and more feet is found here under two to five feet of wet, soggy peat. This deposit lies a half mile from any road and would be difficult to work except in periods of extreme dryness.

Sample # 1023 Analysis 89.00 %

In the S.W.corner of the S.E.¼ Sec. 33 and on the south township line, south shore of Stony Lake is a narrow rim of marl which lies at the base of a steep sandy slope. This deposit extends into the lake where it has a depth of twelve and more feet. The cover is negligible even in the land portion. The steep slopes leading down to the water's edge together with the limited area of material and poor facilities for handling would tend to make the deposit of little or no commercial value.

Sample # 1028. Analysis 77.24 %. Camp Knollslea
J. C. Anderson

On the south side of Stony Lake in the S.E.¼ of the N.E.¼ Sec.5 (fraction) is a narrow rim of marshy land with one to three feet of surface peat and four to twelve and more feet of marl below that runs out into the water. The steep banks leading down to the shore together with limited and difficult facilities for operating and handling the marl would tend to make the deposit of little or no commercial importance.

Sample # 1029. Analysis 85.32 %.

A little farther to the west from where sample # 1029 was taken the marl becomes somewhat darker in color and appears to be of poorer quality. S.W.¼ of N.E.¼ Sec. 5 (fraction). Here also, as in the previous location the marl is found mainly in the water of the lake and with a depth exceeding twelve feet. On shore there is a cover of peat ranging from one to two and one half feet and the marl is somewhat shallower, eight to ten feet in thickness. The slopes to the lake are very steep and operations would be difficult.

Sample # 1030. Analysis 81.36 %

On the extreme west end of Stony on the north side of the outlet channel S.W.¼ of S.W.¼ Sec. 32 is a small pocket of marl that crops out in the valley side. There is practically no surface cover but the marl is not very thick, two to three feet and underlaid with sand. Probably not more than a dozen loads could be obtained from the deposit and consequently it is of little significance.

Sample # 1031. Analysis 81.96 %.

OCEANA COUNTY ____ SHELBY TOWNSHIP

T. 14 N. R. 17 W.

Marl Survey by S.G.Bergquist and A. W. Bergquist

General Description.

Shelby township lies almost wholly within an area of somewhat rugged moraine. A narrow strip of sandy outwash with a northwest-southeast trend cuts across the township near the northeast corner.

The soil is generally quite light in texture ranging from sands and loamy sands thru to sandy loams with local small patches of clay.

The drainage is very well developed. There are no large rivers or streams in the area altho on the west side of the township several small creeks, tributaries to Stony Creek in Benona, find their headwaters in the sandy morainic hills.

There are scarcely any lakes and relatively few swamps in the region. Consequently, marl is not found very extensively and the deposits are quite limited in number.

Marl Deposits.

Class A.

An excellent small deposit of marl was located in a dry marsh just a few rods west of M-11 in the S.E.¼ of N.W.¼ Sec. 20. A surface of one to two feet of muck covers the marl which averages from five to seven feet in thickness. Facilities for excavating, storing and hauling are extremely good.

Sample # 1022. Analysis 91.16 % Fred H. Moore.

Class C.

Marl in small pockets and with a thickness of five feet occurs in a small, brush covered swamp, S.W.¼ of S.W.¼ Sec. 6, extending into N.W.¼

of N.W.¼ Sec. 7. The marl is not persistent in the area and where found is usually covered with four to five feet of muck.

Sample # 1021. Analysis 83.44 %.

Unclassified.

In a small swamp situated between M-11 and the Pere Marquette tracks in the S.W.¼ of N.E.¼ Sec. 29 is found a bed of marl with a thickness of ten and more feet and a cover of muck and peat ranging from five to seven feet deep.

OCEANA COUNTY --- FERRY TOWNSHIP

T. 14 N. R. 16 W.

Marl Survey by S. G. Bergquist and A. W. Bergquist.

General Description.

On the west side of Ferry township is a belt of sandy moraine quite hilly in relief. It extends from Hart township south thru the northwest corner of Ferry and widens out to include the southwest half of the area. Another strip of moraine made up largely of sand and with an undulating surface cuts thru from the north into the center of the township terminating just north and east of the village of Ferry. A narrow belt of sandy outwash, confined between the two morainic limits, extends from near the northwest corner across to the southeast corner to connect up with the sandy plains of Otto and Greenwood townships. A second strip of outwash continues north and east from the village of Ferry thru the middle of the township and extends into the sandy plains of Newfield. Small patches of sandy to clayey till plains are found in the northeast and southeast corners of the township. These areas range in relief from rolling in the north to fairly level in the south.

The drainage is largely thru the north branch of the White River and its various tributaries and mostly to the south.

Lakes are found scattered thru various parts of the township but for the most part they are rimmed with margins of muck and peat and are not very important as sources of marl.

The swamps as a rule are mucky and underlaid with sand. They seem to be confined mainly to the stream courses where in places they contain extensive beds of marl.

Marl Deposits.

The majority of the commercial marl beds of Ferry township were formed in creeks and rivers and now occur either in the upland terraces as dry deposits or in the present low bottoms as wet deposits.

Some marl, of course, is found in certain of the lakes and swamps but these deposits are not of such great importance as those just mentioned.

Class A.

On the north side of the north branch of the White River in the N.W.¼ of the S.E.¼ Sec. 13, is a small deposit of upland, dry marl ranging in thickness from two to five feet. The surface cover is quite negligible, rarely exceeding a foot..

Roads are poor in this region and hauling would be difficult altho conditions for operations are good.

Sample # 1012. Analysis %. John Skinner.

In about the center of section 24 on the upper terraces along the south side of the north branch of White River is an upland, dry deposit several acres in extent. The marl varies somewhat in depth and color, ranging from three to seven feet. It is covered with muck and sand to a depth of six inches to three feet.

The area is surrounded by rather high hills with no good roads leading to it. Facilities for operation however are very good.

Sample # 1012b. Analysis %. J. Parenta, S.W.¼ of N.E.¼
L. Wheeler, S.E.¼ of N.W.¼
G.B.Anderson, N.W.¼ of S.E.¼

Marl in quite extensive quantities, occurs in an upland, marshy area along Robinson Creek in the N.W.¼ of N.E.¼ Sec. 21. The deposit

is fairly dry, at least to a depth of several feet and lies adjacent to M-14, a good gravel road one and one half miles north of Ferry. The marl varies from four feet thick near the road to ten feet and more along the creek. It is overlaid with a surface of one to two and one half feet of muck and underlaid with a very plastic blue clay. The facilities for machine setting and other operations are ideal.

Sample # 1013. Analysis %. L. W. Powers.

Along the west bank of Robinson Creek in the S.W.¼ of S.E.¼ Sec.16, marl occurs quite abundantly in a marshy area that is fairly well drained. This bed is continuous with the Powers' bed and contains marl ranging from eight to twelve feet thick. One to two feet of peat forms the surface cover while the entire deposit is underlaid with plastic clay. The area lies adjacent to M-41 and is bordered on the west side by high ground with excellent facilities for machine operation. Some marl has been removed.

Extreme care should be excercised in excavating not to penetrate the underlying clay which looks so much like the marl but forms a hard crust upon drying out.

Sample # 1014A. Analysis %. C. O. Jordon.
Sample # 1014B. Analysis %. Frank Mallison.

In a dry marsh that crosses the road a short distance west of M-41 in the N.E.¼ of S.W.¼ and extending into the N.E.¼ of N.W.¼ Sec. 21, marl ranging in thickness from six to ten feet occurs below a cover of one to four feet of muck. The deposit is underlaid with sand and very well drained thruout.

Sample # 1015. Analysis %. Herman Smith.
Jake Kidner.

Class B.

In the S.W.¼ of S.W.¼ Sec. 16 several rods south of Robinson Creek is a fairly dry upland swamp in which marl to a depth of two to six feet is found under a cover of one to two feet of muck. The marl is not very uniform, being highly mottled in places and in others impregnating a brownish silty material. The area is small and the amount of marl quite limited.

Sample # 1016A. Marl -- Analysis %.
Sample # 1016B. silty substance -- Analysis %.
G. W. and C. E. Milliman.

Class C.

Landon Lake in the N.W.¼ of N.W.¼ Sec. 21 has a marginal rim of deep muck and peat. In the water margin around the shore, marl with an extremely high water content and of a soft nature was sounded to depths of fourteen feet and more. It is possible that the marl in this lake would be pumped out conveniently.

Sample # 1017. Analysis %. G.W.and C.E.Milliman.

Some marl was found around the margin of Bear Lake in the N.E.¼ of S.E.¼ Sec. 31. The area surrounding the lake is very swampy and wet with peat and muck to a depth of four to seven feet. The underlying marl is ten and more feet deep. There are no roads within half a mile of the lake and the area is quite inaccessible.

Sample # 1018. Analysis %.

In the mucky bottom area of Robinson Creek along M-41 W.C. of S.E.¼ Sec. 16, marl occurs in somewhat limited amounts under a cover of three to seven feet of muck and peat. Near the road the marl is

twelve to fourteen feet in depth but peters out entirely some distance away from the road and gives way to muck and sand.

Sample # 1019. Analysis %.

About a quarter of a mile north of the road, in a marshy swale, S.E.¼ of S.E.¼ Sec. 16, is found a deposit of marl varying from two to seven feet thick and with a surface cover of three feet of muck. The area is covered with stumps, is very wet and quite inaccessible.

Sample # 10120. Analysis %. Eli Near.

Unclassified.

Some marl was found under five feet of peat around the margins of a swamp located on the section line in the S.W.¼ of S.W.¼ Sec. 15 extending into the S.E.¼ of S.E.¼ Sec. 16. The interior of the swamp was largely muck and peat to the bottom.

About a foot and a half of marl under one to two feet of muck was found along the bottom of the north branch of the White River just west of Shallow Lake in Secs. 13 and 18. The area is small and the mud limited in quantity.

OCEANA COUNTY ___ NEWFIELD TOWNSHIP

T. 14 N. R. 15 W.

Marl Survey by S. G. Bergquist and A. W. Bergquist.

General Description.

The eastern half of Newfield township lies largely in an undulating morainic belt made up of a soil that runs in patches of sand and clay in approximately equal proportions. A strip of sandy to gravelly outwash borders the moraine to the west and swings around to the southeast corner. The relief of the outwash plain ranges from somewhat level into undulating. In the west central portion of the township is a small isolated patch of undulating moraine that terminates to the south in a belt of till plain that continues westwardly into Ferry township.

The drainage is principally thru the north branch of White River which headwaters in the McLaren chain of lakes and flows west across the two northern tiers of sections. White River, flowing south across the southeast corner, takes care of a limited amount of the drainage in that area. Lakes are quite numerous and except for those in the northeast, which are marliferous, they are essentially mucky and muddy bottomed.

Swamps are also well scattered thru the area and occasionally are sources of marl but as a rule they contain a layer of muck and peat with a substratum of sand and gravel.

Marl Deposits.

Marl is present in many areas of the township and is associated with swamps and lakes almost entirely in wet deposits.

Class A.

On the county line in the S.E.$\frac{1}{4}$ of S.E.$\frac{1}{4}$ Sec. 24 is a fairly

dry sedge marsh with a surface layer of peat three to four feet deep below which there is a bed of marl that ranges from three to eight feet in thickness. The deposit lies close to a good road and is readily accessible.

Sample # 1051. Analysis 84.36 %.

The largest deposits of marl and those of the greatest commercial value are located in and along the margin of McLaren Lake and the numerous lakes and swamps adjoining.

On the southeast shore of McLaren Lake in the N.W.¼ of N.E.¼ Sec. 12 is a marginal rim of marl that extends a few rods in on the land and about an equal distance out into the water. Soundings made in the water near shore showed a depth of fifteen feet of marl, quite uniform all the way down. A slight odor of hydrogen sulfide was observed in the marl at various depths.

Sample # 1053. Analysis 92.60 %. Willis Ackley.

In the swamp extending to the west from County Line Lake in the E. C. of N.E.¼ Sec. 12 is a fairly dry deposit with seven to ten feet of marl below a cover of two feet of peat. The swamp crosses the county line road and lies in a position that would make the marl readily accessible.

Sample # 1054. Analysis 84.04 %.

In a dried up basin in the N.E.¼ of the N.E.¼ Sec. 12 and extending into the S.E.¼ of the S.E.¼ Sec. 1 not more than sixty rods east of McLaren Lake, marl ranging from seven to ten feet in thickness occurs beneath a cover of a foot or two of peat. The area is heavily

Wooded and the surface peat is penetrated with an exceedingly dense root mat. The deposit lies adjacent to a good road and is quite accessible.

Sample # 1055. Analysis 86,16 % Willis Ackley.

The shore margin of Mud Lake in the S.E.¼ of S.E.¼ Sec. 1 is generally quite mucky and wet. One to two feet of muck covers a deposit of marl that has a thickness exceeding ten feet. The marl extends as a rim into the water of the lake to a depth of fourteen and more feet and with no surface cover. This area lies almost on the county line and very near to a good road.

Sample # 1056. Analysis 90.44 %.

Along the margin on the north end of McLaren Lake, in the center of the N.E.¼ Sec. 1, the marl is very deep. Soundings were made to a depth of sixteen feet and bottom was not reached. Owing to the fact that the lake level has been lowered several feet in recent years, a rather wide rim of former shelf has become exposed. The upper few feet of this land deposit is ordinarily quite dry but below the lake level, the marl is fairly saturated with water. In all places where examined, the marl around McLaren Lake appears to be quite uniform in color and quality with depth. The marl in this area is very accessible and excellent facilities for machine setting and storage make it possible to work out large quantities at fairly reasonable expense. A slight odor of hydrogen sulfide was observed in the upper few feet of marl.

Sample # 1057. Analysis 92.28 %. A.S.Stowers.

On the north end of Cedar Lake in the N.E.¼ of N.E.¼ Sec. 1, some marl is found at a depth of two to five feet below the surface. Along shore the marl is dark in color and apparently poor in quality. The deposit is fairly deep, twelve feet and more.

Sample # 1058. Analysis 90.16 %. A.S.Stowers.

Borings made on the west side of McLaren Lake, S.E.¼ of S.W.¼ Sec. 1, showed the marl here to be quite deep. On the land margin the bed is twelve feet deep and increases to eighteen feet and more in the water. Away from the marl border, the shore is high and sandy and affords excellent facilities for machine operation and storage.

Sample # 1059. Analysis 86.16 %. A.L.Mills.

In the outlet near the S. W. end of McLaren Lake in the center of the N.E.¼ Sec. 11, the marl is eight to twelve and more feet in depth. It extends in on the shore margin for several rods and is exposed to the surface.

Sample # 1060. Analysis 82.50 %.

On the higher land, back from the water's edge on the south shore of McLaren Lake, N.E.¼ of S.W.¼ Sec. 12, the marl is fairly dry to a depth of three and four feet. Below this depth the deposit is wet. The marl on shore varies from five to eighteen feet in depth, increasing towards the present shore line. The peat cover average is about two or three feet in thickness. The area lies near a good gravel road and facilities for operation are excellent.

Sample # 1061a. Analysis 84.64 %.

The marl along the present margin on the south end of McLaren Lake in the S.W.¼ of N.W.¼ Sec. 12 has a thickness of ten to twelve feet. A rather wide rim of marl with no cover is exposed on shore. The material appears to be quite uniform with depth both in color and in quality. A slight odor of hydrogen sulfide was noticed and especially in the surface layer.

Sample # 1061b. Analysis 91.08 %.

In the marshy border on the south end of McLaren Lake, S.C. of N.W.¼ Sec. 12 and extending across the road into the S.W.¼ of the same section the marl has a thickness of eight to ten feet and is overlaid with about two feet of muck. The area is fairly dry to a depth of four and five feet and wet below. The deposit is so located, on a good gravel road, as to be readily accessible and easily available.

Sample # 1061c. Analysis 83.72 %.

In a fairly high swampy area bordering Newell Lake to the west, S.E.¼ of N.W.¼ Sec. 11, is a deposit of marl four to six feet deep with a muck cover that varies from zero to four feet in thickness. The peat is negligible in the center of the area but thickens appreciably towards the edges. A sandy upland area adjoins the marl body to the west and would afford excellent facilities for machine operation and storage. A good gravel road passes along the south edge of the swamp thus making the deposit readily accessible.

Sample # 1062. Analysis 90.16 %. Lea Scott.

Near the outlet on the west end of Second Kennedy Lake, N.E.¼ of N.W.¼ Sec. 11, marl is present both on the land and in the water. On

the land area the deposit has a depth of six to eight feet while in the lake it reaches a depth of twelve and more feet. There is practically no cover on the marl and facilities for operation are very good. Some marl has been removed along the lake margin by means of a clam shovel.

Sample # 1064. Analysis 86.44 %. Tom Kennedy.

Except for the south end no commercial quantities of marl are available, the other borders of Second Kennedy Lake being largely mucky.

Some marl is present in the floor of the outlet for several rods west of Second Kennedy Lake but this changes to sand and clay on approaching Mud Lake in the N.W. corner of Sec. 11.

Mud Lake has a mucky margin practically all the way around and only small patches of marl of no commercial importance are found.

Marl to a depth of twelve feet and in places deeper and with a surface of one to three feet of peat is present in the swamp on the north end of Butternut Lake, N.E.¼ of S.E.¼ Sec. 2. The area is quite wet, the water table being within a few inches of the surface, and is grown up to a dense stand of underbrush.

Sample # 1066. Analysis 84.08 %.

Dry beds of upland marl occur along the northwest and west borders of Darlington Lake in the N.E.¼ of S.W.¼ Sec. 10. The deposits are rather shallow, two and three feet and are covered with a few inches of sand. The marl is of good quality but is interbedded with thin seams and small pockets of sand. Some material has been removed along the

road which passes thru the edge of the area.

Sample # 1069. Analysis 79.68 %.

Class C.

In the headwater swamp of a small stream in the S.E.¼ of the S.W¼ Sec. 21, marl occurs as a marginal deposit with a thickness of ten and more feet under a cover of three to seven feet. Towards the center of the area the peat surface thickens to twelve feet and more and the marl is negligible in quantity. A dense growth of underbrush covers the surface of the swamp and makes it difficult of access.

Sample # 1052. Analysis 82.52 %

On the east end of First Kennedy Lake near the channel from McLaren Lake, N.E.¼ of N.E.¼ Sec. 11 is a limited area of marl with a depth of ten to twelve feet and no cover. The material is quite inaccessible and in such small quantities as to make it of no commercial importance.

Sample # 1063. Analysis 92.32 %. Tom Kennedy.

The other borders of the lake are mucky and contain no marl to speak of.

Marl is present in the floor of the channel connecting First Kennedy and McLaren Lake, in places reaching a depth of eight to ten feet.

Marl of a dark color and apparently of poor quality borders the north shore of Butternut Lake in the N.C. of S.E.¼ Sec. 2. There is no surface cover and the material reaches a depth of twelve and more

feet.

Sample # 1065. Analysis 85.20 %.

The south side of the lake is rimmed with a mucky shore and no marl is present.

A rather poor deposit of marl is found in the swampy area on the east end of Newell Lake in the N.W.¼ of S.E.¼ Sec. 11. A surface of three to five feet of peat and muck covers the marl that extends down to a depth of ten and more feet. In the lake margin soundings were made to a depth of twelve and fourteen feet in the marl but bottom was not reached.

Sample # 1067. Analysis 88.04 %.

This deposit, if found isolated and in some other area would undoubtedly be classed under A. In comparison with the other A. deposits of this region however, it is so poor that it was placed in Class C.

The marshy margin of Darlington Lake in the N.E.¼ of S.W.¼ Sec.10 has a surface of six to eight feet of muck and peat often of a marly nature. Below this cover marl occurs to a depth of twelve to fourteen and more feet. The marl is somewhat brownish in color and undoubtedly is of poor quality.

Sample # 1068. Analysis 92.88 %.

A small deposit of marl is located in the marshy area along White

River in the S.E.¼ of S.W.¼ Sec. 3. A surface of four to ten and more feet of peat and muck covers the area which is largely grown up to sedges and marsh grass. The marl is variable in thickness ranging from merely a few inches up to twelve feet.

Sample # 1070. Analysis 62.84 %.

On the east end of Shallow Lake along the flooded marshy bottoms of the north branch of White River in the N.E.¼ Sec. 18 and S.W.¼ Sec. 8. Marl ranging from five to twelve and more feet is present beneath a cover of four to seven feet of muck and peat. The area is covered with dead trees and fallen timber and so far from roads as to make it an impossible operation for marl.

Sample # 1071. Analysis 91.64 %.

OCEANA COUNTY ___ CLAYBANKS TOWNSHIP

T. 13 N. R. 18 W.

Marl Survey by S. G. Bergquist and A. W. Bergquist

General Description.

The greater portion of Claybanks and particularly the area thru the middle of the township from the northeast to southwest, lies in a morainic belt of fairly heavy clay soil. In the northwest corner is an isolated and small area of sandy to clayey lake plain which merges into the sand dunes that border Lake Michigan in that section. A small patch of sandy outwash extends into the east-central part and connects up with a narrow arm of clayey till plain in the south-central part of the township.

The relief is generally quite level except in the northeast section where it is broken up into a series of hills and there assumes a rolling attitude.

The drainage is to the south, mainly thru Flower Creek and its tributaries into White River. There are relatively few lakes and scarcely any swamps in the township, most of the area being well drained.

Marl Deposits.

There are no marl deposits of any great commercial importance in Claybanks township. Only one bed worthy of classification was located and this one on the farm of Will Stevens in the N.E.$\frac{1}{4}$ of N.W.$\frac{1}{4}$ Sec. 13 along the bank of a small creek was grouped into a Class A deposit. The marl in this area is to be found only in patches and does not persist thruout the entire lowland. In places there is a surface cover of seven and more feet of peat with no marl below. Then again, the cover is only one half foot with a range up to four feet with seven

to twelve feet of marl below. This deposit lies partly on fairly high, well drained upland but mostly in the wet, undrained lowland. It is sufficienly near upland borders to allow good storage facilities after being dug and is situated close to a good road so that transportation would not be difficult.

Sample # 1000. Analysis 46.20 %.

Unclassified.

At the mouth of Whiskey Creek in the southwest corner of Sec. 8 is a small dry deposit of very limited extent. The marl here seems to be concentrated in a single pocket not sufficiently extensive to be commercialized. Some material has been taken out for local use and not more than a dozen good loads remain.

OCEANA COUNTY ____ GRANT TOWNSHIP.

T.13N. R.17W.

Marl Survey by S.G.Bergquist and A.W.Bergquist.

General Description.

The greater portion of Grant township lies within an area of sandy outwash plain that extends eastwardly into Otto township. A small extension of sandy moraine borders the plain to the north and constitutes practically one fifth of the entire area.

The topography in the northern morainic section is somewhat hilly while in the outwash plain the relief is generally quite level but with a tendency to become undulating in places.

The soil thruout is of a light sandy nature interspersed locally with small patches of a light phase of clay. As a whole the agricultural possibilities are limited almost exclusively to horticulture.

The drainage is mainly thru Carlton Creek which flows south thru the middle of the township and the smaller Mud Creek which flows south from Mud Lake thru the east side of the township.

Lakes are quite numerous and seem to be concentrated largely in the central portion of the township. They are poorly drained and bordered with margins that are usually wet and swampy. The lake bottoms are, as a rule, mucky and soft and marl does not occur in them in large proportions.

The swamps are mainly of muck and peat and are underlaid with sand and gravel. Marl is found locally and in limited amounts in them.

Marl Deposits.

Altho marl occurs to some extent in the lakes and their associated marshy margins, by far the most extensive beds are those in the upper

terraces of Mud and Cushman Creeks.

Class A Deposits.

In the N.W.¼ of N.W.¼ Sec. 21, and extending into the N.E.¼ of N.E.¼ Sec. 20 on the margin of Little Wildcat Lake is a marshy area with a surface cover of one to two feet of muck and marl below to a depth of twelve and more feet. The muck thickens towards the outer edges of the marsh and reaches a thickness of three to six feet. Trees are quite abundant and the undergrowth dense. This deposit lies adjacent to a fairly good road and is readily available.
Sample # 1002. Analysis 89.04 %. Lawson.

Along the channel between Little and Big Wildcat Lakes in the S.C. of S.E.¼ Sec. 17 is a marshy area heavily grown up to trees and underbrush. Marl to a depth of twelve to fourteen and more feet with a surface cover of one to two feet of muck makes up the deposit. It lies near a good road and is quite accessible.
Sample # 1003. Analysis 89.08 %.

Marl in quite extensive quantities is found along the course of Mud Creek all the way from its headwaters in Mud Lake to its confluence with Carlton Creek on the county line. Most of the marl in this area is of the upland type and is concentrated in local beds somewhat widely separated. As a rule the deposits are not very thick, scarcely exceeding five or six feet with a cover of sand that is in most cases negligible.

In the S.E.¼ of the S.W.¼ of Sec. 36 is an area of upland marl somewhat distant from the present Carlton Creek but undoubtedly formed when its waters overflowed this area. The deposit varies from

four to six feet in thickness and is overlaid with four to six inches of sand. Below the marl is a layer of sand which in places has developed into a hardpan structure. This is one of the finest dry beds in Oceana county and has been in operation several years. It is situated in the sand plains and located on a sand road about three miles east of paved M-11. Conditions for operation are excellent and the marl readily accessible.

Sample # 1009A. Analysis 96.72 %. John Carlton.

A few rods north of the John Carlton bed and along the bed of Mud Creek, N.W.¼ of S.W.¼ Sec. 36, is a similar deposit of upland, dry marl. The marl in this area extends across the creek and in places forms its bed. A surface of a foot or so of sand covers the deposit which varies from four to twelve feet in thickness. The material is extremely accessible and could be readily removed.

Sample # 1009B. Analysis 81.40 %. J. W. Kershaw.

About a half mile south of Mud Lake in an upland terrace of Mud Creek, S.E.¼ of S.W.¼ Sec. 24 is a deposit of dry marl ranging in thickness from four to six feet. The surface cover is mainly of sand and is almost negligible, having a thickness of three to twelve inches. The deposit lies in the sand plains about an eighth of a mile north of a good sand road, is very accessible and easily worked. Some marl has been removed from the area.

Sample # 1009C. Analysis 88.88 %. John Pouloski.

On the north end of Mud Lake in the N.E.¼ of the N.W.¼ Sec. 24 is an upland deposit of marl that is fairly dry. In this area the

marl is relatively thin around the edges, two to four feet but thickens to eight feet and more towards the center. The peat cover varies from one to four feet, being shallowest where the marl is deepest. The bed is underlaid with sand which in places has developed into a hardpan layer. The marl in this deposit is continuous with the marginal deposit surrounding Mud Lake which is very wet. A fairly good road traverses the deposit thus making the marl quite readily accessible.

Sample # 1009D. Analysis 85.88 %. Mrs. M. Wagner.

In the east central portion of the N.W.¼ Sec. 27 and extending on both sides of Carlton Creek is an upland deposit of fairly dry marl. The marl, which ranges from two to four feet in thickness is white near the surface and assumes a bluish color at a depth of two feet. The cover is quite negligible and consists of six to twelve inches of muck and sand. The deposit is very accessible and could very easily be worked. Some material has already been taken out for local use.

Sample # 1010A. Analysis 70.48 %. Steve Zielinski.

Class B.

In the south central portion of the N.W.¼ Sec. 18 is a small deposit of upland marl averaging three feet in thickness and with a surface cover of ten to fourteen inches. A dense growth of willows covers the area on the south side of the road while on the north side it is fairly open. The bed is on a good gravel road, is readily accessible and could be worked very easily.

Sample # 1011. Analysis 47.36 %. Geo. Pranger.

Class C.

In the S.E.¼ of the S.W.¼ Sec. 7 and extending eastward into the S.E.¼ is a marshy area that is fairly heavily wooded and full of stumps. Around the edges the peat is seven and more feet thick with marl in places reaching a thickness of two and three feet. Towards the center of the marsh the marl has a thickness of twelve and more feet but the overburden is still thick, ranging from five to seven feet. In the east half of the area marl seems to be absent and the layer of surface peat rests directly upon the sandy bottom.

Sample # 1001. Analysis 78.56 %. A.A.Sebring.

Lake 16 in the northern portion of the N.W.¼ Sec. 16 is rimmed with a marshy margin of peat and muck of variable depths with a bed of marl below. In the outlet channel of the lake the overlying peat has a thickness of four feet with marl to a depth of twelve and more feet below it.

At the north end of the lake the peat is three feet thick, on the west side it is five to seven feet while on the east side it is seven feet and more in thickness. In all of these places the marl was sounded to depths of ten and twelve feet. On the south end of the lake there appears to be no marl and the peat which is three and more feet deep rests upon a sand bottom.

This deposit is a rather poor prospect owing to the thickness of the overburden and the marshy character of the surface.

Sample # 1004. Analysis 91.24 %.

In the north central part of the S.E.¼ Sec. 12 is an extensive swamp and marshy area surrounded largely by sand hills. The marl seems to be concentrated mostly along the edges of the swamp and is not

continuous as a bed. It has a thickness of ten and more feet and is covered with two to four feet of peat and muck. In the marshy extensions of the swamp the surface layer of peat reaches a thickness of ten and more feet and little or no marl is found below.

Sample # 1005. Analysis 83.28 %.

To the west of this swamp is a similar area of low lying undrained land S.C. of N.W. Sec. 12, where some marl is found below a layer of five to seven feet of peat. No sample was taken.

In the drainage channel between Lake 16 and Bunker Lake, N.W.¼ of S.E.¼ Sec. 16, marl is found in varying thicknesses below a layer of peat that also varies somewhat. On the west side of M-11 the cover is three to four feet deep and the marl below has a thickness of twelve and more feet. On the east side of M-11 the peat thickens to seven feet in places and the marl thins out entirely altho for the most part it ranges from six to ten feet in thickness. The area as a whole is marshy and wet and is grown up quite extensively to underbrush and small trees.

Sample # 1006. Analysis 82.28 %.

The margin of Mud Lake in the N.W.¼ Sec. 24 comprises a narrow rim of marshy and wet lowland quite heavily wooded and with a dense undergrowth. On the west side of the lake the muck and peat cover is from three to five feet in thickness and the underlying marl averages about twelve feet. On the east side, the peat is not more than three feet thick and the marl has a range from six to eight feet except on the higher terraces where the cover runs to seven feet and the under-

lying marl is slightly more than two feet deep.

Sample # 1007. Analysis 90.28 %. Ernest Krause.

In the marshy flats at the confluence of Mud and Carlton Creeks in the S.W.¼ of S.W.¼ Sec. 36 and extending into the S.E.¼ of S.E.¼ Sec. 35, marl of a dark color and apparently poor quality is found to a depth of twelve and more feet under five and six feet of cover. The area is extremely wet and difficult of access.

Sample # 1009e. Analysis 69.36 %. A. P. Gilbert
J. Kershaw

A small isolated swampy area near Carlton Creek in the S.E.¼ of N.W.¼ Sec. 27 contains a limited quantity of marl. The bed has a thickness of three to six feet, is covered with a foot of muck and underlaid with sand. The deposit is quite wet but readily accessible as it lies adjacent to a good sand road.

Sample # 1010b. Analysis 72.40 %. Russel Monroe.

OCEANA COUNTY _____ OTTO TOWNSHIP

T. 13N. R. 16W.

Marl Survey by S. G. Bergquist and A. W. Bergquist.

General Description.

Otto township comprises an area made up almost entirely of sandy outwash plain. With the exception of a very small extension of hilly moraine in the extreme northwest portion, the topography in monotonously level. The soil is uniformly sandy thruout and of such a texture and quality as to make it unsuited to any type of agriculture. Jack pines and scrub oaks have gained an almost exclusive foothold in the light sand and constitute the greater portion of the vegetative cover.

There are relatively few lakes in the township and those that are present are small and usually bordered with swamps of a mucky nature. The drainage is principally to the south with Sand Creek on the west side and the north branch of White River on the east discharging their waters into the White River which flows westward thru the southeast corner of the township. Swamps and marshes are not very numerous and where found have generally a few feet of muck or peat cover and a substratum of sand.

Marl Deposits.

Marl is very scarce in Otto township and only a few Class C. deposits were located.

In the N.W.$\frac{1}{4}$ of the N.W.$\frac{1}{4}$ of Sec. 30 on the west end of Fogg Lake is a rather extensive meadow marsh of fairly open character. A surface cover of peat to a depth of three to five feet is every where present over the underlying marl which in places exceeds ten feet in thickness. The roads in this vicinity are very poor and in places almost impassible.

This factor coupled with the excessive cover would make the deposit a difficult one to operate.

Sample # 1008. Analysis 40.68 %.

Around the borders of Cedar Lake S.W.¼ Sec. 16 and Blackman Lake N.W.¼ Sec. 21 is found a narrow rim of swampy ground with a cover of muck and peat that ranges from three to six feet. Below this is a layer of marl three to eight feet thick. The lake bottoms are deeply silted and show no evidence of marl in the horizon above ten feet. To the east of the lakes is a large, well drained marsh with an open sedge cover. A shallow layer of muck with sand below make up the section in this area. It would be almost impossible to get the marl out here on a commercial basis owing to the heavy marginal forest cover and the marshy character of the shore. The marl is found only in limited amounts which would not warrant attempts to remove it.

No sample was taken of the marl in this deposit.

OCEANA COUNTY ___ GREENWOOD TOWNSHIP

T. 13N. R. 15W.

Marl Survey by S. G. Bergquist and A. W. Bergquist

General Description.

The sandy outwash plain that characterizes the surface of Otto township continues eastward into Greenwood and constitutes the greater portion of the area of this township. The plain is bordered on the east edge by a small section of moraine to the north which merges into a till plain to the south. The outwash area is predominantly sandy and for the most part the soil is of such a light phase as to be of no agricultural value. The soil of the morainic and till plain areas on the east side is somewhat heavier and ranges from loamy sands thru to sandy loams and clays of a light phase. This portion of the township is well adapted to agriculture and is productive of fairly good crops. The topography as a whole is monotonously level and featureless except for local undulations in the northeast corner.

The drainage is principally to the White River which flows south thru the northwest portion of the township. Small streams flowing north on the south side of White River enter it at intervals. There are no lakes of any extent in the township and those that are found are largely of the mud-hole variety. Swamps and marshes are confined almost exclusively to that portion along Cushman Creek, south of the river and well to the east. As a rule, the lowland areas contain shallow muck and peat and are underlaid with sand or clay.

Marl Deposits.

Marl in quite large quantities is found along the course of Cushman Creek. The creek itself flows mainly over a sandy floor and

only in a few places does it widen out into swampy areas. Very little marl is found in the present creek bottoms but in many of the higher terraces, marl is concentrated in somewhat extensive but shallow deposits. These higher marl beds are generally dry and well drained, easily worked and readily accessible. As a rule, the marl in these areas does not run very thick -- ranging from three to five feet.

Class A Deposits.

In the S.W.¼ of S.E.¼ Sec. 28 is a wet, sedgy marsh of five or six acres. A surface of two feet of peat covers a marl deposit that ranges in thickness from five feet along the margins to twelve feet and more toward the center. The marsh is located near the intersection of two good roads which would make the marl readily accessible.

About a hundred yards have been removed from the south end of the area.

Sample # 1036 Analysis %. Frank Patten
Chas. Zimmerman

On an upland terrace of Cushman Creek but quite removed from the present channel S.W.¼ of S.E.¼ Sec. 15 and extending south into the N.W.¼ of N.E.¼ Sec. 22 is an excellent deposit of dry marl. The marl ranges from three to ten feet in thickness and is covered with about six inches of sand. A portion of the bed lies on the north side of a good road where some marl has been removed; but by far the most extensive portion lies south of the road and has as yet not been touched. The marl in this area is very accessible and conditions for removal are exceptionally good.

Sample # 1037. Analysis %.

In the S.E.¼ of S.E.¼ Sec. 22 along the east bank of Cushman Creek is a lowland area, quite swampy and wet. Two feet of peat covers a bed of marl that ranges from five to ten and more feet in thickness. The deposit lies along a good road and is readily accessible.
Sample # 1039. Analysis %. Ernest Sears.

About a quarter of a mile north of Lost Lake in the S.C.portion of the N.W.¼ Sec. 22 is an upland bed of dry marl quite remote from any passable roads. The marl is in a deposit ranging from three to five feet in thickness and has no surface cover. Some material has been removed from this deposit over winter roads by means of sleighs. Summer hauling from this area would be impossible.
Sample # 1040. Analysis %.

In N.C. of S.W.¼ Sec. 22 on the west shore of Lost Lake is an upland, dry marl deposit located about ¼ mile from a poor sand road. The marl ranges in thickness from four to seven feet with a surface cover of less than a foot. The marl increases in depth at the lake margin but becomes very wet and somewhat darker in color.
Sample # 1041. Analysis %. John Osterman.

The west half of section 23 is occupied largely by an extensive swamp that is heavily wooded and difficult to penetrate. Marl is found in this area in varying quantities under one to five feet of peat. Around the borders, the marl is five to six feet deep and increases in thickness in patches toward the center of the swamp. The region is very wet altho near the outer edges it would be possible to find storage facilities on upland areas. The marl does not appear to be of

exceptionally good quality, for the most part being dark gray to brownish in color. Until some of the timber is removed, the deposit will not be accessible.

Sample # 1043 from the S.W.¼ of N.W.¼ Sec. 23 is representative of the marl from the margin of the swamp.

Analysis %. W.S.Clark.

Class B Deposits.

In the N.E.¼ of N.E.¼ Sec. 27 and extending into the N.W.¼ of N.W.¼ Sec. 26 on the north bank along Cushman Creek is an upland deposit of dry marl about two thirds of which has been removed. The formation lies close to a good gravel road and is easily accessible. The marl averages about three feet in thickness and has a cover not exceeding six inches. The material in this bed could readily be removed by means of a scraper.

Sample # 1034. Analysis %.

Class C Deposits.

In the S.W.¼ of S.W.¼ Sec. 24 along the bank of a tributary to Cushman Creek is a soggy but not extremely wet area where the marl occurs in patches only. The surface peat cover ranges from three to eight feet in thickness with an underlying marl deposit that varies from zero to twelve and more feet. The marl does not cover a sufficient area to make the deposit of very great commercial value.

The present stream bottom contains shallow muck with sand below.

Sample # 1033. Analysis %.

A small isolated sedge marsh, fairly dry on top but with the

water table quite near the surface, situated in the N.E.¼ of N.W.¼ Sec. 28 has a layer of two to eight and more feet of marl below a cover of two to three feet of peat. The marl is of a brownish color and of the colloidal variety. It probably runs quite low in lime content.

Sample # 1035. Analysis %.

On the east bank of Cushman Creek in the S.E.¼ of S.E.¼ Sec. 22 is an upland terrace deposit of dry marl. Six inches of sand covers a bed of two to eight feet of a highly mottled marl. A great deal of the marl has been removed from this area and a relatively small amount remains.

Sample # 1038. Analysis %. R. W. Hawkins.

In the N.E.¼ of N.W.¼ Sec. 26 on the south border of the extensive swamp that runs into Sec. 23 and along the bank of Cushman Creek, is a heavily wooded, swampy area where the marl attains a depth of ten and more feet. The surface peat cover ranges from two to seven feet and is very wet. The marl is dark in color and is a good example of that which is found under the deeper peat thruout the swamp. Owing to the heavy timber that covers the area and the relatively high water table, it would be difficult to remove the marl except at great expense.

Sample # 1042. Analysis %. J. Veenstra.

Unclassified Deposits.

In the N.W.¼ of S.W.¼ Sec. 27 on the S. end of a dried up lake is found a thin seam of marl, one to two feet, under three to seven feet

of peat.

No sample .

In the S.W.¼ of S.W.¼ Sec. 24 is a small swale in which the peat cover runs from three to four feet and the marl below up to six feet in thickness.

No sample.

PART IV.

MAP OF OCEANA COUNTY, MICHIGAN

INDICATING THE

DISTRIBUTION OF MARL DEPOSITS.

MICHIGAN
STATE HIGHWAY DEPARTMENT
LANSING

Marl Deposits
Oceana County

2-A-26

ROAD MAP OF OCEANA COUNTY

SUMMIT
LOGAN
MASON
RIVERTON
EDEN
COUNTY
PENTWATER
CRYSTAL
COLFAX
GOLDEN
HART
ELBRIDGE
LEAVITT
BENONA
SHELBY
FERRY
NEWFIELD
CLAY BANKS
GRANT
OTTO
GREENWOOD
R18W
MUSKEGON
R17W
R16W
R15W
COUNTY
T16N
T15N
T14N
T13N
Bass Lake Park
Bass Lake
Pentwater
Pentwater Lake
Pentwater River
N. Br.
Cedar Cr.
Crystal River
Crystal Valley
Ruby Cr.
School Sec. L.
Walkerville
Gilbert L.
Island L.
Kirk
Round L.
Elbridge
Holton
Mears
Silver Lake
Crystal L.
Campbell L.
Little Campbell L.
Rolson L.
McLaren L.
Buttermilk L.
Mud L.
Newell L.
Darlington L.
Sparks L.
Shallow L.
Blodgett L.
Gilland L.
Highflower L.
Hesperia
Bear L.
Stony L.
Benona
New Era
Smith L.
Iman L.
Dressler L.
Park L.
Carpenter L.
Chase L.
Big Wilcox L.
Little Wilcox L.
Bunker L.
Lake 16
Rothbury
Carlton Creek
Stony Creek
Flower Creek
Foggy L.
Cedar L.
Blackman L.
Mud L.
Last L.
Cubb Inlet
White River
East Lake
Cabmoosa L.
Little Acker L.
Big Acker L.
Big Blue L.
Denver
Newaygo
Dalton
Troy
Beaver
Michigan