THIRD ANNUAL REPORT

ON THE

GEOLOGICAL SURVEY

OF

THE STATE OF NEW JERSEY,

FOR

THE YEAR 1866.

TRENTON, N. J.:
PRINTED AT THE OFFICE OF THE STATE GAZETTE.
1867.

GEOLOGICAL SURVEY OF NEW JERSEY.

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State Geologist—GEORGE H. COOK.

Assistant Geologist—JOHN C. SMOCK.

RESOLUTIONS.

At the annual meeting of the Board of Managers, at the Executive Chamber, in Trenton, December 20, 1866, the Report of the Geologist was read, approved, and passed to Governor Ward for transmission to the Legislature.

It was resolved that the Final Report of the Survey of the State, together with the maps, should be published in one volume, and with atlas at the close of the work.

It was also resolved that the map of the cretaceous formation, including the green-sand marl beds, which is now printed and colored, should not be published until the final report is printed; but that the State Geologist be directed to sell copies at five dollars each to such persons as apply for them—the maps to be backed and mounted on rollers, or folded, as the purchaser may desire.

To His Excellency Marcus L. Ward, Governor of the State of New Jersey, and President of the Board of Managers of the State Geological Survey:

SIR:—I have the honor herewith to submit my annual report upon the State Geological Survey, showing the progress made in the work during the year just closing, and the expenses attending the same.

With high respect, your obedient servant,

GEO. H. COOK,
State Geologist.

REPORT.

The following persons have been engaged with me in the work of the survey, in the course of the year:

The Assistant Geologist, JOHN C. SMOCK, A. M., has been steadily engaged either in the field or in the laboratory, in carrying forward the work throughout the year.

MATTHEW DARNSTADT, a graduate of the University of Giessen, has been employed for about two months in the laboratory, in analysing clays and marls.

EDWIN H. BOGARDUS has been steadily engaged in the laboratory, in the analysis of rocks and minerals, since February 1, 1866.

FRANCIS C. VAN DYCK, A. B., has also been occupied for a portion of the time during the year in analyzing marls, mineral waters, &c.

G. MORGAN HOPKINS, C. E., has been employed a portion of the year in collecting materials and drawing maps for the survey.

T. A. CONRAD, Esq., well known for his attainments in the Paleontology of the Cretaceous Formation, has been employed in making a catalogue of the Invertebrate Fossils, found in the marl region, and has completed the work.

Dr. C. C. ABBOTT has continued his work of perfecting the catalogue of Vertebrate Animals of the State.

The results of the survey will be given in four parts, each of which will be accompanied by an accurate geographical and geological map, and explanatory sections.

These four parts will contain descriptions of the rocks of the four very distinct geological regions of the State. These regions are nearly equal in area, they are well marked by natural features, and they lie almost parallel to each other in belts which cross the State from northeast to southwest. They are

1. THE AROIC AND PALEOZOIC FORMATIONS; *Including the Iron Ore and Limestone Districts.*

This includes the whole of Sussex and Warren, the western parts of Bergen and Passaic, and the northwestern parts of Morris, Somerset, and Hunterdon counties.

2. THE TRIASSIC FORMATION; *Including the Red Sandstone and Trap Rocks of Central New Jersey.*

This formation underlies the eastern and southeastern parts of Bergen, Passaic, Morris, Somerset and Hunterdon counties; the whole of Essex and Union, and almost all of Hudson county; and the northern and northwestern parts of Middlesex and Mercer counties.

3. THE CRETACEOUS FORMATION; *Including the Green Sand Marl Beds.*

The southern parts of Middlesex and Mercer, all but the extreme southern parts of Monmouth, a little of the northwest part of Ocean, and the northwestern and western parts of Burlington, Camden, Gloucester, and Salem counties, are included in this formation.

4. THE TERTIARY AND RECENT FORMATIONS OF SOUTHERN NEW JERSEY.

A small part of Monmouth, the larger portion of Ocean, the eastern part of Burlington, Camden, Gloucester, and Salem, and the whole of Atlantic, Cumberland, and Cape May counties, are included in this division.

Of this work the finished map of the Cretaceous Formation was presented at the last annual meeting of the Board of Managers, together with special maps of two important groups of iron mines in the Azoic region of the State. In the progress of the work, during the year, the Cretaceous Map has been engraved and printed, and its coloring is now being done. The chemical analyses of the marls, clays, &c., amounting to considerably over two hundred, have been completed, and the descriptions and other matter relating to the Cretaceous Formation has been written out, and is ready for the printer. To-day the finished map of the red sandstone region is presented. The outlines of the formation are traced upon the map, and the boundaries of the trap ridges have been carefully traced out and located, and actual sections, which illustrate the structure, have been drawn in the margin, and the whole made plain to the eye by the use of colors. The survey of this portion of the State is well advanced; the analyses of peat and of the trap rocks are nearly completed; and

those of the shales, sandstones, soils and copper ores, will be made during the winter. The map of the Tertiary and Recent formations of southern New Jersey, which is here shown, is completed, but not colored to represent the different geological formations of that part of the State. The work is now in progress there, Mr. Smock being engaged in tracing out the Cumberland marls. The coloring of the map can, without doubt, be properly done in the early part of the season. The map of the northern part is not yet drawn, but the materials are collected, and the work is to be done within the next two months. The limestones, slates and sandstones of this district, have already been traced out, and are ready to be delineated on the map. The work of next year will be mainly in studying the structure of the Highland ranges of mountains, and in describing the rich deposits of iron ore found in them.

It is a source of regret that there are no accurate determinations of latitude and longitude, upon which to base his map. The latitudes and longitudes of numerous points on the other maps, have been determined with great accuracy by the United States Coast Survey, and furnish fixed points around which the numerous maps of local surveyors can be drawn, so as to make a reliable map; but in the northwest part of the State, only a few points along the Hudson have been determined by the Coast Survey; and three points, one on Mine Mountain, one at Walnut Grove, and one at Boonton, by this survey. The position of Carpenter's Point, of one or two points on the line between this State and New York, and as many along the upper Delaware, would be very useful, giving to this map equal accuracy with the others, and in correctness in this particular, making the set of maps geographically more accurate than those which have been heretofore published. Since the report was read, arrangements have been made with J. E. Hilgard, Esq., assistant in charge United States Coast Survey Office, to have some of these points determined.

The progress of the work is such, that it may reasonably be expected that it will be completed by the time originally contemplated, April 1, 1868, and within the sum appropriated, $20,000.

The expenses incurred during the year, are as follows:

For the first quarter of 1866	$804 61
For the second quarter of 1866	1,152 78
For the third quarter of 1866	978 39
For the fourth quarter of 1866	1,420 03
Total expenses of the survey for 1866	$4,355 81

Charges for engraving the map of the Cretaceous Formation, and for paper and printing one thousand copies of the same, $1,078.62.

The examinations in regard to the use of marl as a fertilizer, fully sustain the high reputation which this very useful substance has gained; and efforts are being continally made to extend the area

of country over which it can be profitably used. The West Jersey Marl Company are finding an extensive sale for their marl along the railroad lines to Salem, Bridgeton and Cape Island, and on the north towards Camden, and all along the Delaware River and Bay. They have this year sold from their pits at Marlboro', Gloucester county, 40,714 tons. The Marl Company have not furnished a list of their prices, but it is understood that they will supply marl at New Brunswick next season, by the Delaware and Raritan Canal, for twelve and a half cents a bushel.

Along the line of the Camden and Atlantic Railroad marl is transported from White Horse and delivered at all points along that road, thus benefiting a large extent of country, which has heretofore been quite unimproved. There has been 12,000 tons carried over this road during the past year. The average cost delivered on the farm, if it lie immediately along the railroad or at nearest stations, is one dollar per ton.

S. R. Gaskill and Son have extensive marl pits near Pemberton, and they send marl to all parts of the country which can be profitably reached from the Burlington County Railroad, the Camden and Amboy Railroad, and by the Delaware and Raritan, and Pennsylvania canals. They have this year sold 20,000 tons of marl. They propose to deliver it along railroads wherever it can be afforded, and they offer it, by the ton, at Burlington, for $1; at Hightstown, $2; at Trenton, $1.90; at New Brunswick, $2.70; at Philadelphia, $1.90; at Wilmington, Delaware, $2.10; Schuylkill, Pennsylvania, $2; at Lumberton, Pennsylvania, $2.25; and other places in proportion.

A large quantity of marl is carted by teams from Squankum to Freehold, and from thence down the Freehold and Jamesburg Agricultural Railroad, to be distributed along the line of that road, and on the Camden and Amboy lines. 438,493 bushels have been carried in this way the past year.

The cost at Freehold is 11½ cents per bushel; at Jamesburg, 13½ cents; at South Amboy, 16 cents; at Hightstown, 15 cents; at Trenton, 16½ cents; at Princeton, 15¾ cents; at Monmouth Junction, 14½ cents; at New Brunswick, 16 cents.

The Squankum Marl Company has located its machinery for digging and hauling marl on a little stream about a mile from Lower Squankum. They own the old Manassee Mill, and use the dam and water to carry out their plan of operations. The whole of the ground they operate upon is laid under water. They have a large steam dredging machine, which will float in two feet of water, and will excavate to a depth of twenty-six feet beneath the surface, and to a breadth of forty feet at the surface of the water, and will discharge the material excavated at a height of twelve feet above the water. A branch railroad connects with the Raritan and Delaware Bay Railroad at Lower Squankum. The track from this branch is laid along the margin of the pond, and the cars are brought up to be loaded directly from the excavator. In this way the water is to be made use-

ful instead of being a hindrance. The machine is floated to the place where it is required, it is then set to work removing the top dirt, in the present work six feet deep, which is deposited in a bank along the margin of the pond. The track can then be brought up and the marl dug and dumped in the cars to be carried away. The work is very rapid, a ton of marl can be dug in a minute, and so powerful is the excavator that it gouges out the marl and deposits it in the cars as solid and almost as dry as when in the marl bed. Should this plan in its workings equal the expectations of its projectors, it will be a great advance on other methods in use. The machine, which costs about $10,000, is driven by a sixteen horse engine, is operated by four men, and burns a cord of wood a day. When all is arranged, it digs about a ton per minute, and can probably do half of that for the day through, which would be three hundred tons deposited in the cars in ten hours. An allowance must be made from this for the stripping, which may amount to from a quarter to a third as much as the extraction of the marl. At this time, November, 1866, the excavator is in successful operation, and can dig from six to eight thousand bushels (300 to 400 tons) a day. Two locomotives and twenty cars are constantly employed in the delivery of marl, which is unloaded at any point on the line of the Raritan and Delaware Bay Railroad, or on boats at Port Monmouth, at 8 cents a bushel, or $1.60 a ton.

The railroad from Hightstown to Pemberton, which is in process of construction, and the projected roads from Squankum to Freehold, and from Jackson to Pennsgrove, will add still further to the means of supplying marl at a moderate price, and of extending the area over which it can be used. All the railroad facilities as yet furnished are small, compared with the wants of the State. Immense quantities are conveyed by teams, probably 500,000 tons a year; but the distance to which these can carry it is limited. Its use should be extended over all the southern portions of the State.

In collecting some testimony in regard to the effects of marl, strong and decided opinions in its favor are obtained. The following may be taken as samples:

Under the auspices of the State Agricultural Society, Judge J. G. J. Campbell, N. S. Rue, Esq., and the State Geologist, were appointed a committee to collect information respecting the use and effects of the green-sand marl. This committee sent out circulars, with questions, asking information concerning the source of supply used, character of soils on which it was applied, modes of application, amount used per acre, nature of crop grown, adaptation to particular crop, its cost, and its value compared with barn yard manure. Some very interesting and practical observations were obtained in the replies received. Abstracts of a few of them are presented, showing the value of marl in a more definite and striking manner than any general statements could convey.

Judge William P. Forman, of Millstone, Monmouth county, has used marl for the last thirty years. He says that he looks upon it as

the foundation of his improvements in renovating a tract of worn out land. His supply was obtained at Squankum for ten years or more, costing him ten or eleven cents per bushel delivered on the farm. For a number of years past he has used marl from pits on his lands at home. He has tried it upon all the varieties of soil between a stiff clay and open sand. The most decided effects from its use were seen on the heavier clay soils, the sandy soils being slightly benefited by it. He has used it both raw and composted, but prefers it composted with an equal quantity of barnyard manure. When the marl is acid and poisonous, he has rendered it valuable by composting with slacked lime in the proportion of one part of lime to two of marl, allowing it to remain in the heap for three or four months, being cut down once or twice in that time. His plan has been to work it into the surface about the same depth that wheat is covered. About two hundred bushels of manure and marl composted was applied per acre on wheat, corn, rye and grass. For potatoes about three hundred bushels was preferred, while for buckwheat one hundred bushels was deemed sufficient. He says: "There is scarcely any crop that would not be benefited by it. Root crops of all kinds delight in it, particularly onions, beets, turnips, &c. As to its special adaptation to any crop, he writes: "I cannot tell out of three particular crops to which to give the palm, viz: grass, potatoes and buckwheat." In answer to the question as to its relative value compared with barnyard manure, he replies: "To use them separately, Squankum marl is worth, in my estimation, one hundred and fifty per cent. more than the manure, the quantities being equal, but the value of both may be materially advanced by composting." For renovating worn out, loamy or clay soils, he thinks Squankum marl is the best dressing that can be applied.

Thomas S. Snedeker, of Jamesburg, Middlesex county, has used Squankum marl during the last twenty-five years, at the rate of two thousand to seven thousand bushels per annum. He has applied it upon clay loam or a clay sub-soil, at the rate of from sixty to one hundred bushels per acre. His mode of application has been in its raw state, on the surface, except for wheat, when it has been composted with barnyard manure. He has tried it for grass, wheat, corn, potatoes and turnips, but considers it best for grass. It costs him, at the railroad station, sixteen and-a-half cents a bushel. Compared with barnyard manure he thinks it is the cheapest for the farmer, provided the manure has to be bought and carted any distance.

William Updike, of Dutch Neck, Mercer county, has used about twenty thousand bushels of Squankum marl during the last ten years. His soil is rather a heavy loam on clay sub-soil. He has applied it at the rate of from thirty to a hundred bushels per acre, mostly on the surface, except a small portion which was composted for wheat. His experience is that it is best for potatoes and buckwheat. It now costs him twenty-two cents per bushel. Formerly the cost was fifteen cents. Before the use of marl in that neighborhood very little barnyarn manure was made. The main object of their marling is to grow

clover, which goes in part to the stock for food, and the remainder is plowed under as a green manure; then a light dressing of lime is added, after which they expect a full crop. He further states that the use of marl has increased the value of their lands fully one-half.

Judge Thomas B. Jobes, of New Egypt, Ocean county, has used marl for fifteen years, one hundred to two hundred tons annually. It has been applied to "bottom meadows, black, sandy muck, rather a wet soil, upon loamy up-land too cold for first rate corn ground, upon dry and rolling wheat land, and also upon light sandy soil." He has generally applied it as a top dressing upon grass. Of late years it was spread on the corn ground in the winter and plowed under in the spring following. From six to fifteen tons has been the amount which he has used per acre. With potatoes it was put in the hill, a handful to each hill. He says that he has never known it to fail of benefiting some crop in the rotation, so that he considers himself repaid for expenses of application. He adds: "It generally increases the yield of corn and clover, and I think wheat is helped by it, if it is applied to the grass a year before plowing for the wheat." The cost at present is one dollar to one dollar and-a-half a ton, spread on the ground. He further states that "a field limed and marled with ten loads of marl will not wear out by farming in the regular rotation for twenty years, so that the effect of the improvement could not be seen." He thinks that there is no land in the southern portion of the State upon which it will not pay to apply marl at such prices as railroad transportation ought to afford it.

Philip Withington, of Newtown, Pa., has tried the green-sand marl upon a tough, red-shale soil with very satisfactory results. He used the Pemberton marl, and thus describes his first experiment with it: "I obtained five bushels of the marl and sowed it upon a quarter of an acre of buckwheat, and I certainly believe I had three times as much where I applied the marl." The next application was upon corn, and it could be very easily seen both in the increase and in the quality of the crop. On wheat it produced a much greater yield, and the young grass following the wheat looked much better than that where none was applied. Upon potatoes he found it gave an increase of crop and much better quality. His closing sentence is, "I advise all farmers who can get it to give it a trial and satisfy themselves."

Joseph Mason, of Springfield, Burlington county, says, that "for a top-dressing for wheat and grass it acts admirably for me. On my wheat I think it adds ten bushels to the acre more than anything else I have ever used. And not only in the wheat, but it continues to help the grass following and every crop for at least six or seven years, how much longer it would show good I cannot say, as I go over the field again in that time." He further writes: when I moved on the farm of eighty acres, I now live on, twenty years since, I kept two cows, and had to buy some hay at that. Now I keep twenty-three cows and other stock in proportion, and I am free to say that I

attribute the speedy improvement in my soil to lime and green-sand marl. I have sandy loam and heavy clay loam on my farm, but I receive a like benefit on either."

James A. Fenwick, of Pemberton, has used the Pemberton marl of the Upper Marl bed for many years, and to the extent of several hundred tons each year. He has tried it upon sandy, loamy and drained swamp lands, mostly applied on the surface in raw state. Formerly he put on twelve tons to an acre; now his custom is to use about eight tons. He has applied it to young grass, corn, potatoes (in the hill) and once upon wheat. Composted with ashes or stable manure it greatly helped the potato crop, but the best effects of its use were seen upon grass, when used without any ammoniacal manure. He writes: "upon land that has never had lime, or marl, or plaster, I have seen it more than double the potato crop, when applied, a double handful to each hill." It now costs him sixty to seventy cents a ton. Respecting its value compared with barn-yard manure he says: "used in conjunction with barn-yard manure it is equal with it, ton for ton and more lasting in its effects. One half of a liberal dressing of manure from stables to a piece of land that has been marled will do as much good as the whole dressing to another piece that has not been marled, (the soil being the same), and is more lasting. But if I should go without either, of course I should drop the marl. As a testimony to the value of marl for the permanent improvement of soils, he adds: "I know of a farm so poor that it would not grow rye with straw long enough to be gathered with a cradle, that is now rich, producing large crops of wheat, clover, corn &c. And I know that it was made rich by applying to it marl alone, and sowing clover seed in the rotation. The farm is now rich for any country, and I am speaking of a period of twenty years at most." For clover, he says: "the application of marl to young clover doubles the crop and sometimes more. Lime has a good effect upon a field that has been marled, but plaster and sulphate of soda do not make any show in the least. The same is true of phosphate of lime that is not highly ammoniated."

Phillip Souder, of Deerfield, Cumberland county, says that he has used the green-sand marl for two years upon wheat, corn and grass. He always raises double the amount when he uses marl. He writes: I compost with stable manure six or eight loads for wheat, plowed in with wheat in the fall, I think it worth twenty loads of manure alone." Its stimulating effects on buckwheat are shown by the statements of Thomas M. Barracliff also of Deerfield. He says: "I applied about two loads of marl to the acre on my buckwheat and I am surprised at its action. I left a part of the field where I did not apply any, and the result was, the buckwheat is about six inches high, and where I put on marl by its side, the buckwheat is three feet high. I should not have had any buckwheat, if I had had no marl."

The most striking effects of marl have been in Pittsgrove township, Salem county. A country once too poor to sustain even its sparse

population, has become, through the persistent use of green-sand marl, one of the best portions of that county. Although all of the marl used had to be hauled by teams from Woodstown and vicinity, a distance of about twenty miles, the benefits were so great as to repay the labor and expense of such long and slow transportation. When first tried it was upon buckwheat, and for this crop it was not spread over the surface, but sowed as guano or plaster. Even in such small doses the results were so surprising that the people were stimulated to further and still more satisfactory experiments with it.

In Monmouth county, where the green-sand marl is used very liberally in consequence of the great number of places where its extraction is easy and cheap, the benefits are equally great and striking. Indeed, the enormous amount used and the large application per acre, are the best testimony in its favor. As has been said by a good farmer, "The best farmers use it most largely, and conversely, those who use most of it are the best of farmers." The red, sandy soils which constitute a large proportion of the farming area have been raised from a degree of barrenness to a condition of unusual productiveness. The million and more bushels of Irish potatoes raised in that county are one of the products of the abundant use of marl, for before its introduction the number raised was a small fraction of the present product. Thousands of acres that were formerly out of the pale of even poor cultivation, known as "commons," now command $100 per acre and upwards. This was especially the case in the vicinity of Freehold, Blue Ball, and Colt's Neck, although such improvement is common to all parts of the county. Years ago farmers in the interior of the county depended largely upon a few acres of salt meadow, miles away, along the shore, for their annual supply of hay for the farm stock; now the salt meadows are of small value, compared with the improved upland, and the acres at home yield abundance of food for the large stock yards, besides selling a considerable amount of hay to the New York markets. The changes wrought by this natural fertilizer are not, however, so specific as general—the great change is in the permanent improvement of the soil of nearly the whole county.

THE RICH PEAT BEDS

Of our State have attracted a good deal of attention within the last two or three years, or since the high price of coal has compelled the public to look carefully for supplies of fuel other than coal. There is an abundance of that substance to be found in almost, if not quite, every county of the State. We find it in quantities in the form of *turf*, which, when cut in blocks a little larger than a brick and then dried, can be handled without too much crumbling; and also in the form of *muck*, which is tender and crumbling, so that it can only be put in convenient form by means of machinery. In either form, when properly dried and prepared, it makes a good fuel. It burns freely with a blaze like wood, and without the black smoke of bituminous coal. It has long been in use for fuel in Chat.

ham township, Morris county, and to a smaller extent in many other places, and is well liked. It has usually been prepared by draining the peat by ditches, removing the sod and muck from the surface, and then cutting the turf into blocks of convenient size for drying and handling. The turf is cut by a peculiar spade—light, thin, very long in the blade and sharp, and having a projection from one border of the blade near the edge, at right angles to it. The breadth of the spade and lip may be about five and four inches, respectively. This spade is thrust into the peat, and by two strokes a block four or five inches square and from twelve to sixteen inches long may be cut out. After the first row of blocks, and the first block in each row is cut, every stroke of the spade cuts out a block. These blocks are drawn off to an even meadow and arranged for drying. The best season for drying is in the fall, after the intense heat of the summer is past, so that the turf will not dry, shrink and crack upon the surface before the moisture from inside can dry out. When well dried it can be handled without crumbling, and when kept under shelter is always ready for use. When prepared in this way it is bulky and not firm enough for the frequent and rough handling of public transportation. Though it has shrunk very much in drying, and has lost perhaps four-fifths of its weight and bulk, it is—even in the very best kinds—lighter than water, and in most kinds not half so heavy.

Much ingenuity has been expended in making machinery for condensing peat, so as to render it more susceptible of transportation and more convenient to handle. Of the numerous machines that have been devised for this purpose, those upon one or other of the two plans to be mentioned are in use. In one the peat in the bed is stripped of sod; and the upper surface, for an inch or two in depth, is cut and harrowed, or raked by proper machinery till it is made very fine, when it is allowed to dry in the sunshine. The dried peat is then collected, conveyed to the mill, where, in small quantities at a time, it is subjected to powerful pressure, and is made into masses which are firm, smooth, shining, and heavier than water—not liable to crumble or soil the fingers in handling, and bear transportation well. The machinery devised by Dr. Louis Elsberg is used for working peat in this way. It is in use near Belleville, in Essex county, and extensive preparations are now making for its use next season at Beavertown, in Morris county.

The other process is to take the peat directly from the bog and put it in a mill, where it is beaten and ground in water until its fibres are thoroughly broken up and the whole reduced to a fine pulp. This pulp is drawn off and allowed to settle and drain, and is then dried in the sun. It shrinks and dries solid and firm, and like the other is heavier than water. In this form it can be handled and carried to distant markets without inconvenience or damage. Extensive works for carrying on the manufacture in this way have been erected at Allendale, Bergen county, on the N. Y. and Erie Railway above Paterson. The machinery used in this process is made under Leavitt's patent.

By either of these processes peat can be afforded for from three to five dollars a ton, and the supply which can be had is sufficient for many years to come.

Its absolute value for heating is probably not more than half that of anthracite coal, and is somewhat less than that of an equal weight of hard wood. In making steam, however, it is liked because it gives a long blaze and diffuses the heat around the boiler more completely than hard coal does, and it always leaves the exposed part of the boiler clean and free from soot. The quickness with which it kindles is also in its favor, both for making steam and heating dwellings. It has found large use in Germany for fuel in metallurgy.

There is a peculiar smell about burning peat which is unpleasant to some persons, though most do not dislike it. The ashes of peat are much more bulky than those of wood, and in some varieties are so large as to be troublesome.

The following specimens of peat have been examined for ashes, and the results are given in the appended tabular statement:

	Ashes.	*Combustible Matter.*	*Water.*
Columbia, Morris county, taken from a cornfield	18.22	65.614	16.166
Columbia, Morris county—cut for fuel	17.98	66.870	15.150
Allandale, Bergen county—prepared for fuel	4.50	83.800	11.700
Beavertown, Morris county	3.40	69.80	16.800

Peat has been much used as a fertilizer in agriculture, and those varieties which crumble easily are by many esteemed of as much value as barnyard manure. When composted with lime or manure, or when exposed to the weather in heaps for some months before using it, it is thought to be much improved. Varieties of peat and muck which contain too much earth to be used for fuel, may be excellent for the soil, and such kinds of peat are very common every where through the State, and may be made of the greatest value to farmers who wish to enlarge their supplies of manure. In small deposits it is easily managed by opening in dry weather or by inexpensive drains, but in large tracts it is very troublesome to manage so as to bring the peat deposits to their proper value either as sources of fuel or manure, or when drained, as among the richest and most valuable soils in the State. There are in various marshes of this kind in the middle and northern parts of the State as much as thirty thousand acres of land which might be increased from five to twenty fold in value to the owners and to the State, if properly drained and improved.

THE TIDE MEADOWS

Along the Delaware Bay and River, and those along the Hackensack, Passaic and Raritan Rivers, and the salt marshes along the

sea shore, are attracting much attention. Some of them have formerly been swamps, and covered with a heavy growth of timber, and are, to a considerable depth, made up of muck or black earth, formed from the decay of leaves, twigs, branches and trunks of trees. Others have been formed by the fibrous roots of sedges and coarse grasses, which grow in wet ground and shallow water, and have finally accumulated in sufficient quantity to form a complete net work of roots, which holds water like a sponge. Near the banks of water courses, where muddy water is constantly passing and repassing with every change of tide, the net-work of roots becomes filled with mud, quite solid, and a little higher than the marshes farther from the streams, but where only clear water comes; the substance of the marsh contains scarcely anything except the fibrous roots of coarse grasses. Water, at high tide, runs over and fills these marshes, and is held in their fibrous or peaty substance just as in a sponge, so that their upper surface is kept at high water mark.

In their natural state these marshes, at the best, yield only an inferior quality of hay and grass, and most of them are quite useless. By ditching, clearing off coarse hassocks, &c., and opening ponds and salt holes to the action of the tide, they can be much improved, but are still far less valuable than upland.

In the northern and eastern part of the State very little has been done towards effectually reclaiming these lands, although their improvement has been much discussed. In West Jersey the reclaiming of meadows and marshes from the domain of the tides, has been thoroughly studied and effectually practiced from the earliest settlement of the country. In Salem county, some of those on Alloways creek were banked in, so as to shut out the tide, as early as 1700. The successful improvement of these meadows and salt marshes has been effected by shutting out the high tides (or flood tide) by means of embankment and draining them by sluices. By this means they are drained to low water mark, and thereby rendered valuable farming lands. This work of banking in meadows has constantly gone forward—man constantly winning new conquests over the ocean—until the territory actually rescued from the sea amounts to fifteen thousand acres in Salem county alone, besides large areas in Gloucester, Cumberland and Cape May counties. The largest tracts, and perhaps the most successfully managed, are in Salem county. Their area is constantly enlarged by new embankments that take in more and more of the marshes. Nearly all are the enterprises of individuals, owners associated together for this purpose, and the work is carried on according to the requirements of the banked meadow law.

Where a meadow bordering a stream, or a portion of the salt marsh along the bay is owned by several individuals, the consent of two-thirds of the owned acres is requisite before any work can be legally commenced. This being obtained the ground is surveyed, the banks located, and the courses of ditches and streams arranged by disinterested parties or commissioners, who are generally men of

large experience in the system of meadow drainage. Then there is dug what is termed "a four and two," *i. e.*, a trench four feet in width, and two spits or about twenty inches in depth. This is on the surveyed site of the bank, and by digging such a trench the sward and grass roots of the surface are removed, leaving usually a firm foundation of mud whereon to build the proposed bank. Then a ditch twelve feet wide and three spits deep, is dug outside of the trench, or the side next to the creek. This is known locally as a "twelve and three," and furnishes the material for the bank. The spits thrown out of the ditch are cut into small pieces, and then fitted tightly together in the bank by the "packer," as stone are laid up in a wall. This mud when well packed, forms a very strong and durable bank so long as it is kept moist. If it gets too dry the bank will crumble down. But this is rarely the case, since the flood tides generally keep the banks on the outside quite moist, and even wet. The general size of the banks in Salem county, is about four feet high above the meadow surface, eight feet wide at the bottom, and three feet on the top. The slope is commonly one-half to one on the inside, and one and a half to one on the outside. Exposed situations demand larger and stronger banks—as, for example, those on the losing or concave shores of streams, or where there is danger of high tides from water and wind conspiring together. Thus at Finn's Point, on the Delaware, in Lower Penn's Neck, where there is a very exposed shore for two or three miles on the Delaware river, the bank is usually large and strong. It is about ten feet in height, twelve feet wide on top, affording space for a roadway, and about thirty feet at bottom. Then the mud wall is protected, on the sea side, by a facing of stone, which secures the whole against any dangers from washing, by heavy waves and high tides. This wall or embankment is between two and three miles in length, and protects a meadow of twelve hundred acres from the sea. In Cumberland county, along the Cohansey Creek, the banks range from three to seven feet high, and are built immediately upon the surface of the meadow.

The banks are built at a little distance from the stream, leaving a width of marsh outside, of a rod or more for protection to the bank and also for supplying the mud used in repairing. This space is termed the "guard" or "shore." The cost of banking meadow varies greatly. Banks built of mud from a ditch twelve feet wide and three feet deep formerly cost $1 per linear rod; now about $3 per rod. The banking of Fishing island meadow, Lower Penn's Neck cost $10 per acre. Another tract brought in this year has averaged $15 per acre. The first is about the present average cost. Along the Maurice river, banking now costs $2 a linear rod and upwards. These estimates by the acre include the expenses of cutting drains and water courses in addition to the building of banks. For the proper drainage of the meadows, ditches are cut at intervals varying with the needs of meadow. These are generally seven feet wide and two feet deep. Where they are intended as boundaries it is

necessary to have them nine feet in width or no suit for trespass can be maintained. Wide drains with sloping sides are found the best for securing complete drainage. These meadows need constant attention and require annually considerable outlay of capital for the necessary repairs of banks and drains, and improvements of surface. The expense attending their maintenance in proper condition depends however, upon the locality. Some cost scarcely anything while others draw heavily upon the profits. Generally the cost for repairs annually ranges from fifty cents to $1 per acre. The Finn's Point meadow costs on an average $2 an acre per annum. Much of the expense is caused by the depredations of the muskrat which burrows into and through the banks, rendering them peculiary subject to breaks by high water. The ravages of these animals cost Salem county a large sum every year. To avoid as much as possible injuries from their habits it is considered advisable to examine the banks at frequent intervals and to dig out the holes found in them. This is the more expensive as work can only go on when low water favors the workman's operations. Some companies employ a man one day each week to examine the banks and note the point needing immediate attention, thereby preventing breaks in the banks, so apt to occur where the muskrat has been at work. Another source of danger to the banks is the perforations of the soldier crab or "fidler." These are quite numerous and bore into the mud of banks, rendering them a sort of sieve through which the water issues upon the meadows. Constant watching is needed to guard against their ravages. Besides these living enemies the meadow owner has also to contend against breaks of high tides in exposed locations and settling of banks. Nearly all banks require occasional additions to the top caused by crumbling of mud or more frequently by the settling of the whole bank. Where they are built upon firm mud, as is commonly the case along streams the amount of settling is not very considerable, but where they cross a meadow ("cross banks") or run across an old water course, this settling becomes an item of much expense and labor. Some are known to have sunk down as much as ten feet in as many years. The cross banks are more liable to settle because of the thinness of firm mud covering the peaty mass beneath. Wherever built upon such peaty substratum, settling is inevitable and continues until a solid bottom is reached. This settling is generally a gradual process, but instances are occasionally given where the bank has gone down at once out of sight.

As long as these tide-water marshes are open to the tides, and are kept as it were soaked by them, they remain at level of high water, or nearly at that height; but after banking and draining they become quite dry, and the spongy mass slowly decays and is consolidated, thereby losing its bulk and causing a sinking of the whole meadow surface. Tillage also hastens this subsidence by opening the mass to the action of atmospheric agencies, and by a large withdrawal annually in the form of crops. From these causes a slow and gradual settling

is evident. In nearly all banked meadows the difference in heights of the outside "guard" or "shore" and the enclosed meadow is very perceptible. The constant sifting of fine sediment upon the areas outside the banks often brings them nearly up to the height of the projecting bank. And after long series of years of cropping the meadow settles down to low water mark, so that it becomes unprofitable for further cultivation in consequence of imperfect drainage. To remedy this the banks are opened at several points and the muddy water allowed to enter and deposit its sediment upon the surface. The thickness of this deposit varies exceedingly. Some streams deposit much more than others in the same time. The Maurice river and Salem creek carry down a large amount of mud, while the Alloways creek deposits a mere film on the surface in one season. The meadows are left open to tide water for a period of from five to ten years, according to the rapidity of deposit. A meadow near the city of Salem, which has been opened for ten years, has now a mud deposit covering it to the depth of two feet on an average. By this covering with mud the meadows are raised so as to be drained with more ease, and their character is much improved; the grasses also are much more nutritious. This operation really supplies a new soil, and one of the very best character. Some meadows settle so little that they have been tilled constantly during the last seventy years, and it is said that on some the banks have been in repair for over a century. These are exceptions to the general rule. To open banks to tides the consent of three-fourths of acres owned is requisite.

Another mode of counteracting the settling, and also of improving the meadow, is to allow the tides to enter during the winter, by opening sluices. By this means a layer of mud is deposited, varying from a mere film to twelve inches in thickness annually. The best and most practical meadow managers prefer this winter flooding of their meadows as an improvement and counteraction of settling. By this mode there is no loss of five or ten years in cropping, which is the case where flooding is not practiced. Some farmers think this winter flooding is of no advantage where the meadow is tilled and only beneficial to grass. Others think that flooding is altogether useless. Lime and superphosphates improve them, and there is no need of a fresh mud covering. But as the subsidence is certain wherever there is a peaty substratum of much thickness, flooding must be adopted, or else occasional dressings of marl or upland earth will be needed to keep up the height of surface above low water mark. The frequent application of soil from the adjoining upland would be a cheap and valuable amendment to these soils which contain so much vegetable matter; and besides, it would maintain the level of the surface above low water mark.

The surface of most of the banked meadows of Salem and Cumberland counties is a fine mud, known as "black mud" or "grey mud," generally from two to four feet thick, resting upon a black peaty mass, known as "horse dung muck" or turf. The latter may be several

feet thick, as is evidenced by the settling of some banks and causeways. The "grey mud" is also known as "blue mud," as it is of a blueish color when freshly dug. This is mostly found in the higher parts of the meadow, or where the deposit is thickest. The "black mud" contains more muck in it, and it is found in a thinner covering immediately on the "horse dung mud." In Elsinborough township, Salem county, this order of superposition is reversed, the peaty matter being one to two feet thick, covering the mud. It makes an inferior meadow. The grey mud is generally found bordering streams where deepest the mud is accumulated, while the black is seen further from the streams where the least sediment is deposited. It would seem as if the mud deposits of all these meadows is of quite recent origin—since the settlement of the country and clearing of the forests. Streams now hold in suspension a much greater amount of mud than when the country was all wooded. By settling and constant additions to the surface, it is probable that in time the whole depth will become a solid mass and the settling cease.

These banked meadows of Salem and Cumberland counties are specially adapted for pastures, where they grow white clover and good grasses. They are the best of grazing lands, and furnish indirectly a vast amount of manure for the upland farms. When lower and more wet they will grow herds grass, which is raised for its seed. An immense quantity of this is produced annually in Salem county. The average yield is about thirty bushels per acre, now valued at seventy-five cents a bushel. The stalks are used for fodder and litter for cattle. This is probably worth one quarter as much as good hay. As the cutting of grass is done by mowing machines, the whole expense of raising herd seed is small and the profits considerable. In Cumberland county, along the Maurice river and also along the Cohansey creek, the meadows are largely devoted to raising timothy, and grain, and root crops. Where the latter are grown the meadows are more profitable than the adjoining upland, as the yield of crops is fully as large and there is no need of manuring. At Finn's Point the yield of wheat is from thirty to forty bushels per acre, and of potatoes from one hundred and fifty to two hundred bushels per acre in favorable seasons. For corn and hay they are well adapted. Along Maurice River, Cumberland county, the meadows are considered sure for a crop of corn in any season. They also yield good crops of potatoes. For wheat they are not so well adapted, as there is danger of winter-killing. For hay they will average quite two tons per acre. In Salem county it is said that grey mud makes a soil good for the cultivation of any crop. The black mud is not reliable for wheat or broom corn. The maize or Indian corn thrives on both of these. Lime works like a charm upon meadow everywhere. It is generally applied in heavy dressings, even up to one hundred bushels per acre. Superphosphates also produce valuable results. The effects of marling are not known, as no instance of its use was learned to have been made.

The banked meadows, in Salem county, will average $100 per acre in value. Along the Cohansey creek and Maurice river, Cumberland county, the range of price is from $50 to $200 an acre, much more than the neighboring upland. Previous to the banking, these marshes were comparatively worthless. They yielded at best but salt grass or sedge, which may be used as a coarse fodder or for packing. For the latter purpose, salt grass commands $7 per ton delivered. In Lower Alloways Creek Township, Salem county, salt marsh bordering the Delaware river, is valued at from $1 to $5 per acre. About Leesburg, Cumberland county, it commands prices from $10 to $20 per acre. The common opinion among the best meadow men is, that all marsh which can be made to grow herds grass can be profitably banked where the cost of banking, &c., does not exceed $15 per acre. In short, all meadow or salt marsh that can be drained by open drains, may be reclaimed with profit. And if it is two feet above low water mark, this is quite generally practicable, where water is quite salt, as is the case near the ocean or mouth of the bay, the meadow will need some years to get freshened enough to grow anything excepting salt grass. Time will, however, in nearly all cases after banking, bring about such a change that herd grass may be raised, if not timothy and the clovers. The great desideratum is effectual drainage, no matter how high tides may rise, as they can be shut out. The important point is how much above low water is the meadow in question. If not too low for drainage, banking will be practicable, if not unusually expensive.

There yet remains in Salem county, about 15,000 acres of salt marsh bordering the Bay shore. In the opinion of practical meadow managers, it is possible to bank in all of this extent of ground with profit. In Cumberland county the salt marsh is of still larger area, and very much of it could be profitably drained.

The following is an approximate estimate of the number of acres of tide meadows, fresh or salt, in the different counties of the State:

Counties.	*Number of Acres.*
Bergen and Hudson	23,000
Essex and Union	9,000
Middlesex	4,000
Monmouth	2,000
Ocean	33,000
Burlington	24,000
Atlantic	43,000
Cape May	58,000
Cumberland	48,000
Salem	30,000
Total	274,000

In addition to this large area there is in Burlington, Camden and

Gloucester counties a considerable extent of tide marsh bordering the Delaware river and its tributaries. Of all this vast extent of marsh only about twenty thousand acres are inclosed by protecting banks, and this banked meadow is nearly all in Salem and Cumberland counties. The remaining two hundred and fifty thousand acres (in round numbers) are exposed to the tides, and at present nearly worthless for agricultural purposes. These marshes cover about one-eighteenth of the whole area of the State, or over five per cent. Compared with the improved land in farms, it is as about one to eight. Hence the interest attached to the subject of reclaiming these waste lands.

The depth of the marshes is variable, being in some parts only a few inches, while in others it may be ten, twenty, thirty or more feet deep. The bottom has the same kind of unevenness with the present upland surface, and like it is composed of sand, gravel, clay, or loam. The soft material of the marsh is easily penetrated by a sharpened iron rod, a little force being required in some cases, while in others it sinks by its weight, as if the marsh were fluid. The bottom is told at once by its solidity, and by the grating sound which the rod gives when entering it. In the survey of Cape May county, it was found that the marsh deepened very gradually outwards from the upland and somewhat more rapidly from the beaches inwards, so that the deepest part was towards the beach. In a series of soundings across from the upland to Five-Mile Beach, the greatest depth found was twenty-seven feet. The marsh between Beesley's Point and the Beach is in some places thirty feet deep. In sounding across the marsh at Tuckahoe, for the Raritan and Delaware Bay Railroad, the greatest depth found was seventeen feet, near the mouth of Dennis creek, at a stopping across the mouth of a ditch the piles struck bottom at twenty-nine feet below the surface. The marsh between Jersey City and Bergen Hill is very deep, being in many places forty, and in at least one place, fifty feet deep. Along the line of the Jersey City Aqueduct from Bergen Hill to the Hackensack, the depths at each hundred feet, are eight, nineteen, twenty-seven, thirty-four; from thence they range between thirty-seven and forty-seven feet, the last being on the bank of the river. On the line of the Newark and New York Railroad the marsh between the Passaic and Hackensack rivers is very level on the bottom, fifteen feet deep. The marsh above the line of the Morris and Essex Railroad is much shallower, the greater part being from five to eight feet deep. The salt meadows between Elizabeth and Newark, and extending down to the bay, are of variable depths, from three to thirteen or fourteen feet. The meadows along the Raritan, on the south side, between South river and the canal, vary in depth from two or three to twenty-one feet. On the north side the depth is limited between the above figures, but the average depth is perhaps a little greater. These soundings, incomplete as they are, show that the solid bottom of these meadows is most of it below low-water mark.

The attempts at reclaiming these marshes, thus far, have been confined to surrounding them with ditches and embankments, and then placing sluices in the banks in such a way as to prevent the rising tide from entering the meadow and so as to allow water in the meadow and ditches inside to drain out to low water mark.

In most of the salt marshes in the State the tide water in the water courses contains too little mud in suspension to be useful in filling the marshes by depositing its sediment, and if they are improved for agricultural purposes it must be by allowing them to settle until they become solid, which will, in most cases, be only when they have gone considerably below low water mark. To accomplish this they must be drained by pumping, or otherwise lifting the water above tide level—a work which has not been attempted in this country, but which experience in foreign countries shows to be both practicable and profitable. Holland, which is about twelve thousand square miles in area, has between six thousand and eight thousand square miles of its surface included within banks or dikes—and it is kept dry enough for cultivation by raising all the water that gets on it from leakage of banks, springs, or rains, by means of pumps, to the height of five, ten, fifteen, and in some extreme cases twenty-two feet high. The land thus reclaimed is among the most productive in the world. The course of improvement there, began just as it is beginning here. At first the marshes were protected by dikes and sluices, but as they sank away it was found necessary to continue the work by draining the water to lower levels by pumps driven by wind-mills—and so allowing the settling to go on until the marshes had become solid ground. In addition to the marshes, they have drained in the same way ninety lakes—the last of which, Haarlem Lake, covered an area of forty-five thousand acres, and was, on the average, over twelve feet deep. This immense work required the raising of one thousand million tons of water, which was done in about four years, at a cost of $3,592,537, or about $80 an acre. The first sales of land in it brought $100 per acre, and it is expected that the whole amount of sales will equal the original cost. The annual drainage hereafter will require the raising of fifty-four million tons of water.

On the north and northeast side of England there are immense tracts of reclaimed lands. "The Great Bedford Level" extends over an area of six hundred and eighty thousand acres of the best land in England which has been converted by drainage from a dreary waste into a fruitful plain. These lands are too low to be drained by any system of ditches and sluices and resort is had to pumps driven formerly by wind-mills, but now mainly by steam. The drainage is very effectually done and the power required to do it has been carefully calculated. The annual rain fall there is twenty-six inches or allowing a little for evaporation, two inches a month. This is seven thousand two hundred and sixty cubic feet on an acre, and can be raised ten feet high in two hours and ten minutes by the power of one horse, or a one-horse power engine would drain three hundred

and thirty-two acres. Coleman says that "two steam engines, one of sixty and the other of eighty-horse power are effectual to the draining of forty thousand acres of what is called the *Deeping Fen*. The upper part of these lands, which are thus drained, was peat meadow; the lower part was salt marsh. These lands are now in the highest degree productive; producing fine crops of wheat, oats, potatoes, and swedes, besides furnishing the very best of pasturage and hay lands. There is found to be a difference in the qualities of the grass; the lowest lands are fed with sheep; and the highest with cattle. Barley is not cultivated on these lands; but besides the crops above mentioned, mustard, woad and chicory, are extensively cultivated. Four crops of wheat have been taken in succession from these lands, without manure. As the last crop was less than the former, the land was then laid down to grass. The rent of these lands is 38s. and 40s. ($8.55 and $9.00) per acre; but this must be considered as a moderate rent for lands so valuable. By means of these steam engines, the water is kept down to the desired level. It is not found necessary to work them at all times, and the power is sufficient for any extraordinary emergency.

A tract of land of about six thousand acres, in Nottinghamshire, on the northern boundary of this county, called *The Carrs*, has been drained in a similar way. The general impression is that the sea once flowed over this territory. Half a century ago this morass was first attempted to be brought into cultivation. At that time it was absolutely a bog, and no horse could be used in plowing it. The first attempts at draining it were not successful. In 1828 a steam engine was erected, of forty horse power, at a cost of £6,000 ($30,000), for lifting the water by a wheel. The engine is placed upon the main drain, about three quarters of a mile from the river Trent, into which the drainage of these Carrs empties itself; but, unfortunately, when high tide flowed up that river, there was frequent interruption to the drainage, from the water in the river being higher than that in the drain; and it would have flowed in upon the Carrs had not flood gates prevented it. By placing the engine at some distance from the Trent, a reservoir was then formed in the main drain, within that space flanked by high banks, and so by lifting the water into this reservoir, to a higher level than the water of the Trent, it is enabled to fall into that river at all times. . . .

'The wheel for lifting the water revolves between two stone walls, in a space of about twenty-seven inches wide, through which the whole of the water is driven. The wheel itself is formed of cast metal sides, with wooden paddles between, placed ingeniously at a certain angle, which enables the wheel to lift the water above its own centre; thus a wheel of thirty-three feet diameter creates an artificial drainage equal to more than its radius of sixteen and-a-half feet. Flood gates are again placed immediately before the wheel, to prevent the water coming back on the wheel ceasing to revolve. Absolute command of the water is now effected, and a provision has been

made, of incalculable value to the occupier of these cars, by introducing, during the summer months, water from the adjoining river Idle, as a supply for the stock. The total cost of two engines, for the purpose of this drainage, has been little less than $60,000, and the annual expenditure of working the engines, and cleansing the drains, is from sixty-seven cents to ninety cents per acre.—*Corringham's Report of Agriculture of Nottingham.*"

Our salt marshes in New Jersey are as susceptible of improvement and as productive when in cultivation as those of England or Holland.

For making computations upon the cost of drainage and the amount of water that might have to be pumped, the rain fall at New Brunswick may be taken as a representative for the State:

The mean annual fall of rain for the last twelve years has been	42 45-100	inches	in depth.
Greatest fall in one year	49 67-100	"	" "
Least fall	33 35-100	"	" "
Mean monthly fall	3 57-100	"	" "
Greatest monthly fall	11 52-100	"	" "
Least	0		

The mean annual fall of rain on the east coast of England is 26 inches, which is much less than ours. The atmosphere of England is much damper than that of the United States, and the evaporation from the surface of the earth much less.

In consequence of the great prospective value of our marsh and swamp lands which are yet unimproved, the many futile efforts which have been made to secure the joint action of the numerous owners who hold them, together with the interest which the State has in their improvement, inquiries have been made as to the mode of proceeding in such case in foreign countries. In England all such matters are in charge of the Inclosure Commissioners. A letter addressed to them brought in return a very full answer to the questions asked, together with many documents and laws in relation to the subject, together with blank forms of the proceedings had under them. The following is a list of books and papers sent with the letter.

Memorandum No. 1: Relating to appointment of Commissioners of Sewerage and their duties, in giving facilities for Agricultural drainage.

Thrings Land Drainage, Act 1861: A duodecimo volume of 278 pages, containing in additon to the Act of 1861, the Acts of Henry VIII., William IV., and Victoria, relating to the same subject. This law is very long, and carefully guarded. It requires that the fullest notice of any improvement shall be published with the estimated cost, and work cannot be done under it if proprietors of one-half the acreage interested, object.

26 *and* 27 *Victoria, Cap.* 8: (*Ireland.*)

Memorandum, No. 2, and Appendix to the same: This relates to the great benefits of thorough drainage in agriculture, and together with the following papers, gives the mode of borrowing money from the government for carrying on works of drainage:

Improvement of Land, Act 1864.

Form of Application under Act of 1864.

The Public Money Acts and Forms: As mentioned in Memorandum.

"Projet de Loi:" The French laws of 1864 and 1865, upon drainage.

The work of the survey during the year has not extended much into the mining districts of the State—the survey of those will be a large part of the work of next season. It is interesting to know that our rich deposits of mineral wealth are yielding larger and larger returns every year. The amount of iron ore transported on the Morris Canal during the past season was 217,561 tons. This is by no means the whole amount mined in the State—a large amount being transported on the Central and Warren Railroads—and some transported by teams to the place of consumption.

The agricultural interests of the State are steadily advancing. The price and value of land is increasing every year, just as the advantages of our admirable location, healthy climate, and generous soil come to be better known. The lands, which in derision have been called the Jersey barrens, and have been supposed to be capable of producing only scrub oaks and yellow pines are really as productive as any in the State. I can point to a farm which has been cleared up from the yellow pine stumps, which is now regularly yielding crops of corn varying in different years from fifty to seventy bushels to the acre, wheat from twenty to forty-five bushels an acre, and other crops in proportion. One near the average crop on thirteen acres was forty-five bushels an acre, and this on land which a few years ago was worth only one or two dollars an acre. Twenty acres of land, which four years ago was worth not more than three dollars an acre, sold this year for five hundred dollars an acre, the whole improvement of which is in the growth of the fruit trees and vines upon it, and in opening it to good roads. These are not isolated instances; many such can be shown.

The land in Southern New Jersey was formerly held in large tracts, and the wood upon it was cut off regularly to supply fuel to glass houses and iron furnaces. Scarcely any good roads were opened, and the country was traversed only by the tracks of the teamsters. Such tracks soon become washed, sandy, and forbidding in the extreme. There is an abundance of the best of materials for road making, and no better roads can be found in the country than some of those which have lately been built in this part of the State. The new settlements which have been started are meeting with remarkable success. Hammonton, which a few years ago contained only a small number of dwellings about a glass house, now has three or four thousand inhabitants. Vineland, which 1862 contained less than one hundred in-

itants, has a population exceeding nine thousand. Settlements at Great Egg Harbor City, at Shamong, at Manchester, at Bricksburg, are fairly under way, and at many other locations like enterprises are projected. To carry out the successful cultivation of this soil requires both skill and labor, but with these success is certain, and the rewards are ample.

What we most need is to have our advantages and resources well known and properly appreciated, and this knowledge it is the object of the Geological Survey to further.