GEOLOGICAL SURVEY OF NEW JERSEY.

ANNUAL REPORT

OF THE

State Geologist,

FOR THE YEAR

1875.

TRENTON, N. J.:
PUBLIC OPINION—WM. S. SHARP, STEAM POWER BOOK AND JOB PRINTER

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NEW JERSEY GEOLOGICAL SURVEY

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To His Excellency, Joseph D. Bedle, 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 on the progress and present condition of the Geological Survey of the State.

With high respect, your obedient servant,

GEO. H. COOK,
State Geologist.

New Brunswick, November 26, 1875.

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REPORT.

The work of the Geological Survey of New Jersey, has been prosecuted during the past year in all its departments. Having been organized for the purpose of developing the natural resources of the State, its investigations have necessarily taken a much wider range than would be involved in describing the composition and structure of the materials of our rocks and soils, and of the successive changes in animal and vegetable life, changes in climate and in elevation above, or depression below the level of the sea. The language of the act authorizing the survey, plainly indicates that the work done was not in the interest of geological science alone, but also in the applications of geology to the benefit of agriculture, mining and metallurgy; to making public our supply of materials for which industry may find profitable use, or by which the wealth and comfort of our people may be increased. The instructions received from the Board of Managers of the Survey have been in accordance with their interpretation of the law. And the results of the work done, have shown the wisdom of their interpretation. Prof. Rodgers' Final Reports on the Geology of New Jersey was published in 1840. His work was well done, and it was ably presented in that report, and the publication was of great benefit to the State. The annual reports of Dr. Kitchell and his assistants in 1854, 1855, and 1856, began the development of our geology in its practical and economical relations. Though this work was stopped for financial causes, it brought out in strong light the great value of our agricultural, mineral and manufacturing resources. And the

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yearly reports made to this Board, since 1864, and published, have helped to make Jerseymen, as well as those of other States, appreciate the value and capabilities of our natural advantages.

To understand the growth of our State, notice the population at each United States census, and the per centage of growth for each ten years.

Date.	Population.	Per Centage of Increase.
1790	184,193	
1800	211,949	15.10
1810	245,555	15.86
1820	277,426	13.04
1830	320,823	15.58
1840	373,306	16.36
1850	489,555	31.14
1860	672,035	37.27
1870	906,096	34.83

The increase in per centage for the last twenty years is greater than the average for the whole United States; and in the ten years, from 1860 to 1870, New Jersey rose from being the twenty-first in population to the seventeenth.

The increase in wealth has been still more rapid. The value of all her real estate and personal property was in

1850	$200,000,000
1860	467,000,000
1870	940,976,064

and she rose in the rank of States, in wealth, between 1860 and 1870, from the sixteenth to the eighth place.

The value of farm lands per acre is higher than in any other State in the Union, and it has increased more than any other for each of the last three decades. The use of our marls, lime, fish-guano, and other natural fertilizers has greatly extended, and the annual value of our agricultural products has doubled. The yearly product of our iron mines has more than trebled in the last ten years. The manufacture of our white clays into fire-bricks and pottery, which now produces some millions annually, has mainly grown up within the same period.

This growth in population and wealth which is unexampled in any other of the older States, is due largely to to the circumstances of the times, and our peculiarly ad-

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vantageous location; but it is due to the Board of Managers of this survey, to say that their publication of the resources and advantages of our State have had a very important influence in calling in both capital and industry from other States.

Assistants.

I have been assisted in the work of the Survey during the year by:

Prof. John C. Smock, Assistant Geologist, who in the early part of the year, was occupied in the survey of the clay district of Middlesex county, and since midsummer has been collecting representative specimens of our rocks, ores, and other natural products for the Centennial Exhibition at Philadelphia.

Edwin H. Bogardus, Chemist to the Survey, has been steadily in the laboratory analysing ores, clays, waters, &c., and testing specimens sent from various parts of the State for examination.

Jas. K. Barton, Surveyor and Engineer, has completed the surveys and levels for the maps of the clay district of Middlesex county, and has drawn the map with its contour lines for the engraver.

Robert A. Meeker, B. S., and Edward A. Reiley, students of Rutgers College, have been with Prof. Smock in making collections for the Centennial Exhibition.

Expenses.

The expenses of the year have been increased by the cost of surveying, and leveling, and drawing maps; but as the charges in collecting specimens have been paid by the State Centennial Commission, the regular appropriation of five thousand dollars for the support of the Survey, will meet its liabilities. It is, however, only by the most rigid economy that the expenses have been kept within this amount,

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and the work continued. The Board of Managers in their determined purpose to economize the money of the State, have never taken anything from the appropriations for personal expenses, but have paid their own bills.

The Year's Work.

This may be conveniently presented under the following heads:

1. Survey and Final Report on the Fire and Potters' clays of Middlesex county.
2. Collection of specimens of rocks, ores, minerals, soils, &c., for the Centennial Exposition, and the State Cabinet.
3. On the construction of a Topographical Map of the State, and the aid furnished by the U. S. Coast Survey, in preparing for it.
4. Drainage.
5. Water supply for towns and cities.
6. Laboratory work, regular and miscellaneous.

1.

Survey and Final Report on the Fire and Potters' Clays of Middlesex County.

In the last annual report it was mentioned that a special report and geological map of the clay district of Middlesex county was in course of preparation. It is now nearly done; the map is in the engraver's hands and will be completed in a few days, and the material for the report is ready to be written out. Work in the field has delayed the writing, but it is expected to have the report ready for distribution this winter.

The clay for fire-bricks, pottery, &c., annually dug in this district is worth $1,000,000, and a large part of it is worked up, within the State, into products worth as much more. The business of making fire-brick and other refractory articles, and the manufacture of fine pottery are having a very rapid development in our country, and we have an abundance of the materials used in their production. This

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report describes in detail, and the map shows the structure and arrangement of the various beds of clay, kaolin, &c. The beds lie in an order and position that is regular and easily understood, now—the obscurity that has enveloped them being entirely due to the changes which time and superficial wear have made in the condition of the gravel and earth upon the surface.

Heretofore no order of succession, nor any connection have been traced out between the different clay pits; there is no plainly marked difference between the clays from different parts of the district; fossils are not found in those beds which are worked; and the surface of the country, though uneven, presents no marked differences of material in its composition. The great number of openings that have been made for clay, have, however, furnished the means for making careful and extended comparisons. And they have proved that all the clay, kaolin, &c., in this district are in uniform layers, which are of several miles in extent. These layers are not level, but *dip* or slant down towards the southeast with a regular descent of about 40 feet per mile.

Towards the northwest, layers or *beds* must come to the surface or *crop out*, and the higher the ground the farther towards the northwest the *outcrop* of a bed will be. If the beds are uniform in the amount and direction of their dip, it follows that when the exact height of a bed at a given place is known, its height at any other place can be determined. The country has been surveyed and its height above tide has been ascertained by leveling, and the map is drawn so as not only to give outlines, but heights also. Lines of level or *contour lines* are drawn on the map so as to indicate the height of the surface above mean tide, at intervals of ten feet perpendicular. The lines are really drawn where the water's edge would be if the land should sink ten feet, twenty feet, thirty feet, or any other even ten feet, up to the highest ground in the district which is 240 feet. A section and profiles are also drawn on the map to show the thickness of the several strata, and their height above tide at various places. Understanding these, an inspection of the map will enable any careful and intelligent

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person to determine whether any one of the clay beds is beneath the surface, at any given place, and if there, how deeply it is covered with earth. The only uncertainty is in regard to the thickness of the drift sand, clay, gravel and boulders, which cover the surface, and which have been deposited there long since the formation of the clay beds, and which are not in any regular layers or order. The collections of characteristic specimens, the analyses of clay used for different purposes, and the lists of clay pits worked are all ready, and will be put in order for exhibition in the State Cabinet, at Trenton, before the close of the winter.

The map is drawn on a scale of three inches to one mile, and engraved in the best manner. And it is hoped that with the descriptive matter of the report, it will supply the want which has been long felt by those engaged in this important branch of industry.

2.

COLLECTION OF SPECIMENS OF ROCKS, ORES, MINERALS, SOILS, &C., FOR THE CENTENNIAL EXPOSITION, AND THE STATE CABINET.

Collections of representative specimens of rocks, ores, minerals, soils, fertilizers, building stones, clays, sands, and other natural and useful products, have been needed for our State collection and for institutions of learning. The demand for such specimens, in order to exhibit properly the richness and variety of the natural products of New Jersey at the approaching Centennial Exposition in Philadelphia, has necessitated making the collection this year. Prof. J. C. Smock, with two assistants, has been steadily at this work since July 7. The collection of rock specimens, iron and zinc ores and minerals, in all the northern part of the State, and in the clay district, is finished. Specimens have been collected from at least three hundred and seventy localities, one hundred of which were iron mines, and the specimens number more than two thousand. There are still about one hundred localities to visit, and perhaps three

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hundred specimens to collect, and when this is done the series will be completed as fully as desirable at present.

The specimens for the Centennial will be arranged in the State Cabinet at Trenton this winter, and removed to the Exposition in the spring. At the close of the Centennial they will be brought back to the State Cabinet and arranged there for permanent exhibition. Duplicate specimens have been collected for the geological museums of Princeton and Rutgers colleges. The catalogue of specimens is herewith presented, and it is hoped that the Board will authorize the printing of such portions of it as may be needed for the instruction of those viewing the collection.

3.

On the Construction of a Topographical Map of the State, and the aid furnished by the U. S. Coast Survey in preparing for it.

It is everywhere recognized at the present time that the best interests of any country require an accurate map of all its territory. It should have a map which will show, not only the outlines of its civil divisions, and the location of its rivers and mountains, but which shall also show the height of every part of its surface above the level of the sea. Such a map is indispensable for the accurate description and exhibition of its geology. It is of the highest importance for showing areas of drainage and sources of water supply. It furnishes at once the information needed for the judicious location of roads and railroads; and it offers to every citizen, old and young, that practical information regarding geography of which they have heretofore felt the want.

As countries become thickly settled, and land increases in value, the making of such maps becomes necessary. The older countries of Europe have been engaged, for many years past, in surveying for such maps of their territory. Great Britain, France, Belgium, Germany, Switzerland, Norway, Sweden and Russia, all have such maps. The

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survey of England was begun in 1784, and was completed a few years ago,—and now the survey for mapping the whole kingdom, on a scale of six inches to the mile, instead of the former of one inch to the mile, is in progress.

In our country little has yet been done. The U. S. Coast Survey, organized in the interests of commerce and navigation, has done excellent work in the survey of our harbors, coast lines and approaches by water. Its maps will compare favorably with those of any other nation. A trigonometrical survey of Massachusetts was made between 1830 and 1840, but it was not followed up by accurate topographical surveys, and the undertaking was not carried through satisfactorily. A movement was begun in the Massachusetts Legislature last winter, for the organization of a new scientific survey of the State. In New Jersey a trigonometrical and topographical survey was begun in connection with the Geological Survey in 1854, and was continued through 1855 and 1856. It was not continued further for lack of money. Some of the work then done has been used in the construction of various State and county maps, since that time, while a large part, from being unfinished, was lost.

The U. S. Coast Survey has already surveyed our whole Atlantic coast, has determined the precise latitude and longitude of many points along the shore, and that of prominent ones miles inland. It has a supply of the most accurate instruments for such surveys, and a large corps of trained and skilful assistants are constantly employed in its work. To the Coast Survey the States naturally look to determine for them the precise geographical positions of a sufficient number of points to form a basis upon which to construct their maps In 1871 the Coast Survey received an appropriation, with the proviso "that the triangulation shall determine points in each State in the Union which shall make requisite provision for its own geological surveys." This appropriation has been continued every year since. The Coast Survey assistants determined for us, in 1873, the true position of the western terminus of the boundary line between New York and New Jersey, and

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also the true direction and length of that line. In the spring of 1875 they appointed an assistant to carry on the work of selecting points for extending their triangulation over our whole State. Prof. Edward A. Bowser, of Rutgers College, received this appointment, and has been engaged all summer in his work. The accompanying map of New Jersey has been prepared to show the extent of the Coast Survey work already done in the triangulation of the State, and the additional stations which have been selected this year by Prof. Bowser. It will be seen at once that a large amount of work has already been done at the expense of the general government, for New Jersey.

The importance of this triangulation for the accurate location of points, is apparent when we consider that however careful and accurate a surveyor's map may be made, it cannot be accurately placed upon any general map, unless the location in latitude and longitude of some accessible point is known and can be referred to. These points should be so numerous that they can be easily referred to by persons in every part of the state. It will be seen that the triangles upon the map are of different dimensions. The largest ones belong to the *primary triangulation*, which extends from the measured base near Fire Island, on the south shore of Long Island, along the whole coast from Massachusetts to Maryland. The sides of many of these triangles are thirty miles or more in length, and all the work connected with the measurement of their angles and the computation of their sides, has been done with the best instruments and by the most accurate methods. From the sides of the primary triangles, numerous other and smaller triangles have been measured and the places of their angles determined. These are the *secondary triangles*. On the sides of the secondary triangles, observations for a set of smaller triangles are made. These are much more numerous and are intended to reach all the points whose position it is important to determine. These are *tertiary triangles*.

The expense of determining all these points has been borne by the United States. It is much heavier than could have been borne by our State, though the work is of great value

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to us; and it is to be hoped that the triangulation will be continued by them until the whole State is included in the net-work of triangles.

It devolves then upon the State to continue its geological and topographical surveys, so as to use these triangulation points for the accurate basis of our maps. We already have topographical surveys of one hundred and fifty square miles of country in the richest part of our iron ore region, but we lack the location of points in them, and these the coast survey will now give us. The whole iron ore region of nine hundred square miles needs to be surveyed and represented on a topographical map of large scale. Its benefits to our mining interests would repay its cost in a single year.

The map of the clay district of Middlesex county, which accompanies the special report on our fire-clays, is intended to be a specimen of topographical maps such as we need. It is based on the coast survey triangulation which has already covered that part of the State, and the surveys and levels have been carefully made and checked so as to render them accurate and reliable. Its geological accuracy has also been verified by careful comparison and measurements; and a study of it with the accompanying profiles and section, will enable any intelligent explorer or workman to know the place and depth beneath the surface of any bed of clay in the whole district mapped. The regularity of structure exhibited on this map is characteristic of all the south part of the state, and maps of a kind like this will enable all who are interested to know what materials are underneath the surface at any place and the exact depth at which they can be met. Such maps are now needed for the marls, glass-sands and clay-beds of southern New Jersey.

Law for the protection of Monuments and other survey marks.—Inquiry has been made of the survey in regard to the proper preservation and protection of monuments, station marks, &c., and the laws upon the case. An act in relation to the subject of this inquiry was passed for the benefit of the U. S. Coast Survey in 1841. A copy is here-

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with presented, with the request that the Legislature be asked to extend its provisions to the monuments of the Geological Survey. (*Laws of New Jersey*, 1841, *p.* 112.)

"AN ACT concerning the survey of the coast of New Jersey.

"SEC. 1. *Be it enacted by the Council and General Assembly of this State, and it is hereby enacted by the authority of the same*, That it shall and may be lawful for any person or persons employed under and by virtue of the act of the Congress of the United States, entitled "An act to provide for surveying the coasts of the United States," passed the tenth day of February, in the year of our Lord eighteen hundred and seven, at any time hereafter, to enter upon any lands within this State for the purpose of exploring, surveying or leveling, or doing any other matter or thing which may be necessary to effect the objects of the said act; and to erect any works, stations, buildings and appendages necessary for that purpose, doing no unnecessary injury to private or other property.

"SEC. 2. *And be it enacted*, That in case the person or persons so employed under the said act can not agree with the owners or possessors of the said land so entered upon for the use of the same, or upon the amount of the damage done thereto, it shall and may be lawful for the person or persons so employed, or the owners or possessors of the said lands, to apply to one of the Justices of the Supreme Court of this State, who shall thereupon appoint three disinterested and judicious freeholders, resident in the county wherein the said lands do lie; which said freeholders, having first severally taken and subscribed an oath or affirmation before some person duly authorized to administer the same, faithfully to examine the matter in question, and assess the damages sustained by the owners or possessors of the lands so occupied, by reason of such occupation thereof, according to the best of their skill and understanding; and the said freeholders, or a majority of them, having given to the owners or possessors of the said lands, and to the person or persons so employed, five days' notice of the time and place of meeting, shall proceed upon the testimony of

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witnesses, to be by them sworn or affirmed and examined, or upon their own view, or both, to assess the said damages; and shall make report thereof, in writing, under their hands and seals, and file the same within five days thereafter in the office of the clerk of the county in which the said lands do lie; which report, as between the said parties, shall be final and conclusive, and the amount so assessed and reported, be paid to the said owners or possessors of the said lands within ten days after the filing of the said report; and upon default of such payment, any person or persons so entering upon the said lands shall forfeit all his or their right of entry given by this act, and shall be taken and considered as guilty of trespass, in like manner as if this act had not been passed; and the said Justice of the said Supreme Court shall, on application of either party, tax and allow such costs, fees, and expenses, to any person or persons performing any of the duties prescribed in this act, as he shall think equitable and just, which shall be paid by the person or persons employed under the said act, within the time above limited.

"SEC. 3. *And be it enacted*, That if any person or persons shall wilfully injure, deface or remove any signal, station, monument, or building, or any appendage thereto erected, used or constructed under the said act of the Congress of the United States, or under this act, such person or persons so offending shall severally forfeit and pay the sum of one hundred dollars, with costs of suit, to be sued for and recovered by any person who shall first sue for the same in any court having cognizance thereof; one half thereof for the use of the said prosecutor, and the other half thereof to be paid to the overseers of the poor in the township in which the offence was committed, for the use of the poor of said township, and shall be also liable to pay the amount of damages thereby sustained, to be recovered, with costs of suit, in an action on the case, in the name and for the use of the United States of America in any court of competent jurisdiction.

"SEC. 4. *And be it enacted*, That this act shall go into effect immediately after the passage thereof.

"Passed, March 11th, 1841."

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Drainage.

The commissioners for the drainage of the Great Meadows on the Pequest, in Warren county, have been pushing their improvement during the entire year. Pecuniary difficulties have made its progress slower than it should have been. But the heavy work of cutting down the outlet is now advancing finely, and it is expected that before winter sets in the bed of the stream where it leaves the meadows will be lowered five feet. The work is done by a steam dredge, and is begun at the upper end of the obstruction where the water is deep enough to float the scow and machinery. The dredge moves down the channel, cutting this out to the proper width, depositing the earth taken out upon either side and deepening it sufficiently to hold water enough to float the dredge down to its work. The plan is successful, and the entire outlet can be worked through in a few months. The slight lowering of last year, which was only about a foot, has made a decided improvement in the dryness of the surface. The logs and other temporary obstructions in the channel of the Pequest, have been taken out for four miles above the outlet, and the remainder will be cleared out early next year.

The improvement of the outlet and the clearing out of the channel through the meadows will complete the first step in an improvement which will remove an unsightly and insalubrious marsh, and add several thousand acres of rich farming and grazing land to the State.

The commissioners for the drainage of lands on the Passaic and its branches, between Little Falls and Chatham, have not yet begun active operations.

There is difficulty in raising money to pay for the water-power, or the lands taken, and to pay the cost of doing the work, while the benefits of the improvement are not seen, and the taxes to repay the expenses are not yet assessed.

The lands themselves are not a certain source of income to any one, in their present condition. The entire crop of hay on them this year was lost by freshets. That on the Passaic was worth at least $100,000, and the land owners

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are that much poorer than they would have been if the floods could have had free vent. Such losses have occurred several times within the last ten years. Of course, people who depend upon property of this kind for their living, cannot have money to advance. The benefits of such drainage are shared by all the uplands lying in their vicinity, and by all the people whose health can be affected by the miasm from them, and it would be but justice if such lands and such people were to share the expenses of the improvements by which they are to be benefited. If the assessments could be made by the regularly constituted township authorities, and on the ground of public benefit, the financial credit of such enterprises would then be secured, and the cost, however, divided in the final settlement, would not be burdensome, even if it were all collected from the lands drained.

The subject of drainage for health as well as for profit, is receiving the hearty support of enlightened and prosperous communities everywhere. The American Public Health Association asked from this survey a report to be read at their annual meeting in Baltimore, in November of this year, "on the drowned lands of Orange county, N. Y., and Sussex county, N. J., and the sanitary and economic importance of drainage for them." This report was prepared and read as requested. The U. S. Commissioner of Agriculture, in September, addressed to Governor Bedle, president of this board, a letter asking for information relative to wet lands. The letter and its answer are as follows:

"DEPARTMENT OF AGRICULTURE,
"WASHINGTON, September 21st, 1875.

"*To the Governor of New Jersey:*

"This Department desires to collect all available information relative to the extent of boggy, water-soaked, marshy and swampy, or occasionally overflowed lands in the several States and Territories of our country. It is presumed that such data exists as a matter of record in some department of each State, or is of general knowledge among its well-

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informed citizens. We wish, also, to learn to what extent and by what means this class of lands are being reclaimed for economic and agricultural purposes.

"We make similar inquiries of all the States, and, to facilitate replies, formularize the points upon which we particularly desire information.

"We would also be pleased to receive suggestions relative to the reclamation of such lands from an economic, geographical, and sanitary point of view. You will much oblige by furnishing the solicited information, and, if convenient, it will be esteemed a favor to receive your answer by or before the first of November.

"Respectfully,

"FREDERICK WATTS,

"*Commissioner of Agriculture.*"

Hon. Frederick Watts, U. S. Commissioner of Agriculture:

SIR—The Hon. Joseph D. Bedle, Governor of New Jersey, has requested me to reply to the circular of September 21st, from the Department of Agriculture, and to furnish information in relation to wet lands in this State, and I respectfully submit the following:

1. Name of State.

New Jersey.

2. What extent, in acres or square miles, of boggy, water-soaked, swamp and marsh lands are there in your State? Please give locality and local name of swamps.

There are 295,000 acres of tide-marsh in the State. It borders on Newark Bay, Staten Island Sound, Raritan River and Bay, the sea-shore—from Sandy Hook to Cape May, and the shores of Delaware Bay and River as far up as Camden. The amount in each county is as follows:

Bergen	11,910
Hudson	12,896
Essex	4,282

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[illegible]	4,445
[illegible]	7,335
[illegible]	5,958
[illegible]	31,155
[illegible]	25,429
[illegible]	38,003
[illegible]	58,824
[illegible]	51,078
[illegible]	28,602
[illegible]	9,958
[illegible]	3,652
[illegible]	1,946
Total	295,474

Of the lands wet and liable to overflow in freshets, there are 1,600 acres on the Wallkill, in Sussex county; 5,500 acres on the Pequest river, in Warren county; 25,000 acres on the Passaic, in Somerset, Morris, Essex and Passaic counties; 1,600 acres on the Paulinskill, in Sussex county, and many tracts of smaller size in other parts of the State.

3. Has there been a survey of this class of land by your State?

The area of these lands has been found while prosecuting the Geological Survey. No direct survey has been ordered by the Legislature.

4. If published, please furnish this Department with a copy, or furnish us with information as to where it may be seen.

The Geology of New Jersey, and the annual reports of the Geological Survey for 1869 1870, and 1871, give extended notices of these lands.

5. What amount of such lands have been reclaimed in your State?

Perhaps 25,000 acres of tide-marsh has been reclaimed; and the swamps and overflowed lands along the rivers have been partially reclaimed.

6. Please state what successes have attended efforts for their reclamation.

For full answer to this question see Annual Report of State Geologist for 1869, pp. 23–32. The reclamation is successful and profitable.

7. Please state what methods have been adopted for the reclamation of these lands.

For this also see answer to question 6.

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8. Are such lands found to be very productive when reclaimed?

Such lands, when reclaimed, are more productive than uplands.

9. Are the water-soaked, boggy, and swampy lands deemed to be prejudicial to health?

They are. Settlers are found along their borders everywhere, but strangers fear them. Their salubrity is everywhere questioned, and in some places it is demonstrated that they are not healthy.

10. Does the reclamation of these lands enhance their value and the value of lands in the vicinity?

The lands are greatly increased in value—from five to ten-fold, and the discredit they bring upon lands adjacent is also taken away. The damage to uplands from their nearness to swamps and wet grounds is very great, though it is seldom taken into consideration.

11. Is the possibility of reclaiming this class of lands engaging the attention of capitalists and farmers for agricultural purposes?

The reclamation of such lands is attracting attention, as may be seen from the Annual Reports of the State Geologist for 1869, 1870, 1871, which are sent with this report.

12. Do the health authorities or physicians of your State complain of them as insalubrious?

They do. See report of the N. J. Health Commission, pp. 18–23.

13. What kinds of farm products are most profitably cultivated upon such reclaimed lands?

This question is answered in the Annual Report of the State Geologist for 1870—p. 51.

14. Please give references to any acts of your Legislature which have been passed bearing upon the reclamation of swamp lands.

Special laws have been passed for draining particular swamps or marshes, and the works have been carried through successfully. The present drainage works are being done under the law "To provide for the drainage of lands," a copy of which is sent herewith.

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15. If you cannot furnish exact data to the above inquiries, please give answers that will approximate the facts.

Where swamp, marsh, or other wet lands are held by a large number of individual owners, there is difficulty in getting them to unite for a general work. Persons owning and living on unimproved and wet lands are not usually very thrifty or vigorous; and they need credit and direction to help them, even in making improvements which are sure to be profitable, in the end. On streams where dams have been built to obtain water power, the ponds which are raised have, in many cases, become damaging to farm lands and injurious to the public health. The adjustment of the property rights in such cases is the source of much complaint, litigation and ill-feeling. When a country becomes sufficiently thick-settled, so that boggy, water-soaked, marshy and swampy or occasionally overflowed lands, are discreditable and so damaging to the neighboring lands or injurious to the public health, such lands should be drained by public authority, and the expense borne in part by the lands drained, and part by the whole property of the district.

(Signed) Respectfully yours,

GEORGE H. COOK,
State Geologist.

Water Supply for Cities and Towns.

In the report of last year, mention was made of our resources for the supply of water, to the thick-settled parts of the State. The magnitude of the interests involved, and the anxiety everywhere felt for a supply of pure and wholesome water, render it important that this survey should use the means at its disposal, to furnish information on this subject. The water which is everywhere found by digging a few feet down from the surface, or which issues from springs, does not come from any hidden source of supply within the earth, but is the rain-water which has fallen upon the surface and then soaked down through the soil and into the wells, or drained off through beds of earth, gravel, or fissures in rock to the springs. Such water is usually

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clear and sparkling, but it is not as pure as when it fell from the skies, but has in it whatever of foreign matter it could dissolve in its course through the ground. The water of wells and springs in country places, and away from dwellings, may be hard or otherwise impure, but it is not usually unwholesome. In cities and towns, however, it is is soon observed that the water of wells and springs grows impure and unwholesome. The filth thrown upon the surface or run into sinks and cess-pools is allowed to soak into the soil and gradually to reach the wells and mix with the purer water. The water from such wells becomes the cause of sickness, even before it is specially offensive to the senses, but finally it becomes disgusting in smell and is abandoned. Such is the course in all our towns and cities; a long time may intervene before the conclusion is reached, and sickness and deaths may occur in the course of it, but finally it comes. Many such cases of the abandonment of wells have occurred to my knowledge, in New Brunswick. Prof. H. B. Cornwall, of Princeton College, has furnished me the results of analysis of several well-waters in Princeton. They show plainly enough the impurities which have got into the water by draining through the ground about dwellings. In his communication he says, "I send you some analysis of well-waters in our town. The results show in nearly every case where a well has been suspected, owing to the nature of the sickness prevailing among those using it, that the well has been worthy of suspicion. My experience with our wells, and no doubt it is the same in every closely built town, has shown that cess-pools, vaults and wells are crowded together too closely to admit of obtaining pure water; but wherever care has been exercised in locating the well plenty of excellent water is to be had. Our people ought to use more cistern-water and less well-water, and there would be less sickness.

"In making the analysis I have followed Wanklyn's method, with the Nessler test for ammonia.

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Analysis of Well Waters in Princeton, N. J., February and March, 1875.

	Free Ammonia, Parts per Million.	Albuminoid Ammonia per Million.	Chlorine Grains per Gallon.	REMARKS.
1	1.36	0.28	8.5	Very bad water. The high amount of chlorine and free ammonia indicate recent contamination from neighboring privy vaults. Much typhoid fever has prevailed among people using No 1. No. 2 is not used. It is an example of the careless way in which wells are located, as an abundance of good water might be had on this lot by properly selecting the ground.
2	2.56	0.22	7.4	
3	0.04	0.14	3.6	These wells are suspicious. No. 3 is almost certainly bad. The comparatively small amount of free ammonia indicates contamination by soakage through ground contaminated by old privy vaults; which is, in fact, the case. Diarrhoea is frequent among strangers using No. 3, and typhoid fever has prevailed to some extent among persons using No. 4, although it cannot, with certainty be attributed to the well water.
4	0.054	0.098	2.7	
5	0.04	0.07	2.9	Two samples of fair well water. Both receive some surface water, which accounts for their being less pure than the two following. No sickness attributable to water occurs from their use.
6	0.045	0.064	2.7	
7	0.048	0.05	2.3	Two very pure well waters. Neither of them receive any surface water, and both are located so that the strata dip from them toward the cess pools, situated at a reasonable distance.
8	0.016	0.036	2.0	
9	0.21	0.28	1.9	A bad well, but it is not easy to ascertain the reason. The low amount of chlorine does not indicate sewage impurities. The well is close by the kitchen door, and probably receives some of the slops containing animal matter. It is a deep well with little water at the bottom. Probably only needs cleaning and care to keep away surface water. The occupants of the house are troubled with fevers of a typhoid nature."

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In January of this year an application was received, first from citizens, and afterwards from the city authorities, for an examination of the water supply of Atlantic City, and an opinion as to the qualities of the different samples sent.

The waters were examined and a report made at once, and afterwards I went to Atlantic City and saw their surface wells, their Artesian wells and their rain-water cisterns.

Water sufficiently fresh for drinking is obtained on all the sand beaches along the sea shore of New Jersey, by digging holes two or three feet deep in the hollows between the hillocks.

Wells, as they call them, are made by sinking a barrel or hogshead, from which the heads have been taken out, into the sand to the depth of from two to six feet, and removing the sand from the inside of the cask. The water rises in the inside of the cask to within a foot or two of the top, and the well is complete. It needs no bucket or pump, and is usually without cover or curb, so that the water can be dipped out with a pail. Wells of this kind, situated so that water from the sloughs, or from the sea could not readily soak into them, were considered to be good enough, when but few people lived on the beaches, but as population increased, and waste matter, refuse and filth of every sort accumulated, upon the surface, the products of their decay would naturally be carried into the sand with the rain, and so find their way into the wells. The necessary consequence of drinking water poisoned in this way was soon seen in the increased sickness and mortality among those who used it, especially in summer and autumn. The first and easiest means of supplying *pure* water, was to collect rain, from roofs, into cisterns, and it has been resorted to with most satisfactory results. The large hotels, and the better class of houses, are being provided with cisterns, and are able to store water enough for all purposes of domestic consumption; and wherever such water is used there is an entire exemption from the diseases which afflict those who use water contaminated with putrefying organic matter. Cisterns, however, are not provided for the poorer class of dwellings, or for

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fires, or steam, and the attempt was made to obtain a more abundant supply of water by sinking Artesian wells. As early as 1858 the late Manasseh McClees sunk a well one hundred and eighty-five feet deep, at Cottage Retreat, between Atlantic and Pacific avenues, and near the light-house. The ground was about six feet above high-water mark. The materials passed through were—

Fifty feet beach sand.
Five feet blue clay, like marsh mud.
Thirty feet beach sand.
Five feet very tough blue clay and salt water.
Ninety feet sand, more or less coarse; water salt.
Five feet clay, yellow and blue in streaks; water salt.
Beach sand and salt water.

The boring was lined with an iron tube eight and a-half inches in diameter. The whole cost of the well was $1000, which of course was a total loss. In 1874 the Atlantic City Gas and Water Company sunk two Artesian wells upon the middle of the beach, at the south end of the city, and on ground eight feet above high water. One was sunk ninety feet and the other one hundred and eighteen feet. The material passed through in the first well was reported to be—

Sixty feet beach sand.
Fifteen feet mud and sand.
Fifteen feet beach gravel, and fresh water.

The material passed through in boring the second well was—

Fifty-six feet beach sand.
Five feet black mud and sand.
Fifty-seven feet beach sand, gravel and fresh water.

The wells were tubed with twelve inch iron pipe, and the water rose in them to within ten feet of the surface. A steam pump was applied, and water drawn for twenty-four hours steadily, without lowering it more than three feet in the tube. A gallon of Artesian well water, on evaporation, left $24\frac{20}{100}$ grains of solid mater. This was mostly in the form of mineral carbonates, and no nitrates, or ammonia were found in it. The water was clear, and without smell when

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examined, though persons, present when the pumping was going on, say that it then had a disagreeable smell, which was perceptible at the distance of sixty feet.

Water from the well of J. Adams, which is one of the best surface wells in the city, on being analysed, was found to contain 15.74 grains of solid matter in a gallon. It contained less of carbonates, and more of sulphates, and a trace of nitric acid. The water was slightly yellow, and the solid matter, when burned, gave off a strong but not unpleasant odor.

The rain water was, of course, unexceptionable.

The water from the surface wells there is contaminated with organic matter, and it is unsafe to use it. That from the Artesian wells is palatable and contains no poisonous organic matter. I think there would be risk in depending upon it for a full supply; for it is apparent from the three borings that the material of the beach is the same from the surface to the bottom of the tubes, and if the wells are drawn hard the water from the sea is likely to be drawn in and spoil them, as it evidently did in the McClees well.

The safe and economical plan is to provide rain water for domestic purposes, and to construct large surface wells for supplying water for fires, and other purposes not requiring pure water.

An abundant supply of pure and excellent water can be had from Absecon Creek, which is a considerable stream on the main land opposite to Atlantic City. The expense of bringing this water across the marsh would be heavy, and may delay the execution of the work, though it will finally be done. It was intended to present here an analysis of the water from Absecon Creek, but it has not been received as expected. Instead of this, an analysis of water from Lawrence Brook, near New Brunswick, is presented. The water is of the same general character with that from Absecon Creek, and from any of the streams to the south of this. If there is any difference, it is, that they are purer. This water is used for the supply of New Brunswick, and its quality is unexceptionable. The analysis was made by Prof. F. C. Van Dyck, of Rutgers College.

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"The water supplied to the city of New Brunswick has a dark amber color, a pleasant taste and is very soft. When boiled down it deposits a light reddish sediment. Examination proves this to be organic matter, probably derived from the swamps in which the water first accumulates.

"For technical purposes it is superior to any other water to be obtained in this vicinity. Steam boilers last a much longer time than before this water was introduced, and engineers speak of the brightness of boiler flues even after years of its use. An inspection of the subjoined analysis will account for this freedom from corrosive action. It will be noticed that the chlorine and sulphuric acid are accompanied by sufficient sodium and calcium to fix them in combinations not decomposed by ordinary heat, while in many natural waters these acids are in combinations which readily yield their acids to the iron of boilers. Moreover, the quantity of mineral matter is surprisingly small, not amounting to two grains per United States gallon. The fitness of the water for household use is dependent upon its softness, which makes it economical for washing purposes, and its freedom from sewage contamination.

"Analysis failed to detect any of the impurities usually derived from sewage; it contains no nitrates, nor any free or albuminoid ammonia, which are the substances considered to cause water to be unwholesome.

"Experiment seems to prove that this water has little or no action on lead pipes, but it should be stated that the trials were made with pipes which had conducted the water for two or three years. Either the water has no action on lead, or a protective coating is spontaneously formed.

"Appended is the analysis, giving the parts of each constituent, in one million parts of water.

ANALYSIS.

Solid residue dried at 212° Fah	60.5
" " at a red heat	32.0
The weight lost in burning was humus.	
The solid residue at a red heat is composed of:	
Silica	4.50
Oxide of iron	2.25
Alumina	1.25

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Lime (as carbonate)	11.25
Magnesia	1.62
Sodium chlorine	4.50
Chlorine, otherwise combined	.55
Sulphuric acid	4.29
	30.21

"The above is in one million parts of water; if expressed in the ordinary form of per centage, the fixed residue would be 0.0032 per cent. of the whole.

"The sample was taken from the supply pipes in the city in September, when the water would be in its most impure condition."

The examinations and conclusions regarding the water supply to Atlantic City are equally applicable to all the beaches on our coast, from Long Branch to Cape May.

The question of a supply of wholesome water to the cities of Newark, Jersey City, and other towns and villages in that thickly settled part of the State near New York city, was referred to in last year's report, and an abundant supply of the purest water was shown to exist in the mountainous country in which the Passaic and its branches rise. Both Newark and Jersey City get their present supply by pumping water from the Passaic, only a short distance above the former city. This water is of questionable purity; the city of Paterson, with its 33,000 inhabitants and its numerous factories, is only thirteen miles above Newark, and all its sewage is discharged into the Passaic, and the country from Paterson to Newark is very thick-settled, and the river receives all its wash and drainage. The sewage of Newark, too, though emptied into the river lower down, is yet carried up by the rising tide almost, if not quite to the pumping-works, so that it may help to pollute the water pumped to supply these cities.

Some have maintained that sewage largely diluted with water is oxidized by the air in running a short distance, and that water purified in this way is clean enough to drink, without injury to health. This, however, has never been proved, and the evidence of smell in warm weather is altogether against the assumption.

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It is unfortunate that we have no series of reliable statistics of disease and deaths in the different parts of our State, from which to prove anything absolutely, on this question. The evidence collected in other countries on water supply, is, however, very full, and the conclusions reached are clear and safe. In that collected by the English Royal Commission on Water-supply, Dr. Frankland says: "There is no process practicable on a large scale by which that noxious material (sewage matter) can be removed from water once so contaminated, and therefore I am of opinion that water which has once been contaminated by sewage or manure matter is henceforth unsuitable for domestic use." And Sir Benjamin Brodie says: "I believe that an infinitesimally small quantity of decayed matter is able to produce an injurious effect upon health. Therefore, if a large proportion of organic matter was removed by the process of oxidation, the quantity left might be quite sufficient to be injurious to health. With regard to oxidation, we know that to destroy organic matter the most powerful oxidizing agents are required; we must boil it with nitric acid and chloric acid, and the most perfect chemical agents. To think to get rid of organic matter by exposure to the air for a short time is absurd."

Mr. Simon's report on the cholera epidemics of London in 1848–49, and 1853–54: "When the Lambeth Company took its water from the Thames near Hungerford Bridge, the people who drank that water died at the rate of 12.5 per thousand. When the source of supply was removed to the Thames at Thames Ditton, the mortality was only 3.7 per thousand, while at the same time, and in the same districts, the mortality among the people who were supplied with water by the Southwark Company from the Thames at Battersea was at the rate of 13 per thousand."

These statements are sufficiently strong, and from sources near enough to command attention.

Profs. Henry Wurtz and Albert R. Leeds, of Hoboken, have made extended and careful examinations of the Passaic river water, and the results have been published by the authorities of Newark and Jersey City. Prof. Leeds also

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read a paper on the subject, before the State Sanitary Convention, at Newark, in October of this year. They prove that the water is remarkably free from mineral impurities, and are of opinion that it is, as now taken, safe to use for household purposes.

Gen. E. L. Viele, of New York, takes the ground that the water as now supplied to Newark and Jersey City is unsafe to use. And at the Sanitary Convention in Newark he read an elaborate paper on the water supply for Newark, Jersey City, and other towns in the vicinity. This paper was accompanied by a good map of the whole country to be supplied. He showed the sanitary and economic advantages of taking the water from the Passaic at Little Falls, above Paterson, and more than one hundred feet higher than the present pump-works.

The general question of water supply is, in the present rapid growth of our State, of great importance to all our people, and the special case above mentioned is of vital interest to nearly one-third of our whole population. It is certain that in this case an abundant supply of water of unquestioned purity can be had from the upper Passaic or its branches, and by proper storage this supply can be had without materially affecting the water rights at present in use.

In view of the sanitary importance of preserving pure water for domestic use, some legislation should be had by which streams used for water supply may be protected from pollution by sewage, manufacturers' waste, filth, or impurity of any kind.

6.

LABORATORY WORK: REGULAR AND MISCELLANEOUS.

The Laboratory is kept open constantly. Examinations and qualitative analyses of specimens collected in the explorations of the survey have to be made; quantitative analyses of clays, ores and limestones are made for the regular reports of the survey; analyses of fertilizers are made for the State Board of Agriculture, and numerous

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tests and partial analyses have to be made in preparing replies to the many applications for information regarding specimens sent from all parts of the State. A moderate charge is made for the analysis of fertilizers, and a similar one might be made for the analysis of ores and minerals. These charges, however, are not sufficient to meet the expense of making the analyses, and as we claim the right to publish the results for the public benefit, it is judged to be fair and useful to expend a portion of the funds of the State in this way. The good effects of it are already shown in the improved quality and uniformity of the fertilizers sold in the State. The information in regard to ores has in some cases stimulated to further and more intelligent work, and in other cases has saved much waste of time and money that would otherwise have been wasted in fruitless explorations.

The publication of the analyses of our soils has attracted the attention of the eminent English agriculturist, J. B. Lawes, esq. And in a letter in which he refers to the soils of Sussex and Warren, he says: "I notice the high per centage of potash, which you give in the analysis of many of your soils. We have no such analyses, showing so high a result as four or five per cent. of potash." The owners of those remarkably productive soils have long experienced the advantages they enjoy; and it is to them, as well as to all our farmers, both satisfactory and suggestive to know a reason for it.

Miscellaneous Analyses and Examinations.

1. Magnetic iron ore, sent to the State laboratory by Philip George, Ringwood. This was taken from a new line of openings west of the Ringwood mines, and about half way between Ringwood and Greenwood Lake, Passaic county. These are reported as indicating a more continuous vein and lacking the short, shoot-like out-crop, characteristic of the group at Ringwood. Several holes show a vein four to six feet wide, of ore rather lean, but of superior character.

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The examination showed (.058) fifty-eight thousandths of one per cent. of phosphorous and no sulphur. It can probably be used for Bessemer pig metal.

2. Magnetic iron ore from P. C. Bloom, near Little York, Hunterdon county. It contained:

Insoluble in acid, (rock)	49.7 per cent.
Metallic iron	37.5 " "
Titanic acid	4.7 " "
Phosphorus	Trace.
Sulphur	Trace.

These figures show a lean one, but remarkable for the per centage of *titanic acid* and the *traces* only of phosphorous. The ore was reported to form a workable vein.

3. Magnetic ore, sent by the Pequest Mining Company, from the Bayard property, near Alamuchy, Warren county, for J. B. Venable. The results of a partial analysis were:

Insoluble matter (rock)	26.6 per cent.
Metallic iron	49.5 " "
Titanic acid	5.9 " "
Phosphorous	Trace.

This is another titaniferous ore, and also remarkable for the small amount (trace only) of phosphorous.

These analyses, together with many others made in previous years, indicate this curious relation between titanium and phosphorous, that a considerable per centage of the former always consists with a *very small* amount of the latter. The behavior of such ores in the blast furnace and the character of the product might be an interesting point in the metallurgy of iron, and the chemical examination of iron ores, to test further this hypothesis or substantiate these facts, ought to be continued.

4. Several specimens of ore, said to contain manganese, from the Hoff mine, near Port Oram, Morris county, have been examined. No manganese could be detected in them. This result appears to confirm the generalization in the Survey Report for 1873, viz., that there is a belt of manganiferous iron ore on the northwest—the Pequest Belt—and in the ores of the other belts this element occurs very rarely in any weighable amount.

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5. Sphalerite or zinc blende (sulphide of zinc). This mineral has been found on Philip Raub's farm, 1½ miles northwest of Oxford Furnace, Warren county. It occurs in small crystalline aggregates, irregularly disseminated through a greyish white limestone, and associated with magnetic iron ore. The pit from which the rock containing this mineral was taken, was dug for iron ore. A small vein of brownish black ore, partly earthy, was found in the crystalline limestone, with ore irregularly scattered through this rock. Parties from Pennsylvania have leased the property with the intention of searching for zinc ore. The amount of blende is very small, and not sufficient for working, but the discovery is very important, as it is the fourth zinc locality in this range of white limestone belonging to the Pequest Belt, and it is the first ore found anywhere southwest of the old Andover mine. Taken together, the isolated zinc ore localities appear to belong to a very narrow range, the exact location of which is, in the present state of our topographical surveys of this part of the State, only hinted at on our geological maps. A more thorough survey of the topographical features of this county will no doubt define the limits of these zinc ores and manganiferous iron ore belts, and thus plainly mark out the areas in which prospecting may be done with success.

6. Blue limestone sent by S. T. Scranton, of Oxford Furnace:

	1	2	3	4	5
Ins. Matter	3.9	2.2	3.2	2.6	3.7
Carbonate of Lime	52.6	52.0	92 7	51.6	53.9
Alumina and Oxide of Iron	0.6	0.8	0.3	1.0	1.9

These limestones were from Warren county, from Pace's quarry, near the Pequest river, north of Oxford Furnace, from the quarry at Changewater, worked for the Oxford furnaces, and No. 3, from the Warren Railroad cut, about a half mile east of Washington. Nos. 1, 2, 4 and 5 are common magnesian limestones, and the per centage of lime is about the same in each of them. No. 3 is darker blue in color, and finer grained, and is a pure limestone. The outcrop of this latter variety, as is seen in the railroad cut,

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measures ten feet, and it is bounded on the west by a rough, knotty-looking blue limestone, in thick beds, traversed irregularly by calcite veins, while on the east there are only ledges, here and there, of ordinary blue limestone, covered by a yellow clayey earth. The difference in the appearance of these varieties is so great that they are clearly defined in extent. This mode of occurrence of pure limestone, imbedded in the magnesian stone, has not been observed elsewhere. The great value of such stone suggests a more careful survey of all blue limestone outcrops, to determine their character, and the probable extent of both the magnesian and pure limestones. The development of our natural resources, and the corresponding utilization of them all, to the greatest extent and with the greatest economy, will, in the not distant future, make use of all these pure limestone outcrops of the State, for the manufacture of superior lime.

The specimens were analyzed with reference to their value as fluxes in the blast furnace. For such purpose there is a diversity of opinion both among scientific metallurgists and among practical iron workers. And location favorable to economical working is, perhaps, more important than composition. So that magnesian limestone will continue to be preferred, where they are cheaply got, to those without magnesia.

7. Clay from the bank of the Wallkill river, Drowned Lands, Orange county, near the New Jersey line. Sent to the State Laboratory by M. F. Ten Eyck, of Warwick, New York:

Silicic acid, in combination	28 9
Quartz	22.9
Silicic acid, free	1.2
Titanic acid	0.5
Alumina	23.1
Peroxide of iron	7.2
Water	9.7
Lime	0.7
Magnesia	2.6
Potash	4.1
Total	100.9

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This clay is said to exist in large quantity, forming a thick layer at this point in the alluvial district of the Drowned Lands, and probably underlying much of the black muck surface of this tract.

The specimen sent was thoroughly air-dried, and was slate-grey in color, and showed a little fine gritty sand. It contains too much oxide of iron and potash for any refractory or fire materials. Washing out the fine sand might enable it to be used in some styles of paper facing. It is most interesting as the basis of a valuable, enduring and fertile soil, and, if properly drained, it would be unsurpassed for tillage or pasturage; and as such it furnishes another argument for the drainage of this tract of Drowned Lands.

The mining industry of the State partakes of the depression so general in all branches of business. And that portion devoted to iron mining is more seriously affected in consequence of the stagnation in the *manufacture of iron*. During 1874 many of the companies kept their force of labor in the mines nearly, if not quite, equal to that of 1873, hoping for a revival of business and a better demand for ore, and thus to be ready to reap the first results of such improvement, and also to keep their mines in a good working condition. This, in part, explains the comparatively small decrease in the amount of iron ore mined last year as compared with that of 1873. During this year there has been a marked change. The continued lack of demand has discouraged work, and in nearly all the large mines the mining force has been reduced to a minimum consistent with keeping them from suffering injury by an entire stand-still. Several of the large companies have stopped altogether. The smaller mines and individual enterprises are doing even less than the companies. We have no figures of ore mined for the year up to date, but from a careful survey of the iron-ore district it is very certain that the reduction in the product for 1875, compared with last year, will greatly exceed the loss in 1874. As many of the furnaces are out of blast, the stock at the mines is generally much greater than ever before. In some cases the accumulation is at the furnaces. So that, altogether, there is a large amount of

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ore ready for them whenever the demand for iron shall call for it. One company is reported as having one hundred thousand tons of magnetic ore stocked. And there is probably as large an amount now on the bank at a-half. dozen of our larger mines.

In the midst of this almost universal depression there are some marked exceptions. These are doing quite as much as in any previous years while there a few newly opened localities which are being quite actively worked. In a few cases there are special business arguments which are driving them. But in the most of them we find the superior character of the ore—its adaptation to the manufacture of iron for Bessemer steel—claiming a market for it and enabling its owners to keep at work. Such ores are wanted and command remunerative prices, and mines having such can be worked profitably and vigorously even in these times. It would probably be invidious here to enumerate, if it were possible, the mines which are furnishing Bessemer ores as they are known to the iron men generally. It is, however, eminently proper to state here that we are not yet fully acquainted with even the best known mines so as to say in advance of chemical examination, what ores may or may not be suitable for Bessemer steel. Our knowledge of the geological structure of the iron ore district is yet too incomplete to enable us accurately to locate all the ores free, practically, from phosphorous. Hence the urgent importance of ascertaining at all times, and especially at the present, what are the capabilities and values of the ores raised in all of our mines. The force of this becomes more apparent by a reference to the past. Only a few years ago there was scarcely any ore mined in the State which was supposed to do for making into steel. We had no Bessemer ores on account of the *assumed* universal presence of too much phosphorous. Chemical analysis followed by experiment and routine practice have upset this wrong conception so much that in 1874 several furnaces made steel pig, running on New Jersey magnetite. Their success has started the examination of known ores and stimulated prospecting in search of new mines of the same character.

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And every mine owner should consider this matter and examine his ores. A reference to the reports of previous years will show that there are several localities in the State where such ores occasionally occur in workable beds, and they ought to be tested. It was stated in the report for 1873 that the ores found in the northwestern or Pequest belt were characterized by the presence of manganese, and further the analysis of several of them showed low per centages of phosphorous.

That this character will be found to be true, generally, there is little doubt. Here then is a belt of country where the prospector has a field for his operations, and success in it will lead to work and demand for his product. But this generalization is not confined to this belt. The analyses given in this report exhibit onl traces of phosphorous. Further surveys and chemical investigations may bring out a series of ranges of ores containing no phosphorous. In view of the future increasing and wider use of steel over that of iron there is the strongest probability that all ore which can be used in its manufacture will find a more ready sale and greater demand than the ordinary ores containing phosphorous, unless some process, efficient and practicable, can be found which will remove this element so prejudicial to the highest value of iron. In the old method of iron making in the Catalan forge, our ores which had a comparatively large amount of phosphorous in them were used and made excellent bar iron. In this mode of manufacture the phosphorous nearly all went out in the cinder, whereas now, in the more intense heat and greater reducing action of our high blast furnaces, it is released from its combination as existing in the ore and enters the iron. It should here be stated that in the magnetic iron ores of New Jersey the phosphorous is combined with lime, forming the mineral *apatite*, or phosphate of lime, which mineral is only mixed with the oxide of iron of the ore. The grains of *apatite* are plainly seen, and in the small way can easily be separated or picked out. Any method which can be discovered of separating this mineral from the magnetic either *before smelting, by some roasting process*, or by causing it to go out in

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the cinder, will allow of the use of nearly all of our ores in making steel, and work a great change in iron metallurgy, and add *very* largely to the industry of our State. No field seems more tempting to the inventor, and we cannot conceive of any more marked or valuable step in the metallurgy of iron than this would be, nor of one more to be desired. The subject deserves the attention of scientific as well as practical men, and further, of all who are interested in the development of the resources of our State. And when we consider how the great difficulty in the practical use of sulphurous ores has been overcome we feel confident that the inventive genius of our iron workers will yet solve this problem.

The ores which formerly were considered almost worthless in consequence of the large amount of sulphur in them are now successfully used, the removal of the sulphur being effected by treatment in roasting furnaces previous to going to the blast furnace. One of the latest forms of such furnace has been designed and erected by Wm. Taylor, formerly of High Bridge, at Chester, Morris county. This is said to do the work effectually and very cheaply, besides putting the ore in a better condition for smelting than in its raw state.

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