GEOLOGICAL SURVEY OF NEW JERSEY

HENRY B. KÜMMEL, STATE GEOLOGIST

BULLETIN 8

Annual Administrative Report

OF THE

STATE GEOLOGIST

For the Year 1912

INCLUDING A SECOND REPORT ON

SHARK RIVER INLET

BY

C. C. Vermeule, Consulting Engineer

AND

A LIST OF NEW BENCH MARKS

TRENTON, N. J.
MacCrellish & Quigley, Printers, Opposite Post Office.
1913.

Geological Survey of New Jersey.

BOARD OF MANAGERS.[1]

HIS EXCELLENCY WOODROW WILSON, Governor and *ex officio* President of the Board,.....Trenton

Members at Large.

JOHN C. SMOCK,	Trenton,	1913
ALFRED A. WOODHULL,	Princeton,	1914
FRANK VANDERPOEL,	Orange,	1914
T. FRANK APPLEBY,	Asbury Park,	1915
DAVID E. TITSWORTH,	Plainfield,	1916
WILLIAM LIBBEY,	Princeton,	1916

Congressional Districts.

I.	STEPHEN PFEIL,	Camden,	1916
II.	P. KENNEDY REEVES,	Bridgeton,	1917
III.	HENRY S. WASHINGTON,	Locust,	1914
IV.	WASHINGTON A. ROEBLING,	Trenton,	1913
V.	FREDERICK A. CANFIELD,	Dover,	1915
VI.	GEORGE W. WHEELER,	Hackensack,	1916
VII.			
VIII.			
IX.	E. H. DUTCHER,	East Orange,	1914
X.	HERBERT M. LLOYD,	Montclair,	1917
XI.	CLARENCE G. MEEKS,	North Bergen,	1915
XII.	JOSEPH D. BEDLE,	Jersey City,	1913

State Geologist,

HENRY B. KÜMMEL.

[1] As of October 31st, 1912.-In April, 1913, Acting Governor Fielder appointed John H. Cannon, of Paterson, and George F. Reeve, of Newark, to fill the vacancies in the VII and VIII Districts.

Letter of Transmittal.

TRENTON, N. J., March 4th, 1913.

Hon. James F. Fielder, Acting Governor and ex officio President of the Board of Managers of the Geological Survey:

SIR—I have the honor to submit by administrative report summarizing the work of the Geological Survey for the year 1912. This report is made in accordance with Chapter 46 of the Laws of 1912. Several other bulletins on various scientific subjects are nearly ready for publication. These will give in greater detail the results of investigation along certain lines.

Respectfully submitted,

HENRY B. KÜMMEL,

State Geologist.

Administrative Report.

HENRY B. KÜMMEL, *STATE GEOLOGIST*.

Contents.

Administration.
Expenditures.
Organization.
Publications.
Distribution.
Library.
Note recording.
Inadequacy of survey rooms.
Topographic and Engineering Work.
Bench marks.
Revision sheet 37.
Improvement Shark River Inlet.
Geologic Work.
Pleistocene formations of South Jersey.
Shark River marl.
Mineral production.
Well records and underground water.
Chemical Laboratory.
Soil analyses.
Oil, asphalt and pavement samples.
Miscellaneous work.
Soil Survey.
Archaeologic work.
Meetings and Conventions.
Appendix A - Second Report of the Board of Managers and Its Engineer on the improvement of Shark River Inlet.
Appendix B - List of Bench Marks. Revision of 1912.
List of Publications.

ADMINISTRATION.

Law and custom demands an annual report from the State Geologist regarding the work under his direction. This report is distinct and apart from the scientific reports which with varying detail set forth the results of the different investigations carried on by the Survey Staff. These results are published as Bulletins and Final Reports and can be obtained upon application to the State Geologist. In the case of a few reports, the remaining copies of which are less than 200, there is a small charge to cover cost of printing and binding.

Expenditures.—The Legislature annually includes in the regular appropriation bill the funds necessary for the work of the Survey. For the fiscal year ending October 3, 1912, the sum of $16,500 was voted. This was later increased by a supplemental appropriation of $2,000, so that there was available for the customary work of the Survey $18,500. In addition to this amount the last Legislature appropriated $500 for salaries and expenses of archeological investigations and the acquistion of archaeological material. There was also appropriated in 1911 and 1912 the total sum of $2,250 for borings, surveys and plans for permanent improvement of Shark River Inlet, Monmouth County. The total of all sums available for work during 1912 under the direction of the State Geologist, but subject to an immediate audit by a Committee of the Board, was $21,250. The disbursements may be classified as follows:

EXPENDITURES.

Salaries clerical force,	$1,796 36
" scientific force,	11,164 03
Traveling expenses,	1,568 14
Office furniture,	3 50
" supplies,	213 29
Laboratory equipment,	28 12
" supplies,	322 08
Library,	29 95
Postage,	708 25
Express and freight,	107 31
Telegraph and telephone,	50 89
Engraving and printing maps,	2,460 92
Sundries,	226 13
Unexpended balance, lapsed to State treasury,	2,571 03
	$21,250 00

Unexpended balance is to be apportioned to the various appropriations as follows: General, $2.566; Shark River, $3.90; Archaeology, $1.13. In addition to the above expenditures made from Legislative appropriations, the State Geologist received and disbursed the following sums:

Balance on hand November 1st, 1911,	$63 45
Receipts from sales of maps and reports,	990 64
" " laboratory work,	70 00
" " sale of second-hand property,	1 00
	$1,125 09
Disbursements—Paid State Treasurer,	997 90
Balance on hand October 31st, 1912,	$127 19

Organization.—There were no changes in the membership of the Board of Managers during the year, the following members whose terms expired being all reappointed by the Governor for the new terms ending in 1917:

Harrison Van Duyne, Newark—Member at Large.
P. Kennedy Reeves, Bridgeton—Second Congressional District.
Herbert M. Lloyd, Montclair—Seventh Congressional District.

During the year the Legislature made a new apportionment thereby creating two new Congressional Districts and. changing the lines of several old ones. As a result of these changes H. M. Lloyd formerly of the VIIth is shifted to the Xth District; E. H. Dutcher of the VIIIth is now credited to the IXth; J. D. Bedle of the IXth is now in the XIIth; and C. G. Meeks of the Xth represents the new XIth District. There are vacancies in the new VIIth District comprising the county of Passaic except the townships of Pompton and West Milford and in the new VIIIth District, made up of the Eighth, Eleventh and Fifteenth Wards of Newark, Towns of Belleville, Bloomfield and Nutley, in Essex County, and Harrison, Kearny, East Newark, Bayonne and the Seventh Ward of Jersey City.

April first the resignations of Assistants H. M. Poland and S. Percy Jones were received and accepted to take effect the first of May. On August first the resignation of Miss Laura Lee was received and took effect October first.

On May first Henry Jennings, formerly of the Bureau of Soils, U. S. Department of Agriculture, who had been engaged in the Soil Survey work for three years in Northern New Jersey, was engaged to continue his work in soil mapping under the direction of the State Survey. Mr. Jennings had resigned from the Bureau of Soils, and was planning to enter another line of work. The experience which he had gained in three years' work in this State would have made his loss a serious handicap to the work and the Survey was fortunate in being able to retain his services.

Dr. M. W. Twitchell, Professor of Geology at the University of South Carolina and formerly State Geologist of that State, was appointed to the Scientific Staff of the Survey on July first.

He will relieve the State Geologist of some of the routine administrative work of the Survey and will also take an active part in the scientific investigations. Previous to his work in South Carolina, Dr. Twitchell had experience in State Survey work while on the staff of the Maryland Geological Survey.

The vacancy in the office force caused by the resignation of Miss Lee was filled by appointment on September first from the certified list of the Civil Service Commission of Miss Henrietta Kruse.

As in former years most of the men on the Survey rolls are on a per diem basis and are employed only temporarily for specific lines of work. In addition to those mentioned below several employees of C. C. Vermeule, consulting engineer, were engaged on Survey work as in previous years, but under ruling of the Civil Service Commission, these are not regarded as on the Survey Staff.

The following persons were employed during the last fiscal year:

Henry B. Kümmel, State Geologist.
M. W. Twitchell, Geologist.
R. B. Gage, Chemist.
R. Percy Jones, Geologist.
Henry Jennings, Assistant in charge of Soil Mapping.
H, M. Poland, Assistant in charge of Collection of Well Data.
Laura Lee, Clerk and Stenographer.
Henrietta Kruse, Clerk and Stenographer.
John S, Clark, General Assistant.

C. C. Vermeule, Topographer and Consulting Engineer.
R. D. Salisbury, Geologist.
J. Volney Lewis, Geologist.
D. W. Johnson, Geographer.
Ray Pinkle, Assistant on Soil Survey.

Alanson Skinner, Assistant. Archaeology Survey.
Max Schrabisch, Assistant. Archeology Survey.

John G. Baumann, Janitor at Laboratory.

Publications.—The new plan of publications of the Survey reports does not seem to be thoroughly understood. Previous to 1909 the Annual Report of the State Geologist for each year included miscellaneous scientific papers. These were of diverse nature and rarely could all of them be of interest to persons

receiving the entire report. This meant more or less waste in distribution, although the publication each year in a single volume of all the scientific reports did bring to the notice of those receiving it, the varied activities of the Survey. It was felt, however, that economy in printing and distribution would be better served by publishing as separate bulletins the various scientific reports. In this way, those requesting specific information could be sent what they wished unencumbered by extraneous matter, while at the same time each report would stand by itself and would not be lost sight of by being bound up with others and included in an "Annual Report." Recognizing, however, that there were a few institutions and persons who for peculiar reasons might properly have all reports. it was arranged to make up a limited number of "Year Books" comprising the bulletins published during the year. Since, however, these are restricted to 100 copies, they are reserved chiefly for libraries. Up to the present time seven bulletins in the new series have been published and their titles are given on page . The publications during the past year were as follows:

New editions of atlas sheets.

Elizabeth, Boonton, Paterson and Jersey City. Scale, 2,000'=1 inch. Sheets Nos. 24, 25, 28. Scale, 1 mile = 1 inch.

Bulletin 6. The Administrative Report of the State Geologist for the year 1911, by Henry B. Kümmel, State Geologist. Including a Report on Shark River Inlet by C. C. Vermeule, Consulting Engineer, pp. 82 and IV Plates.

Bulletin 7. The Mineral Industry of New Jersey for 1912, by Henry B. Kümmel, State Geologist, pp. 37.

Distribution.—The demand for the maps and reports of the Survey continues with little variation. The topographic maps are sold at the uniform price of twenty-five cents per sheet, which includes postage, while the geologic folios cost from twenty-five to fifty cents, postage extra. No charge is made for the reports of the Survey except in the case of some volumes of which only a few copies remain on hand for distribution. These are sold at cost price. Recipients are requested to pay the cost of transportation of certain of the larger volumes.

The following is a list of the reports which can be obtained only by purchase:

Annual Report for 1883, ... Price, $0 50
Annual Report for 1892, ... Price, 1 55
Annual Report for 1903, ... Price, 40
Annual Report for 1905, ... Price, 55
PaleontoIogy, Vol. I-Braciopoda and Lamellibranchiata of the Raritan Clays and Greensand Marls of New Jersey. To residents of New Jersey, by express charges collect : to non-residents, $1.50, express charges prepaid.
Paleontology, Vol. II-Gasteropoda and Cephalopoda of the Raritan Clays and Greensand Marls of New Jersey. To residents, by express, charges collect ; to non-residents, $1.40, express charges prepaid.
Paleontology, Vol. III-Paleozoic Paleontology, ... Price, $ 1 00
Paleontology, Vol. IV-Cretaceous Paleontology, ... Price, 2 70
Final Reports, Voy. II, Pt. 1-Mineralogy, Botany, bound, price $1.50; unbound, postage 25 cents.
Final Reports, Vol. IV-Report on the Physical Geography of New Jersey, paper over, price $1.00; bound, price $1.35; photo-relief map, $1.50 extra.
Final Reports, Vol. VI-Report on Clay Industry of New Jersey. bound, $1.60.

The sale of maps by the Survey during the past three years has been as follows :

	Sheets sold		
	1910.	*1911.*	*1912.*
Maps on scale of 1 inch per mile, ...	1485	1491	1718
Maps on scale of 2½ inches per mile, ...	2039	2096	1658
Geologic folios, ...	150	65	69

Several of the bulletins printed late in the previous year were mainly distributed early in the fiscal year covered by this report. In addition Bulletins 6 and 7 were distributed as soon as published and during the year many requests for back reports were received and filled. The total number of reports sent out was 10,856.

Library.—The Survey library continues to increase chiefly by exchange, but to some extent by purchase. It now numbers 1,054 bound volumes, 4,107 unbound volumes and pamphlets and 2,101 maps. During the year the accessions were 48 bound volumes, 164 paper covered volumes and pamphlets, and 65 maps and atlases.

Note Recording,—In the Administrative Report for last year, a new system of note recording was described. This system has been in successful operation during the past year by men engaged in diverse lines of work, as the archaeological survey, the soil survey and stratigraphic studies. In all of these lines, this system has been successful in affording an accurate and not too

complicated method of recording the localities exactly. In this system, every locality in the State can be represented by a combination of numbers peculiar to itself. This combination represents, first, the number of atlas sheet, and second, the exact point within the sheet. Each atlas sheet is divided into rectangles measuring 6-minutes of latitude and 6-minutes of longitude. Beginning in the upper left-hand corner, these are numbered across the sheet from 1 to 5, inclusive, number 5 being an incomplete rectangle comprising 2-minutes of longitude at the right. Those on the second row are numbered 10 to 15, those on the third 21 to 25, those on the fourth 31 to 35 and on the fifth 41 to 45. The rectangles numbered 41 to 44, inclusive, differ from the others in comprising 6-minutes of longitude and 4-minutes of latitude. Number 45 embraces 2-minutes of longitude and 4-minutes of latitude. Each of these rectangles is divided into smaller rectangles measuring 2-minutes of latitude and 2-minutes of longitude by lines already engraved upon the sheet. The 2-minute rectangles in each of the 6-minute rectangles are numbered from 1 to 9 beginning in the upper left-hand corner and numbering to the right, number 4 being on the left under number 1. The subdivisions of the incomplete 6-minute rectangles on the right of the sheet, *i. e.*, those numbered 5, 15, 25, 35, are numbered 1, 4, 7, of those at the bottom, *i. e.*, numbers 41, 42, 43, 44, the subdivisions are numbered 1, 2, 3, 4, 5, 6. The subdivisions of the incomplete rectangle in the lower right-hand corner, number 45, are numbered 1, 4. It is evident that by writing first the number of the atlas sheet: second, the number of the 6-minute rectangle; and third, the number of any 2-minute rectangle, we can form a combination of numbers peculiar to any 2-minute rectangle within the State. In order to locate points more accurately each of the 2-minute rectangles is divided into nine equal parts, numbered from 1 to 9, beginning in the upper left-hand corner, and each of these is again divided into nine, numbered similarly. The smallest rectangle represent areas about 330 yards from east to west and 440 yards from north to south. By adding the appropriate numbers of these two smaller divisions to the three already written, it is possible

to get a combination which represents the exact location of any area 330x440 yards. If it is desirable to locate a point still more definitely, a small rectangle representing this area can be drawn in the note-book and a dot inserted in the appropriate place to represent the exact point of observation.

In actual practice, it has not been found necessary to rule upon the field maps any lines subdividing the 2-minute rectangles. The smaller divisions can be more conveniently ruled and numbered on a small piece of tracing cloth or of transparent celluloid which can be laid upon the map in the desired position and from which the smaller numbers can be read. When not in use this is conveniently carried in a pocket in the cover of the note-hook. In practice a dot is made on the field map at the point of observation. The number of the atlas sheet of the 6-minute rectangle and of the 2-minute rectangle is entered in the note-book from the map. The transparent guide is laid on the map and fitted to the boundaries of the 2-minute rectangle. Then the numbers of the two smaller divisions are read off.

One advantage of a definite system of this character is that it permits anyone reading a survey report in which in addition to a general description of a locality, its exact position is given by this system, can fix it on any survey atlas sheet for himself if he so desires. Specimens labeled with this number can always be referred to their original source, even if the original field map be not at hand. Cumbersome descripitions of localities are also avoided.

Survey quarters inadequate.—The crowded condition of the quarters available for the work of the survey is such as to interfere very seriously with the efficiency of its workers. There is one room measuring 19 by 15 feet which is shared with the Forest Commission of which the State Geologist is Executive Officer. In this are five desks, table, filing cases and four clerks. Not a single article of furniture can be spared and there is barely room to properly transact the routine business. Callers waiting an opportunity to consult the State Geologist or the Forester are compelled to stand for lack of room. The only other office room measures 13 by 14 feet and serves as the private office of the State

Geologist and the department library. It contains 66 unit bookcases (11 vertical rows), a filing case, desk, and a drafting table which now has to be used as a desk for Dr. Twitchell. He is constantly interrupted in his work by the conversation of callers to see the State Geologist and by the transaction of routine work. There is no room for sorting out material collected in the field so that it can be studied nor for the preparation or proof-reading of maps, etc. It has been necessary to arrange for one field man to work to the State Experiment Station at New Brunswick during the winter, largely through lack of room at the capitol.

In addition to the meager office room described, the Survey has a small fireproof vault in another portion of the State House and several storage and shipping rooms in the basement. The latter are fairly adequate for their needs but of course cannot be used as rooms for scientific investigations.

For several years it has been necessary to maintain a chemical laboratory in connection with the Geological Survey. The work in this department is constantly growing, very largely because of the co-operative work which the Survey has been asked to undertake in behalf of other departments of the State. In addition to the chemical work incidental to the investigations of the Survey, a great deal of work is constantly being done in the way of testing oils and bitumens used in the construction of State-aided improved roads. This work is largely physical rather than chemical and cannot be carried on in the same room and with the same apparatus as is used. in chemical determinations. Every year there has been urgent need for the testing of more road materials and wider experimentation along these lines. This work must be carried on if the State is to build properly certain classes of roads and apparatus and quarters must be provided for the work. The loss which may ensue to the State under a single contract from the use of improper material may exceed the entire cost of a properly equipped laboratory.

For the past nine years the Survey has occupied, free of charge, the second story of a brick building belonging to Col. W. Roebling, a member of the Board of Managers. While the best that could be obtained under the circumstances it was not

planned for a chemical laboratory and all work which has been done there has been carried out at considerable inconvenience.

The rooms occupied are as follows:

Analytical Room.—Dimensions 12 by 13 feet, two windows, north exposure. This room contains hoods, sink. water still, table for work, drawers, etc. It is the only room except the toilet with running water and sewer connections. Two closets opening off this room are 4 by 5 feet which are used for storing glassware and chemicals.

Grinding Room.—Dimensions 8 by 8 feet, one window, western exposure. This room contains three pieces of machinery and an electric motor for crushing and grinding rock samples and fro separating bitumen. In order to install this machinery, it was necessary to set it up in the toilet room.

Oil Testing Room.—Dimensions 10 by 10½ feet. with a small closet 2 by 8 feet, two windows, north exposure. This room contains gas ovens, water baths, cupboard for storing small apparatus. It is used chiefly in the testing of oil and bitumens but is not sufficiently large to accommodate all the apparatus used in this work.

Weighing Room.—Dimensions 10½ by 15 feet, four windows, south and west exposure. This room contains the working library of chemical books, analytical balances, and numerous bitumen-testing machines.

Office and Record Room.—Dimensions 10 by 16 feet, with closet 5 by 4 feet, two windows, south exposure. This room contains a filing cabinet, desks for chemist and assistant, typewriter, table for microscope, etc.

Store Room.—In connection with the work of the laboratory, it is necessary to store for considerable periods large numbers of samples of materials, awaiting examination or kept for future references in case the accuracy of the determinations should be questioned. This is particularly true in the case of road materials, where, under some contracts, the successful bidder is required to file samples of the materials to be used. These have to be kept for comparison with samples of the materials actually used in the road, until the work is completed and the road ac-

cepted. A large store room, readily accessible, is therefore necessary. The room at the present laboratory available for this purpose is in the air chamber between the ceiling and the roof. It is reached by a vertical ladder through a narrow trap door and a more inconvenient place to store samples can hardly be imagined.

So crowded are the present laboratory quarters that it is impossible to install several pieces of machinery of which there is urgent need for certain lines of work. The time has certainly come when the State should make adequate provision either by the erection of a special building for the office and laboratory of the Geological Survey alone, or preferably by the construction of a large building specially designed to house all scientific departments of the State Government. Until larger quarters are provided, the work of the Survey will continue to he done under conditions which very greatly reduce the efficiency of its workers.

TOPOGRAPHIC AND ENGINEERING WORK.

Mr. C. C. Vermeule has continued in charge of the Topographic and Engineering work of the Survey. In this he has been chiefly assisted by Mr. P. D. Staats.

Bench Marks.—During the summer of 1911, in connection with studies of the stability of the New Jersey coast, it was apparent that many of the old bench marks established, during the original Topographical Survey between 1877 and 1887 have been obliterated. Owing to the extreme economy with which this earlier work of the Survey was done, an economy so rigid that the total cost of the field work and the preparation of manuscript maps on a scale of three inches to a mile amounted to only $6.93 per square mile (exclusive of some triangulation by the U. S. C. & G. S.), it was not possible to establish as many permanent bench marks as would have been desirable. A large number of secondary elevations were listed in the Report on Topography, but it was found that these lists were fast losing their value owing to the disappearance of these marks. Accordingly, last March, the Legislature was requested to grant an increase in the Survey

appropriation to permit the running of new lines of levels and the establishment of new bench marks. This increase was granted and in the autumn two parties were placed in the field. Mr. Vermeule has submitted the following report of their operations :

NEW YORK, November 27th. 1912.

Dr. H. B. Kümmel, State Geologist, Trenton, N. J.:

DEAR SIR—I send herewith a report of the leveling operations from September 16th to October 31st, inclusive. During this period there were two leveling parties in the field.

Mr. Jeffrey R, Hosking started at Paterson, including the bench marks on the Morris Canal at Centreville and Richfield, and worked westward along the line of the Delaware, Lackawanna and Western Railroad to Phillipsburg and Easton. He also made a branch run to Morristown, examining all of the original bench marks of the Survey, so far as they could be found, and verifying their elevations. He also stablished a considerable number of new bench marks. The statistics of his work are as follows:

Number of miles run once,	83
Number of miles repeated,	39
Old marks re-established,	31
Old marks missing,	25
New bench marks established,	93

You will note that during 40 working days, of which 4 were lost by storm, 36 days being actually employed in leveling, this party leveled 122 miles, or an average of 3.4 miles per day.

Mr. Staats operated in Hudson, Bergen and Passaic counties, and also in Newark and Bloomfield, Essex County. His operations were generally similar to Mr. Hosking's, including the examination and verification of the original bench marks and the establishment of new bench marks. The statistics of his work are as follows:

Number of miles run once,	89.6
Number of miles repeated	15.4
Old marks re-established,	32
Old marks missing,	17
New bench marks established,	86

The rate of leveling was for this party 2.92 miles per day. It should be stated that much time was necessarily consumed in preliminary examinations of the old bench marks and in looking up sites for new bench marks. Mr. Staats, in his territory, Was often delayed considerably in getting permission to place bench marks on public and private buildings. In neither case was anything like all of the time employed in the actual running of levels, and bearing this in mind, the running of a total of 227 miles of levels by the two parties during 36 working days, averaging almost exactly 3 miles a day, per party, must he considered a very satisfactory rate of progress.

You will observe that the two parties together established 179 new bench marks in the place of 42 old bench marks lost; consequently, where we had formerly 105 bench marks in all, we have, as the result of the work during the period covered, 242, showing a substantial increase in the number of bench marks. You will also observe that about 40% of the old bench marks are missing.

The cost of the foregoing work was $1,253.38, being at the rate of $5.52 per mile for 227 miles of levels run, or at the rate of $5.18 per bench mark for 242 resulting bench marks.

Respectfully submitted,

C. C. VERMEULE.

Since the leveling parties were already organized and at work, it was decided to continue the field work into the new fiscal year as long as weather permitted. The parties remained in the field through November and the early part of December. In the list of bench marks, which they have established, given on p. 58, no distinction is made between those located before the first of November and those in the present fiscal year. The latter, though strictly belonging to next year's report, are there included, in order that the data may be made public at the earliest possible moment.

Revision of Sheet 37.—In accordance with the policy of the Survey to engrave from time to time copper plates to replace the worn-out lithographic stones of the atlas sheets, work has been started on sheet 37, comprising chiefly Cape May County. As a preliminary, the culture was corrected in the field in order to incorporate the many changes which have occurred since the original survey. In the belt between the main shore road and the ocean, these changes were so extensive that it was necessary to make entirely new drawings for the engraver. For the remainder of the sheet, the additional corrections will he made upon photographs reduced from the original mother map made in 1884. An entirely new projection on a scale of one inch to the mile has been laid down for the use of the engraver with measurements carefully marked in order to secure accurate control of the engraving, The route of the Inland Waterway will be shown on the revised map as well as the extensive improvements at Cold Spring Inlet, the new harbor at Cape May and the new railroad to Wildwood.

Improvement of Shark River Inlet.—An act of the Legislature approved May 1, 1911, appropriated the sum of $1,000 and directed the Board of Managers of the Geological Survey to employ an engineer to make a survey of the mouth of Shark River and to draw plans and make estimates of the expense of making a permanent inlet thereto. In accordance with this action the Board of Managers appointed a Committee, consisting of Messrs. Harrison Van Duyne, Clarence G. Meeks and T. Frank Appleby

to employ an engineer and carry out this work. Mr. Vermeule, Consulting Engineer of the Survey, was requested to make these plans and estimates and a preliminary report was submitted to the Board under date of February 5, 1912, in time to be published as an appendix to the Administrative Report of the State Geologist for 1911, although its preparation was a part of the work of the present fiscal year. Only a portion of the appropriation was used in the preparation of this preliminary report, but the balance was inadequate to make the necessary borings and to carry the work to a point which would enable the engineer to prepare the final plans and specifications. The report as submitted by the Engineer was transmitted to the Governor, under date of February 14, 1912, with the recommendation that "If the improvement of Shark River Inlet be deemed by the Legislature to be of public importance, the Board of Managers of the Geological Survey recommends that this plan be adopted."

A further appropriation of $1,250 was made in the supplemental appropriation bill, approved April 3, 1912, for completing the survey. This was done and the final report and specifications, under date of October 21, were presented by the Engineer.

The Legislature also appropriated the sum of $35,000 for the purpose of making a permanent inlet at Shark River, the work to be done under the management and supervision of the Board of Managers of the Geological Survey. This appropriation, however, was conditioned upon the municipalities adjacent to Shark River raising and placing at the disposal of the Treasurer of the State of New Jersey the sum of at least $20,000 to be used in conjunction with that appropriated by the State. The required amount was promptly appropriated by the municipalities involved and soon after the close of the fiscal year, a portion of it was paid into the State Treasury. At its meeting, December 3, 1912, the Board of Managers accepted the report of the committee and the accompanying final plans and specifications of the Engineer and directed the State Geologist to advertise for bids as soon as the terms of the law regarding the improvement had been fully complied with by the municipalities. The report of the commit-

tee, the action of the Board and the final plans and specifications of the Engineer are fully set forth on pp. 38-53 of this report.[1]

GEOLOGIC WORK.

Report on the Pleistocene Formations of Southern New Jersey.—The manuscript of a report upon the Pleistocene Formations of Southern New Jersey, by Prof. R. D. Salisbury, has been received for publication. This report summarizes the results of field studies commenced in 1892 by Mr. Salisbury and his assistants, chiefly, G. N. Knapp, and continued at intervals until 1905. Reports of progress were made in a number of Annual Reports of the State Geologist, notably those of 1892, 1893, 1894, 1895, 1896 and 1900. Mach additional field work in the way of revision of mapping and study of alternative hypotheses was done subsequent to 1900, but further publication of results in the Survey reports was reserved until the final report should be prepared. This has been considerably delayed, chiefly because of the very brief period each year that Mr. Salisbury could spare from his many other duties for this work. In the interval, however, descriptions of Pleistocene deposits have been prepared and published as part of the text of the Philadelphia and Trenton Geologic Folios issued in co-operation with the U. S. Geological Survey.

The final report now in manuscript will be published as soon as the State Printing Board authorizes its printing.

Shark River Marl.—Through the researches of Cook, Clark, W. B., and Knapp, the areal distribution and lithologic features of the Eocene of New Jersey are already fairly well known. Whitfield, supplementing the earlier studies of Conrad, Gabb and others, describe the Eocene fauna in detail and Clark, Harris and Vaughan have discussed the correlation of New Jersey Eocene with that of other regions. Since, however, the earlier workers differ somewhat in their mapping of its areal extent and diverse views are held regarding the very interesting question of the re-

[1]Since writing the above, bids were received on Feb. 27th, and rejected because they exceeded the amount available for the work. The Legislature made an additional appropriation early April and the plans were slightly modified so as to reduce the cost. New bids are to lie received May 8th.

lation which the New Jersey Eocene bears to that of other regions, more particularly that of Maryland and Virginia, it has been thought desirable to reinvestigate the New Jersey deposits, and the fossils obtained from them. The degree of the diversity of opinion as to the proper correlation of the New Jersey Eocene is shown by the fact that Clark regarded it as older than that of Maryland and Virginia; Harris, according to Dall, regarded it as younger, while Vaughan is inclined to think it is younger than "The Aquia Creek beds of the Pamunkey" of Maryland. In view of these different conclusions the investigation was begun and at the request of Dr. M. W. Twitchell was assigned to him. He commenced field work in September.

Careful examination was made of the ocean bluff near Deal Beach, the several arms and adjacent ravines of Deal Lake, the main stream and branches of Shark River near Hamilton, the main stream and branches of the Manasquan River near Farmingdale and the Metedeconk River near Bennett's Mills, and detailed study made of every exposure. At least fifteen good sections of the Shark River Marl, the only Eocene formation in New Jersey, were found, six near Deal Lake, three along Shark River and six along Manasquan River. Fossils were collected at nearly every one and these collections constitute a valuable addition to the materials already in the State Museum, as their exact geographic and stratigraphic position is known, and the relative abundance and value as index fossils of certain species can be in large measure determined from them. The fossils were casts and, as the matrix became pulverulent on drying, had to be promptly treated with melted paraffin to preserve them.

A start has been made upon the study of the fossils collected; but this work has not yet proceeded far enough to justify any final statement at the present time. It may be said, however, that as the result of his investigating, Dr. Twitchell has fixed more definitely than before the areal extent of the Shark River Marl, at present actually exposed or covered only by post-Miocene formations and has made some corrections in the maps of previous workers. He has determined the uppermost exposed layer of the New Jersey Eocene to be a light-green non-glauconitic sandy

clay, carrying fossils, and passing gradually downward through layers intermediate in character to the typical dark bluish-green, mottled, highly glauconitic layer known as the Shark River Marl. The so-called "indurated layer" at the top of the Shark River Marl is not a distinct stratigraphic layer, but an induration of whatever portion of the bed happens to be nearer the surface, and therefore to have lost some of its moisture. He has also discovered fossils in the "Ash Marl" of Cook. *i. e.*, the upper layer of the Manasquan formation. The fossils are not very abundant and consist chiefly of casts of poor quality; but they may enable us to determine whether the "Ash Marl" is Cretaceous, as hitherto held, or Eocene. If it proves to be Eocene then the areal extent of the Eocene formations of the State will be somewhat enlarged.

Mineral Production.—Early in the year the statistics of the mineral production of the State for 1911 were collected by co-operation with the U. S. Geological Survey and were published as Bulletin 7, issued in June. The total value of the mineral industry for 1911 amounted to $37,716,411, a substantial increase over the figures for 1910. This is equivalent to an average of $4,585 per square mile of territory and $15 per capita of population, on the basis of the last census. It is evident that New Jersey has maintained its high rank in the value of her mineral productions per square of territory.

The lists of producers comprise approximately 700 names from practically all of whom some reply is received. Those who do not answer at first, second or third requests for information are favored with a registered delivery letter, a telegraph request, a long-distance telephone call, and finally, if all else fails, and the matter is of importance, with a personal call from an assistant. A few producers, by their neglect to return the inquiry cards properly filled out, delay very much the completion of the work and at the same time increase the expense. Co-operation with the National Survey has reduced the expense of this work, since all correspondence in this line is done under frank and the necessary blanks are furnished by the U. S. G. S.

Well Records and Underground Water Supplies.—The question of underground water supplies continues to be one of great interest to many citizens of the State and the Survey receives frequent requests for information and advice. These come both from individuals, municipal officers, and from State Boards. In every case all the information available is freely imparted, even though it may necessitate considerable investigation by some one of the Survey staff to get at the pertinent facts. During the year the State Geologist has been consulted by the authorities of the State Prison at Trenton and by the Fish and Game Commission, by Borough and County authorities and by individuals. In many cases this office is not advised of the final results, so that the State Geologist does not always know whether the information given has been of assistance or not, or whether his suggestions have been followed.

In view of the wide application of much that is contained in some of these replies, they may be of general interest and several of them are here included.

Endeavors to obtain water in the granites, gneiss or trap rock of Northern New Jersey frequently are unsuccessful or only partially successful. The Saddle River Oil Co. drilled along the Pequannock River 3 miles above Butler, and penetrated first glacial drift 125 feet, then hard granite gneiss to 4o6 feet. A little water was obtained at 8o feet in drift, and some in rock at 198 feet. The company wrote asking for the depth at which water might be found *under* the granite gneiss. Inquiry was not made until after drilling over 400 feet. The following reply was sent:

TRENTON, N. J., Sept. 9th, 1912.

Mr. C. J. Skidmore, Saddle River Oil Co., 26 Broadway, New York City:

DEAR SIR—I have your letter of September 7th in reference to a well you are drilling below the Newark Water Company's intake on Pequannock River. If you have not obtained the amount of water you need, I cannot advise you to go any deeper. In fact I should advise you not to because I believe your chances of obtaining water are steadily diminishing. It has been found as a result of drilling several hundred wells in the granite and gneiss rocks of Connecticut and New Jersey that the chances of obtaining water decrease below 250 to 300 feet.

There is no possibility of penetrating the rocks you are in as they represent the very foundations of our geologic system. Of course with deeper drilling you may find slight variation in the texture of the rocks, and there is a remote possibility that your drill would intersect a water-bearing fissure, but the chances of this are diminishing with every foot of increased depth, and I should not advise further drilling.

Before abandoning the well you might find it advantageous to shoot it with dynamite at about the depth at which water was found in the rock.

Yours truly,

HENRY B. KÜMMEL,

State Geologist.

A somewhat similar case was that of the State Prison, Trenton. No attempt was made to utilize the in formation on file in this department until after the work was commenced and a dry hole 300 feet deep obtained. Later in response to a request for information the following letter was sent the Supervisor:

TRENTON, N. J., March 5th, 1912.

Mr. Samuel W. Kirkbride, Supervisor, State Prison, Trenton, N. J.:

DEAR SIR-In response to your request I am pleased to put in writing substantially what I told you and the other gentlemen in your office this morning regarding the possibility of obtaining water on the State Prison grounds.

The data at hand show that these grounds are underlain at a depth of about 40 feet by crystalline rock, which we may refer to in general as granite or granite gneiss. These rocks are extremely dense, the pore space in them being considerably less than 1 per cent. That is, a mass of this rock without cracks would absorb through its microscopic pores less than 1 per cent. of its volume of water. The denseness of this rock as compared with some porous sandstones is shown by the fact that the latter absorb as high as 25 per cent. of their volume. This being the case, the only water which can be expected in this formation is contained in cracks and crevices which traverse it and which lead downward from the surface or intersect other cracks which communicate with the surface. Whatever water exists in the rocks has beyond all question fallen as rain water in comparatively close vicinity to the wells, and, after percolating through the overlying stratum of more or less clayey gravel, found its way into these cracks.

A large part of Connecticut is underlain by rocks of similar character to that at the State Prison, and the results of 300 borings are on record. The yield varied from nothing to 200 gallons per minute, the average being about 15 gallons. Only three wells were reported as yielding more than 100 gallons per minute, and eight wells 6o to 100 gallons per minute, although the yield of several others is reported as "good," large" or "very large." About 10 per cent. yielded less than 2 gallons per minute.

In New Jersey very similar results have been obtained. Of twelve wells drilled in gneiss and granite near Bernardsville, the average yield was only 15 gallons per minute, although one well was reported to give 100 gallons per minute.

You will note, therefore, from the above that it is not often that large yields of water can he expected from this formation.

The Connecticut wells range from 15 to 845 feet in depth. The deepest of those in New Jersey, in this formation of which I have record, are a little over 700 feet. Experience has shown that the most ample supplies are usually (though not exclusively) found within 250 feet of the surface. Below that depth the chances of obtaining water decrease. Since the cost of drilling also increases with depth, it is usually better not to continue a boring in this rock below 250 or 300 feet. If water has not been obtained within that depth, it is usually better to try another hole elsewhere than to continue the old one.

Experience has shown that it is sometimes possible to increase the yield in wells of this character by shooting them. This shatters the rock in the vicinity of the well and increases the possibility that streams of water in cracks adjacent to the boring will be tapped.

I therefore, recommend that, if you are advised by men who have had experience in shooting wells, that your well can be shot without danger to

the neighboring buildings, it be done, as I understand that at a depth of 300 feet it is practically dry.

I might add that there is no probability whatsoever that by deeper drilling you will reach a geologic formation materially different from that in which the well is now located. Minor variations in texture, color and hardness of the rock may be expected, but I know of no reason which would warrant me in expressing the belief that a water-bearing stratum can be reached by deeper boring. There is, of course, a possibility that at a greater depth the boring would intersect a fissure or shattered zone in the rock through which considerable water might be obtained. On the other hand, the greater the depth the greater the pressure and the more the tendency to close all joints and cracks by the mere weight of the overlying rock.

Yours truly,
HENRY B. KÜMMEL,
State Geologist.

In response to a request regarding ground water conditions near Stanhope, the following letter was written:

TRENTON, N. J., February l0th, 1912.

Dr. D. A. Feddle, 378 Ninth St., Brooklyn, N. Y.:

DEAR SIR—In reply to yours of recent date regarding water near Stanhope, N. J., I would state that I cannot give you any very definite information without making a personal inspection of the ground. All the underlying rock in that region is a very dense, hard crystalline rock, technically a granite gneiss. This rock is practically impervious to water, except as it is traversed by numerous joints and cracks. In some places these are so numerous that a well 200 or 300 feet deep intercepts a sufficiently large number to obtain a moderate supply. Yields of 25 gallons per minute are rather the exception than the rule. In most cases the yield is less.

The gneiss rock is overlaid to a greater or less thickness by a mantle of glacial drift. This varies from sand and gravel to a tough, stony and bowldery clay. Locally it is so thin that the underlying rock is within a few feet of the surface, or, in fact, appears at the surface. In other places, not necessarily very remote, the drift may attain depths of 100 feet or more. Where it attains considerable thickness, and is an open texture, the best chances of obtaining water are in its lower portion, inasmuch as the ground water would tend to accumulate in the basal portion of the drift just above the relatively impervious rock.

If the rock outcrops on your property or in the close vicinity, the chances are that it does not lie very deep where you will have to drill. If, however, there is any reason to believe that the rock lies deep, the chances of obtaining water in the drift are very much better.

If you drill, I would not recommend that you penetrate the bed rock for any great distance, provided it is covered by a considerable thickness of drift, for if you do not obtain the water you need in the drift there is even less chance of your getting it in the rock. If, on the other hand, the rock lies very close to the surface, it may be worth while to drill not to exceed 250 feet in the granite gneiss.

Yours truly,
HENRY B. KÜMMEL,
State Geologist.

The Empire Steel and Iron Company, desiring to supplement their water supply for use in the furnace and power plants at Oxford Furnace, wrote the Survey for information before spending money in drilling. The reply sent was as follows:

TRENTON, N. J., May 31st, 1912.

Mr. J. S. Stillman, Empire Steel and Iron Co., Catasauqua, Pa.:

DEAR SIR—I have your letter of May 28th in reference to a boring at Oxford, with a view to increasing your water supply. The mines at Oxford will give you the best information you can get regarding the possibility, or probability, of obtaining an adequate supply of water in the crystalline rocks at Oxford. I do not know whether your mines there are very wet or not. The amount of water you could expect to obtain from a well sunk in the crystalline rocks on the sides of the valley would bear about the same proportion to the amount you have in your mines as an 8-inch hole has to the area of the mines. It is, of course, possible that the 8-inch hole might strike a fissure containing a very considerable quantity of water, and so yield proportionately more. But, on the other hand, it is equally possible that the hole might penetrate for its whole length comparatively dry rock.

In the bottom of the valley the bed rock is somewhat deeply buried beneath the unconsolidated deposits of clay, gravel and muck. Along the railroad track, about one-quarter of a mile north of the station, there is an outcrop of a limy sandstone which rests upon the crystalline rock, and which in other portions of the State always underlies the blue limestone. Its occurrence here has been interpreted to mean that a tongue of limestone extends up the valley from the northeast perhaps as far as the furnace. If the unconsolidated deposits on top of the rock are of considerable thickness, as seems to be the case from the absence of any rock exposures, I think there is a pretty good chance of your getting the supply of water in the valley. If the basal beds of this unconsolidated material are coarse gravels, your chances are much increased, as the rock below would form an impervious layer, holding the water in the gravel. I doubt whether you would obtain a great supply of water in the rock, if you do not find it in the layers above the rock. Your best chance of obtaining water is along the central line of the valley, as the ground water from the sides of the valley would tend to concentrate along this line. * * *

Yours truly,
HENRY B. KÜMMEL,
State Geologist.

It will he noted that the essential points in these four letters are the following; 1. Granite and gneiss rock have so dense a structure that they contain practically no water in pore spaces. The only water in these formations is contained in the cracks and crevices by which they are traversed. 2. Experience has demonstrated that the chances of obtaining adequate supplies are best in the upper 250 feet of these rocks, and they decrease with greater depths. 3. There is absolutely no basis for the hope that it may he possible to drill through this formation and reach other strata beneath. 4. While there is a remote possibility that a large open fracture carrying much water may be found at depths greater than 300 feet, the probability is extremely remote and does not warrant the necessary expenditure. These conclusions are of wide application—since they hold true for all of New Jersey underlain by granite or gneiss rock. Except No. 3 they are also true for all territory underlain by trap rock.

A request for information regarding the possibilities of obtaining a flowing well at the State Game farm at Forked River was received from the Fish and Game Commission. A good supply of water at about 180 feet had been obtained, but it rose only within 4 feet of the surface and did not overflow. A flowing well was desired to furnish water for the bird pens, animal paddocks, etc., without the cost of pumping. The data at hand regarding deep-water horizons at that locality were meager, but such as they were, it seemed probable that there were two chances in three of obtaining a flowing well at a depth of 400-450 feet. Subsequent drilling showed that this estimate was somewhat in error, the water-bearing stratum being reached at 509 feet. The pressure, however, was sufficient to raise the water several feet above the surface and at a height of 2 feet above the surface give a moderate flow.

Before leaving this subject, the State Geologist wishes to emphasize the importance of sending to this office complete records of all new wells drilled. These should include the following facts: Location, elevation and name of owner; record of strata passed through, depths at which water was struck, height water rose in pipes, yield on pumping test, amount water was lowered by pumping test. More and more, property owners and well drillers are availing themselves of the data on file in the office of the State Geologist and are applying for information. It must be remembered that he is able to answer questions of this nature chiefly because of the records on file. The more complete these records, the more accurate and detailed the information available. The hearty co-operation of all well drillers and property owners who have wells drilled is therefore strongly urged.

CHEMICAL LABORATORY.

The work in the laboratory has continued in charge of Mr. R. B. Gage, who has been assisted by Fred Baumann. In substance, Mr. Gage's report of the operations there during the past year is as follows:

The major part of the work has consisted in making analyses of soil samples collected in the progress of soil survey investiga-

tions and of asphalts, oils, paving mixtures and pavement samples for the State Road Commissioner. These two lines of work are carried along together, so that it is hardly possible to state how much time has been given to each. It is approximately shown by the numbers of samples of the different materials which have been analyzed, but this method is not entirely satisfactory since some materials naturally require much more time for analysis than others.

Soils.—Sixty-three complete analyses of soil samples have been made and eighty-six other analyses have been checked up for the determination of certain elements. In some only one or two determinations are thus checked, while in others several are made, if, for any reason, the first analysis is found to he questionable. Owing to the inadequate facilities, these analyses represent the expenditure of much more time than their numbers would indicate, for it is impossible under present conditions to work on certain determinations while others are being made. It has, therefore, frequently been necessary to suspend all other kinds of work when determinations of this character are made.

During the year considerable new apparatus has been installed which will greatly facilitate the work and increase its accuracy. In order to place some of this, the laboratory had to be partly remodeled. Considerable time was consumed in making these changes, during which very little scientific work could be done.

In addition to the analyses of the soil, several samples of water have been tested and preparations were made for testing samples of coal purchased by State institutions under contracts based on the heat-producing qualities of the coal. No samples of coal were tested during the last fiscal year, but determinations made since demonstrate quite conclusively the necessity of these tests if coal of proper quality is to be obtained.

Oils, asphalts and pavement samples.—Tests of these materials have been made at the request of the State Road Commissioner in accordance with the plan of co-operation existing between the two departments. The greater part of the expense of this work has been paid by the Road Department. Much more work in this line has been done during the past year than ever before.

An endeavor has been made to test each shipment of asphalt used on all roads to the cost of which the State made any contribution. This necessitated testing over 200 samples of asphalt and about 75 samples of oil. In addition to the examination of these bitumens over 100 samples of pavements. paving sands and stone were tested.

In order to protect the State thoroughly in the construction of bituminous pavements, samples of the pavement should be taken each day during construction, in order to determine that the required amount of bitumen and the proper grade and quality of road metal have been used and also that the pavement is of the proper composition. With the force of men and laboratory equipment available, it was impossible to do this for all pavements laid during the past summer. Additional apparatus has now been secured, and it is hoped that with the employment of another assistant these tests can be made in another season. With an additional helper, one chemist can handle the soil and another the asphalt work exclusively so that more and better results can be accomplished.

Miscellaneous work.—A small number of miscellaneous determinations have been made in addition to those on the subjects specified above. For some of this work a charge has been made and the receipts paid into the State Treasury. The Chemist of the Survey is frequently called upon to make determination of various sorts for other members of the Survey—determinations related to their specific lines of investigation. These are of such a miscellaneous character that only a general report regarding them can be made.

Importance of work.—There is every prospect that in the near future this department will be called upon to do more testing of road materials than ever before. The analyses of soils in connection with the soil survey should also be carried on more rap-idly. Conditions in the laboratory get worse as the volume of work increases. Every square foot of available space is now being used. The ventilation has never been satisfactory, and with the increased amount of work done the fumes rising from the work become more concentrated. At times it has

been necessary to stop all work, open the windows no matter what the outside temperature, and leave the building until the atmosphere had cleared. The necessity for larger and better-equipped quarters for this important branch of the Survey has already been set forth in previous pages of this report. The importance of the work which the Survey is doing for the State Road Department is indicated by the following quotations from a letter recently received from Col. E. A. Stevens, the Road Commissioner:

TRENTON, N. J., December 5th, 1912.

Dr. H. B. Kümmel, State Geologist, Trenton. New Jersey:

MY DEAR DR. KÜMMEL—Referring to your verbal inquiry as to the necessity for the work now being done by the Chemist of the Geological Survey for this department, I would say that there can be no question as to the importance and necessity of these services. Our most expensive types of roads require the use of bitumen, and, in some cases, Portland Cement in quite large quantities. Of the former materials there are on the market a very large number, many of which are not suited to our use, and many others suited only to special types of construction. The competition between the sellers is very keen and the salesmen often induce the local bodies to request the use of an entirely unsuitable material for a certain specific job. The Chemist of the Geological Survey has had special training in hydro-carbon chemistry. Such a training is comparatively rare, there being but few consulting chemists who could very well advise the department. We will either have to dispense with the service entirely and trust to luck in buying our materials or have to depend upon the services of consulting chemists. Such services would be much more expensive to the State, and the department could probably not rely upon the prompt examination of specimens submitted, which promptness is absolutely essential to anything like efficiency in the work of contracts. The risk to which I have above alluded is increased by the fact that brands of good material may be prepared for an entirely different use from that intended, which fact requires careful and expert examination to detect.

* * * * * In order to be assured of receiving the quality of materials and work specified, it is necessary, especially in bituminous work, to have samples. These we have absolutely no room to file in the rooms set aside to the department in the State House, and Mr. Gage is now taking care of them in the laboratory, I fancy, at considerable inconvenience to himself and some detriment to his work. At the same time the samples must be preserved, and there is no other place where we can find room for them. * * * * * * *

I want to also call your attention to the need for additional testing facilities. We have now some testing apparatus for which there is no adequate room in the laboratory, and absolutely none in our offices. From this lack of room we are unable to carry out many tests upon the physical structure of pavements and the physical qualities of their constituents, which would be of great value. These could be very well provided for in a new building, and I take it would be of some use in your work.

Very truly yours,

E. A. STEVENS,

Commissioner.

SOIL SURVEY.

The soil survey, carried on in co-operation with the State Agricultural Experiment Station and the Bureau of Soils at Washington, has been prosecuted in Monmouth County. The field work begun May 4, and actively prosecuted until the end of the year, has been in charge of Henry Jennings, formerly of the Bureau of Soils, Washington, D. C., and now on the Survey Staff. He has been assisted by Mr. Dickey of the Bureau of Soils. Each department has paid the salary and expenses of its own employee. Copies of the maps and reports will be prepared for each department.

The area mapped the past season was chiefly in the vicinity of Red Bank and Freehold. The Freehold-Red Bank area is one of great agricultural fertility and importance and at the same time great soil complexity. The smaller area around Lakewood is of less agricultural value and of more uniform soil conditions. Geologically the region is one underlain by various formations of Cretaceous and later age. These are made up of layers of alternating beds of clay, sand, marl (glauconite) and gravel which appear at the surface in comparatively narrow bands. The variations in size, texture, mineral and chemical composition of these beds introduce the first element in the soil differences. Shifting and mixing of materials by the agents of erosion, chiefly rain, running water and wind, addition of varying amounts of organic matter, secondary chemical changes through weathering, have all had their share in producing the present diversities of soil types. In the region mapped a number of series of soils of varying texture, but with a common origin in the same or similar lithologic formations, and having the same general colors, and similar mineral composition, has been recognized. These series are subdivided into soil types which are the units of mapping. In the same type are placed soils having the same texture, structure, content, distribution of organic matter, agricultural value and crop adaptation. The soil map, while in a general way agreeing with the geological map, is on the whole more complex, since the same geological formation may and usually does give rise to several soil

types. On the other hand, two geological formations may be practically identical so far as lithological characteristics are concerned and so give rise to the same series of soils. In the region under study there are three beds of greensand marl of different geologic age and separated vertically by thick beds of sand. Nevertheless they give rise to only one soil series, since their soils have similar mineral and physical characteristics which differentiate them from all other soils of the region. This series is further divided into types, mainly on the basis of texture, a sand, sandy loam, loam and clay loam type being recognized.

In the Freehold-Red Bank region so far as mapped six upland series have been established, having 30 soil types. On the low and poorly drained areas there is one series with four types, besides several miscellaneous types such as coastal beach, tidal marsh, etc., so that 40 types in all have been recognized.

In the southwestern corner of the sheet, covering the region known as the "Pines," one series with six types has so far been recognized.

In addition to the field work considerable work in connection with the soil survey has been done in the office and laboratory. Mr. Gage has made many soil analyses as noted in the paragraph relating to the laboratory. He has also devoted some time to the preparation of manuscript describing the methods of soil analyses used and in tabulating results.

ARCHÆOLOGIC WORK.

The last Legislature included in the Supplemental Appropriation bill an item for archæological work under the direction of the Geological Survey. For the past season this was $500. By direction of the Board, Mr. Lloyd and the State Geologist were appointed a Committee to plan and direct this work. Suggestions regarding the scope of the Survey were solicited from a number of the leading Archæologists of the country and it was finally determined to spend the appropriation for the first summer in locating, as far as possible, the known Indian village and camp sites, burial places, etc. A co-operative arrangement was made

with the Department of Archæology of the New York Museum of Natural History to undertake the general supervision of the work and to detail men for its execution, the State Survey to pay their salaries and field expenses when actually employed. Alanson Skinner spent about two months in the field and Max Schrabisch a lesser period. One or two other men were employed for a few days. Messrs. C. C. Abbott, of Trenton, and R. W. Emerson and Edm. Shimp, of Bridgeton, rendered valued assistance, as did a number of other volunteer assistants. In all nearly one thousand sites, camps, burial grounds and rock shelters were located and mapped.

A report on the general characteristics of the various types of remains found and a list of sites has been prepared for publication by Messrs. Skinner and Schrabisch. Considering the small amount of money available the progress made is very gratifying. This was largely due to the willingness of many persons to furnish the Survey full information regarding sites known to them. To Mr. Schrabisch in particular is the Survey under obligations for many facts gathered as the result of years of study in the Passaic River watershed.

Plans for the continuation of the work have not yet been fully matured but are under consideration. Much work still remains to be done before our knowledge of these prehistoric sites is complete. Local collectors and students can greatly assist by advising the State Geologist of any sites which have not yet been located. Except for a few points along the Delaware, the whole of Warren and Sussex Counties and much of Hunterdon and Morris is *terra incognita* in these matters, so far as the State Survey is concerned. Nevertheless, there must be hundreds of localities for Indian relics within these counties which are known to some local enthusiast. The assistance of all such is requested.

MEETINGS AND CONVENTIONS.

During the year the State Geologist attended the following meetings in an official capacity:

In December, 1911, at Washington, D. C., meetings of the Association of State Geologists; the American Association for the Advancement of Science; the Geological Society of America; the Paleontological Society and the American Geographers—three days.

In August a large number of eminent geographers from various European countries assembled in New York preparatory to an extended geographical excursion in the United States. In co-operation with Mr. Hice, State Geologist of Pennsylvania, the State Geologist arranged a two-day excursion across northern New Jersey, northeastern Pennsylvania and Southeastern New York. Twenty-six foreign geographers participated. The route of the Delaware, Lackawanna and Western railroad was followed and stops were made at Delaware Water Gap, Mount Pocono and Scranton, Pennsylvania. At Scranton, the party was shown the city and the coal mines through the courtesy of the local Board of Trade. The return trip to New York was made via the Erie railroad. By means of topographical and geological maps supplemented by verbal explanations by the locol geologists, the visitors were able to gain a comprehensive knowledge of the geography and geology of the region traversed, which is typical of the northern Appalachian belt.

Following this excursion, the State Geologist was a member of the transcontinental geographic excursion for several days but did not accompany the party the entire distance. He joined them again at the latter part of their trip which terminated in New York, October 17, eight weeks from the start. On this trip they met most of the State Geologists of the States visited, as well as many of the other prominent workers in geography, geology and allied sciences, who joined the party for longer or shorter periods. In this way the work of the various State surveys was brought prominently to their notice, none more so than that of New Jersey, both by their special trip across this State and by the participation of the State Geologist in the more extended excursion.

APPENDIX A.

Second Report of the Board of Managers and its Engineer

ON THE

Improvement of Shark River Inlet

AS

Ordered by Act of Legislature, May 1, 1911

Reports of the Committee on the Improvement of Shark River Inlet.

TRENTON, N. J., May 7, 1912.

To the Members of the Board of Managers of the Geological Survey of New Jersey:

GENTLEMEN—The Committee on the Improvement of Shark River Inlet reports that the Legislature included in the Supplemental Bill an appropriation of $1,250 for further surveys and borings necessary to complete the plans for the improvement of the inlet. The Committee authorized Mr. Vermeule to proceed with this work, there being available, in addition to the sum mentioned, about $350.00, the unexpended balance of the former appropriation.

The Committee further reports that the Legislature has appropriated in the regular bill available November 1, 1912, the sum of $35,000 for making a permanent inlet to Shark River "the work to be done by contract and to be under the control, management and supervision of the Board of Managers of the Geological Survey. * * * Provided, however, no part of the said $35,000 shall be paid for any work * * * until the municipalities adjacent to the said Shark River shall have raised and placed at the disposal of the Treasurer of the State of New Jersey the sum of at least $20,000 * * * to be used in conjunction with the moneys appropriated by the State of New Jersey for the purpose of making a permanent mouth or inlet to the said Shark River."

The Committee further reports that steps are now being taken by local parties interested in this improvement to provide for the raising of these funds so that it will be possible to proceed with this work at the beginning of the new fiscal year. The Commit-

tee requests that at this meeting the Board provide for the carrying out of this work.

Respectfully submitted,
HARRISON VAN DUYNE,
Chairman.

TRENTON, N. J., Dec. 3, 1912.

To the Members of the Board of Managers of the Geological Survey of New Jersey :

GENTLEMEN—The Committee of the Board of Managers of the Survey appointed to direct the survey for the improvement of the Shark River Inlet presents the following report:

It has received from C. C. Vermeule, Consulting Engineer—

First. A supplemental report regarding the improvement.
Second. Maps showing the location of the proposed jetties and the proposed changes in riparian lines.
Third. Drawings showing the profile of the jetties and details of construction.
Fourth. Complete specifications for the work.

The new plans differ from those of the preliminary report only in minor details. The general scope of the improvement is unchanged. The alterations are as follows: The curvature of the jetties has been somewhat flattened, so as to make them conform to the natural tendencies of the inlet and to bring about stability in the location of the channel; a stone dike is recommended for the westerly end of the Avon or north jetty instead of the single line of concrete piling, specified in the preliminary report; the easterly end of the north jetty is extended about 300 feet further seaward; the south jetty is extended about 150 feet eastward and placed nearer the north jetty; changes in the riparian lines as established by the State Riparian Commission are recommended. These changes compelled refiguring the cost, the new estimate being $59,268.22 as against $58,000.00.

The Committee has been informed that the Freeholders of Monmouth County have appropriated $10,000, the Borough of Avon $5,000 and the Borough of Belmar $5,000 for this im-

provement, and that a portion of this amount has already been paid into the State Treasury. Under the terms of the law the Board will be in position to advertise for bids as soon as the entire $20,000 is on deposit, but if the total expenditure under the lowest bid be in excess of $55,000, no contract can be entered into.

On November 15th, the Committee made an inspection of the inlet, plans in hand, in company with the Engineer, C. C. Vermeule; Mr. Poole, the Mayor of Belmar; Mr. Leon Taylor, Assemblyman from Monmouth County and the State Geologist. Later they were joined by the Counsel for the County Board of Freeholders. At a meeting of the Committee, held November 15th, at Asbury Park, the following resolutions were adopted :

Resolved, That the Committee approves the supplemental report, plans and specifications submitted by Mr. Vermeule under date of October 21st, 1912, and recommends to the Board their adoption.

Resolved further, That the Committee recommends that authority be given to the State Geologist to advertise for bids for the carrying out of the proposed improvement as soon as he is advised by the State Comptroller that there has been deposited with the State Treasurer the sum of twenty thousand dollars as required by Chapter 130, Laws of 1912.

Resolved further, That the Committee recommends that the Board approve the proposed change in the riparian lines on both sides of the inlet as shown on the maps submitted by its engineer, and urges its adoption by the State Riparian Commission.

Respectfully submitted,

(Signed) HARRISON VAN DUYNE,
CLARENCE G. MEEKS,
T. FRANK APPLEBY,
Committee.

Resolutions Adopted by the Board of Managers.

At the regular meeting of the Board of Managers held December 3, 1912, the following resolutions were adopted:

Resolved, That the supplemental report, plans and specifications submitted by C. C. Vermeule under date of October 21st, 1912, and relating to the improvement of Shark River Inlet, be adapted by the Board of Managers of the Geological Survey, and that the improvement, if made, he made according to them.

Resolved, That as soon as the State Geologist is advised by the State Comptroller that the provisions of Chapter 130, Laws of 1912, relating to the deposit of $20,000 have been complied with, he be authorized to advertise in the

manner prescribed by law for bids for the improvement of Shark River Inlet according to the plans and specifications submitted by C. C. Vermeule under date of October 21st, 1912.

Resolved, That the Board of Managers of the State Geological Survey hereby approves the changes of riparian lines at Shark River Inlet as proposed by its Engineer, C. C. Vermeule, in his report submitted to the State Geologist under date of October 21st, 1912, and requests the State Riparian Commission to refix them accordingly.

Resolved further, That the State Geologist present this resolution to the Riparian Commission and urge favorable action thereon.

Engineer's Report.

NEW YORK, October 21st, 1912.

Dr. H. B. Kümmel, State Geologist:

SIR—In accordance with your instructions, I have proceeded with and completed the surveys at Shark River Inlet and perfected the plans and specifications for the work. I beg to submit herewith the results. Accompanying this report, I send the complete specifications, including the form of proposal and contract. Also the following plans:

1. A plan of Shark River Inlet from the highway bridge eastward to the ocean containing the present bulk-head lines and also the bulk-head lines which I propose in order to make them conform with the jetties and general scheme of improvement.

2. A plan of Shark River Inlet showing the results of the surveys and borings, together with the location of the proposed jetties.

3. A sheet of profiles and cross sections along the line of the proposed jetties.

4. A sheet showing the detailed plans of the reinforced concrete pile jetties.

RESULTS OF SURVEYS.

A careful transit survey was made covering the entire area between the highway bridge and the ocean, together with soundings, the results of which are indicated on the plans by contour

lines showing the depth of water at mean high tides. All surveys and soundings are referred to mean high tide in the ocean as determined from the Survey bench marks. Reference to the plans as compared with the plans submitted in my original report of February 5th, 1912, will show that since that time the Inlet has been forced far to the north and is now immediately to the south of the bulk-head at Garfield Avenue in Avon. The soundings indicate the course of the channel down to the old Inlet and illustrate its tendency to remain near the concave bank in all cases, thus showing that the proposed scheme of curve jetties is in conformity with the natural tendency of the channel. The deepest point in the channel at present is immediately next to the south jetty and a little easterly of the continuation of A Street in Belmar, being eleven feet at mean high tide. As we shall see later, the borings indicate that eleven or twelve feet is apparently about the maximum depth to which the stream is or has been capable of excavating its channel. Off-shore soundings were made as indicated on the map, although it was found impracticable to obtain such soundings between low water-line, which is nearly equivalent to five feet below mean high tide and the line of seven feet depth, owing to the turbulence of the surf and the constant variation in the depth due to the action of the under-tow.

The position of the borings is indicated on the plan, and the results are shown on the sheet of profiles. The following are the records of the borings in detail:

No. I.

0 — 12'	sand.
12' — 20'	sand and gravel.
20' — 23'	fine gravel.
25' — 30'	fine gray sand.
30' — 35'	marl.

No. II.

0 — 11'	sand.
11' — 20'	fine gravel.
20' — 25'	coarse gravel.
25' — 30'	coarse sand, marl.
30' — 35'	coarse gravel, marl.

No. III.

0	— 0.5'	water.
0.5'	— 10'	sand.
10'	— 15'	sand, gravel.
15'	— 20'	black sand.
20'	— 25'	black sand.
25'	— 30'	black sand, marl.
30'	— 35'	marl.

No. IV.

0	— 1.0'	water.
1.0'	— 10'	sand.
10'	— 20'	sand, a little gravel.
20'	— 25'	marl.
25'	— 30'	marl and silt.
30'	— 35'	marl.

No. V.

0	— 0.5'	water.
0.5'	— 10'	sand.
10'	— 20'	sand and gray clay.
20'	— 31'	clay and silt.
31'	— 35'	fine gray sand.

No. VI.

0	— 15'	sand.
15'	— 22'	sand, some clay.
22'	— 27'	marl.
27'	— 30'	clay, some sand.
30'	— 35'	clay—silt.

No. VII.

0	— 0.5'	water.
0.5'	— 12'	sand.
12'	— 17'	marl, a little sand.
17'	— 20'	sand, little clay.
20'	— 30'	fine black sand.
30'	— 35'	fine black sand.

No. VIII.

0	— 3.75'	water.
3.75'	— 8'	fine sand.
8'	— 12'	marl.
12'	— 20'	fine sand and clay.
20'	— 22'	coarse sand.
22'	— 35'	gravel, little fine sand.

No. IX.

0	— 11'	water,
11'	— 35'	fine gray sand and silt.

No. X.

0	— 12.5'	fine sea sand.
12.5'	— 23'	coarse sand—gray clay.
22'	— 35'	fine sand—traces of clay and silt.

It will be observed that the upper sand or sea sand which has been worked over by the water extends from 8 to 15 feet below

mean high tide. It is usually from 10 to 12 feet. Below this, the samples are mixed with clay and marl to an extent which indicates that they have not been worked over by water during any recent period. In a number of the borings, pure marl was passed through. No obstructions were met within these ten borings.

LOCATION OF JETTIES.

The alignment and location finally adopted for the jetties differ only in unimportant details from the suggestions contained in my original report. The curvature has been flatened somewhat with a purpose of reducing it to just what appears to be sufficient to conform to the natural tendencies of the inlet and to bring about stability in the location of the channel. This brings the south jetty very nearly in line with the present pile and timber jetty built about 1898. This whole jetty is in fairly good condition west of the angle at Station No. 5, being a little west of the extended westerly line of A Street. From that point eastward the old jetty is much weakened, and I propose to substitute for it a concrete pile jetty, Type B, which, however, will not be extended through the beach to the ocean for reasons stated in my original report, and hereinafter referred to. This new jetty will differ somewhat in location from the present pile and timber jetty, and is intended to thoroughly protect the beach to the southeast against a possible cutting through of Shark River in that direction. The further purpose of this jetty is to deflect the stream northward and against the northern jetty which is mainly relied upon to confine the inlet to a fixed position.

That portion of the north jetty indicated as Type C, and which extends from the end of Second Avenue easterly, is recommended to be built as a stone dyke of the cross-section indicated in the plans. This dyke will be on the convex side of the channel and there will consequently he no erosion near the dyke. Its principal purpose is to prevent a breach of the river or the ocean along the north side of the northern jetty and to confine the inlet entirely to the south of that jetty. Easterly, for 750 feet,

the jetty will be of Type B. This will extend from the easterly end of the stone dyke, Type C, about to the present high water-mark on the ocean. This portion of the jetty will be built on a curve with a radius of 716.8 feet. From the easterly end of Type B jetty, there will be 300 feet of Type A jetty, extending southeast into the ocean and terminating at a depth of about 7 feet at mean high tide. This is the most exposed part of the jetty, and will be built of a double line of concrete piles, well tied together at the top and tilled between with sand.

RECOMMENDED CHANGES OF BULK-HEAD LINES.

On a sheet especially devoted to that purpose, I have shown by means of tints the present and the proposed bulk-head lines. My reason for suggesting certain modifications of these lines is to make them conform to the general scheme and purpose of the improvement, and also to coincide with the proposed jetties. The proposed change in the Avon bulk-head lines begins in the present bulk-head line at a point 260 feet westerly from the easterly line of Second Avenue and 288.25 feet southerly from the southerly line of Washington Avenue. Thence the proposed line extends to a point in the proposed north jetty, said point being 160 feet easterly from the produced easterly line of Second Avenue and 411 feet southerly from the southerly line of Washington Avenue. Thence a line extends easterly on a curve to the left with a radius of 819 feet, said curve being tangent with the proposed bulk-head line previously described, a distance of 630 feet, measured in chords of 100 feet; and thence by a curve to the right with a radius of 716.8 feet, a distance of 830 feet, measured 100-foot chords, to a point in the ocean; thence southeasterly and tangent to the aforesaid curve into the Atlantic Ocean.

The Belmar bulk-head line has been changed throughout in order that the contraction of the river as we proceed easterly to the inlet may be continuous and gradual, as this is the only method by which we can prevent injurious and troublesome deposits which are sure to occur at points of sudden enlarge-

ment of the channel. There is, on this side of the river, an extensive flat only slightly submerged at high tide. Preparations are now being made to dredge the river at this point and use the dredged material to fill in this flat. If this improvement is conducted properly and along the lines which will be defined by the bulk-head lines which I now propose, it will be beneficial and will conform in all respects to the purposes of the proposed jetties. The location of the proposed bulk-head line is described as follows:

Beginning at the southerly abutment of the highway bridge at a point in the present bulk-head line, thence running northeasterly to a point 330 feet northerly from the north line of Fifth Avenue and 200 feet westerly from the produced westerly line of E Street; thence northeasterly to a point 900 feet northerly from the north line of Fifth Avenue and in the produced easterly line of E Street; thence northeasterly to a point in the produced easterly line of D Street, 1,300 feet distant from the northerly line of Fifth Avenue; thence easterly to a point 200 feet easterly from the produced easterly line of C Street and 845 feet northerly from the northerly line of Third Avenue; thence easterly to a point in or near the present jetty, said point being 140 feet distant from the southerly line of First Avenue, measured on a perpendicular thereto at the intersection of said southerly line of First Avenue with the easterly line of the River Road; thence easterly along the present jetty to a point 30 feet westerly from the produced westerly line of A Street and 220 feet northerly from the southerly line of First Avenue; thence northeasterly to a point 108 feet easterly from the produced westerly line of A Street and 292 feet northerly from the southerly line of First Avenue; thence by a curve of 1,298 feet radius curving to the left 240 feet, measured by chords of 100 feet; thence curving to the right with a radius of 478.3 feet, a distance of 552 feet, measured by chords of 100 feet; thence tangent to the aforesaid curve southeasterly into the Atlantic Ocean to an intersection with the present bulk-head line.

Should the above proposed changes of the bulk-head lines be approved, I would suggest that a recommendation to this effect be made to the Riparian Commission, but I presume that such recommendation would have to be supported by an application from the owners of the riparian rights thereby effected.

TYPE OF CONSTRUCTION.

I have already alluded to the substitution of a stone dyke for the single line of reinforced concrete piles and caps suggested in my original report for Type C jetties. The general form of construction of Type A and Type B jetties remains similar to what was then suggested, although the details have been more carefully worked out and some additional strength has been given to Type A. Generally, Type B consists of a continuous line of reinforced concrete piling tied together at the top with a reinforced concrete cap or beam and braced at intervals of 10 feet on the side away from the channel by a reinforced concrete pile and brace beam. The side next to the channel I propose to protect with stone riprap, as indicated in the plans, in order to prevent too deep a cutting by the current immediately along the face of the piling, as such cutting will diminish the support and security of the jetty.

Type A jetty will consist of two lines of continuous reinforced concrete piling tied together with reinforced concrete caps and braced by cross beams of reinforced concrete at intervals of 10 feet, the space between to be filled with sand. The two bents on the ocean end I propose to cap over with a plate of reinforced concrete 12 inches thick, in order to bind the whole together with a cellular form to resist more effectually the pounding of the waves.

ESTIMATE OF COST.

The quantities are somewhat modified from those given in my original report owing to an increase in the amount of Type A jetty and some other changes more particularly the change to a

stone dyke for Type C. The latter change effects some economy which is offset, however, by the increase in amount of Type A and Type B reinforced concrete jetty. I propose to pay for the Portland cement used by the barrel, in order to be able at any time to change the proportions of cement used in the concrete, in order to obtain the best results and to fill the voids in the stone and sand, as such voids may be determined by actual experiment. I have changed the form of my estimate throughout in order to make it conform to the form of proposal which I have found best for the purpose. I have also entirely recomputed the cost in detail for the purposes of this estimate. In each case I have added the fifteen per cent. for the contractor's profit to the particular item dealt with, consequently this does not appear at the end as formerly. The result is as follows:

Portland Cement, 3,706 bbls. @ $1.55,	$5,444 30
Steel Reinforcing bars, 410,234 lbs. @ 2.3c.,	9,435 38
Standard Jetty piles 26 ft. long — 300 @ $19.95,	5,985 00
" " " 24 " " 710 @ $17.10,	11,641 00
Brace and Partition piles 28 ft. long — 12 @ $19.95,	239 40
" " " " 20 " " 56 @ $14.30,	800 80
" " " " 16 " " 103 @ $11.40,	1,174 20
Reinforced Concrete in Caps, Beams and Plates, 11,890 cu. ft. @ 25c.,	2,972 50
Stone in Jetty, 1,865 cu. yds. @ $3,	5,595 00
Stone Rip Rap, 1,660 cu. yds. @ $2.50,	4,250 00
Dredging, 10,000 cu. yds. @ 25c.,	2,500 00
Removing old piles, 100 @ $5,	500 00
Removing old timber,	1,000 00
	$51,537 58
Contingencies, omitted items, engineering, etc., 15%,	7,730 64
	$59,268 22

THEORY OF THE IMPROVEMENT.

The broad considerations which influenced my original recommendations as to the alignment and location of the jetties have received) further attention from me, but I have found no reason to change the conclusions which I then reached. Later studies of the movement of the sand and of the inlet appear to entirely confirm what had been observed and set out in my original report. The strong tendency of the inlet to shift to the north has been again exhibited in the recent changes. This tendency I

ascribe to the steady pressure of the sand moving along the beach to the northward under the combined influence of the waves, and the southeasterly winds which prevail during so large a part of the year, and which are the most active in determining the transporting tendencies of the waves along the beach. This movement is gradual, but is so continuous that it cannot be prevented by any ordinary construction. The effect of the northerly storms, however, although not continuous, is sudden and violent, and the transporting action of the waves during these storms is in the contrary direction, namely, southerly. The suggestion has been made that the northerly movement of the sand should be guarded against by the extension of a dyke at the southerly side of the inlet. I am of the opinion that such a measure will be ineffective and that such a dyke would rapidly fill with sand at the southerly side so that the beach would again extend out beyond the end of it, and the northerly movement would again continue. So long as the inlet is open, this sand moving northerly must be swept in with the flood tide, and no arrangement of jetties can prevent such action. Because of this consideration, I have concluded that this northerly movement of the sand must be provided for and taken care of by allowing it to be carried into the inlet on the flood tide and providing so far as possible that it shall be again carried out on the ebb tide until it passes the end of the northerly jetty, after which it will continue its travels northerly up the beach. What I hope to accomplish by the proposed jetties is to prevent the inlet moving northward and to keep it in a fixed position by means of the northerly jetty. So long as it is kept in this position, I believe it will be amply able to take care of the sand slowly moving northward, for the reason that this sand is moved northward under a current less powerful than the current through the inlet, and, indeed, a large part of it is moved northward by the wind alone, and is consequently fine material, which will be easily transported by the water of the inlet.

In addition to its usefulness in confining the inlet to a fixed position, the northerly jetty, it is hoped, will also prove effective in preventing the sudden transportation of large quantities of sand into the inlet during northeasterly storms.

So long as the inlet is held in a fixed position, as it will be by the proposed jetty, even should it temporarily fill up, it must break out again and must break out along the south side of the jetty in the same position as before, whereas at present it is free to move to a new position further north. When it does so move to the north, it usually, in time, becomes so feeble in its action that it closes up entirely and then breaks out anew in some other place, which at the time happens to be the point of least resistance. The inlet cannot remain permanently closed for any length of time, owing to the accumulation of fresh water which will eventually overflow the beach and cut a new opening. I believe that the proposed jetty construction will make the entire closing up of the inlet extremely improbable.

OMISSION OF SOUTH JETTY THROUGH BEACH.

As already stated, it is practically impossible to hold the northward moving sand on the beach by means of a jetty at the south side of the inlet. Another reason for omitting this jetty was stated in my original report to be that if built, it is a practical impossibility to accurately fix its distance from the north jetty at the present time. If it is built too far from the north jetty, so that the channel between is larger than is required to accommodate the inflowing and outflowing tides, then the sand will continue to accumulate on the channel side of the south jetty and the jetty will be useless. If, on the other hand, the distance between the jetties is too small, the tidal action will be limited and the tidal prism in the bay will be diminished in volume thereby partially defeating the purpose of this improvement. There has not been heretofore and is not likely to be any tendency of the inlet to cut away the beach at its southerly side. The south jetty as planned will be sufficient to deflect the inlet northerly and the action of the wind, together with the steady northward pressure of the sand, will unquestionably hold the inlet in a fixed position. After the construction of the north jetty, in course of time, the regimen of the inlet will become established, and its needs as to width may then be determined with certainty. When this occurs, it will be

possible to accurately determine the proper position for a bulk-head at the south side of the inlet if the interests of the property owners will be served by such a bulk-head, but meanwhile, its omission will effect a large saving in cost without in any respect impairing the efficiency of the works.

SOUTHEASTERLY TREND OF THE INLET.

I called attention in my original report to the consistent tendency of all inlets to take a southeasterly course through the beach to the ocean. There unquestionably exists a strong tendency to this location for the principal channel, for the reasons which I set forth in my previous report, being principally the action of the wind. I have been asked whether this southeasterly direction might not increase the accumulation of sand moving northerly up the beach, or, in other words, whether the northerly jetty might not act as a sand catch. It has been suggested that the direction might on this account more properly be to the east or northeast. I have given full consideration to this phase of the problem. It should be apparent at a glance that whatever the direction of the mouth of the inlet, the sand moving northerly must, as it reaches the inlet, be swept in with every flood tide. A cursory glance at the map might suggest that it would be possible to deflect the sand across the mouth of the inlet by having the jetties project northeasterly, but proper consideration of the subject will show that it is manifestly impossible that the sand should travel across the mouth of the inlet and resume its northerly course up the beach at times when there is a strong current in shore on the flood tide. I am satisfied from my observation and examination of the question that there is no method by which we can prevent the sand being carried in on the flood tide, and we must trust to proper regulation of the channel in such manner that the sand carried in will be carried out again on the ebb tide, and when so carried out beyond the end of the north jetty, it will, of course, resume its travel northerly along the beach. A study of the sketches submitted in my previous report must convince us that the old jetties, which faced nearly eastward, did

not line up with the natural tendency of the inlet and furthermore that their facing eastward did not prevent the sand from filling up the inlet. If they had faced northeasterly, conditions would have been still worse. During the northeasterly and easterly storms, which are the most severe and protracted, the sand is transported shoreward in large quantities, and also the ebb tide is usually very feeble in action, owing to the position of the wind. At such times jetties facing easterly or northeasterly invite large accumulations of sand in the Inlet. I believe that the jetty which I have planned, running in a southeasterly direction, will in large measure exclude this sand, and that such part of it as finds its way around the end of the jetty, however feeble the ebb tide, will at such times continue its travels down the beach and will not be carried into the inlet.

I have thought it best that I should set forth these considerations, and the theory upon which I have located the jetties, somewhat more in detail, although I had intended that it should be made clear in my previous report. It should be borne in mind that this report should be considered with the previous report, as I have not intended to repeat what was therein set forth, but have endeavored to supplement and amplify it.

Respectfully submitted,

CORNELIUS C. VERMEULE.

APPENDIX B.

List of Bench Marks in Bergen, Essex, Hudson, Morris, Passaic, Sussex, Union and Warren Counties

(55)

Primary Bench Marks.

Dr. H. B. Kümmel, State Geologist, Trenton N. J.:

DEAR SIR—In compliance with your instructions, I have had a careful examination made of the primary bench marks established by the Geological Survey originally during the progress of the topographic survey in 1885, 1886 and 1887. A full list of these bench marks was first published in Volume I of the final report in 1888, and republished in Volume IV, Physical Geography of 1895. The primary purpose of the work was to control and form a basis for the topographical levels. The bench marks were established upon the most permanent structures then available, such as bridges and public buildings. It has been found that the progress of rebuilding and removal of such structures has caused the loss of a large number of the original bench marks, and the present work of revision was planned with a view to checking the remaining original bench marks and substituting other permanent ones on newer structures, to take the place of those which have been lost. During the progress of this work a large number of additional bench marks were established. The following list includes both the original bench marks and those recently established. All elevations have been rechecked and in case those now given differ from the original elevations the present elevations are to be taken as correct. Some clerical and topographical errors were discovered in the original list and these have been rectified. The field work of the original leveling operations has been found to be generally correct and the errors which have been rectified are entirely clerical or topographical. As in the original list, the accompanying list is arranged by counties and by localities, the arrangement of the latter being alphabetical for each county. The work of the past season has been confined to the Counties of Sussex, Warren, Morris, Passaic, Hudson, Essex and Union.

Respectfully submitted.

C. C. VERMEULE.

BERGEN COUNTY.

ALLENDALE. Eleva., 321.81 ft.
A cross cut in the west end (about 6 inches from north end of west truss, 6.3 feet from the end and near the edge) of the north abutment of the bridge which carries the Erie Railroad over Hohokus Creek, three-quarters of a mile south of the depot.

ALLENDALE. Eleva., 269.49 ft.
A cross cut in the southeast corner of the second step from the top of the east end of the north abutment of the bridge which carries the Erie Railroad over a small brook, about 300 yards south of the station.

BLAUVELTVILL, N. Y. Eleva., 182.80 ft.
A cross cut in the outside corner of the west end of the south abutment of the bridge which carries a road over the Piermont Branch of the Erie Railroad, at the station.

CARLSTADT. Eleva., 145.85 ft.
A cross cut in the north end of the doorsill (near the edge and close up to the door jamb) of the entrance to the public school building, which stands on the east side of Third Street, between Hoboken and Broad Streets. This entrance is near the north end of the school building, and leads into the old part.

CLOSTER, Eleva., 65.06 ft.
A cross cut in the east corner of the sill of the front door of C. Hansen's feed store, on the west side of the Erie Railroad, at the junction of two roads.

CLOSTER. Eleva., 65.06 ft.
A cross cut in the north end of the doorsill (3½ inches from the edge and 3½ inches from the wall) of the most northerly entrance to the public school building, on the east side or front. The school building is located between High and Demarest Streets, and faces the east.

CLOSTER. Eleva., 30.65 ft.
A cross cut in the west end (3.3 feet from I-beam, 2.5 feet from end, 1.6 feet from edge, 0.83 foot from back wall end, 3.2 feet below track) of the north abutment of the bridge which carries the northern branch of the Erie Railroad over Dwar's Kill, three-quarters of a mile north of the station. The cross is cut on the shelf of the abutments supporting the north ends of the I-beam.

CLOSTER. Eleva., 25.71 ft.
A cross cut in the south end (4.7 feet from I-beam, 0.6 foot from end, 1.95 feet from edge, 0.45 foot from retaining wall behind, and 3.05 feet below track) of the east abutment of the bridge which carries the northern branch of the Erie Railroad over the North Branch of Dwar's Kill, 1 mile north of the depot. The cross is cut on a shelf of the abutment supporting the south end of the I-beam.

DEMAREST. Eleva., 38.87 ft.
A cross cut in the south end of the sill of the front door of the station of the Northern Railroad of New Jersey.

DUNDEE LAKE. Eleva., 41.14 ft.
This bench mark is on the New York, Susquehanna and Western Railroad bridge crossing the lake. The point is a cross cut in the northwest corner of the iron bed-plate on which rests the most easterly truss, on the north side of the track.

EAST RUTHERFORD. Eleva., 82.29 ft.
This bench mark is a point taken on the northwest corner of the base of a monument, "Dedicated to the Memory of Soldiers and Sailors Who

Fought in Defence of the American Flag," standing in the junction between Paterson Avenue and Grove Street, opposite Second Street. This monument is a cannon mounted upon a granite base. The point is on the corner of the granite base, between the breech and the trunnion bed. Looking towards the muzzle, it is on the left of the cannon.

EMERSON. Eleva., 47.97 ft.

A cross cut in the north end of doorsill (.35 foot from outer edge. 1.2 feet from north end, and near the corner of a bay-window) at the entrance to a building owned by R. Alexander, standing on the west side of the main road, opposite the point where this road crosses the New Jersey and New York Railroad. This building has a yellow brick front, with stone trimmings, red brick sides, and is two stories high; the upper story is occupied as apartments, the lower story is used as a store, and occupied by the Emerson Grocery Company.

ENGLEWOOD. Eleva., 36.48 ft.

A cross cut in the southeast corner of a flat stone on the east end of a stone culvert which carries the Northern Railroad of New Jersey over a small stream 200 feet south from Slocum Avenue and one-quarter of a mile north of the station.

ENGLEWOOD. Eleva., 27.49 ft.

A cross cut in the east end of the doorsill (8 inches from the edge, and near the door jamb) of the only entrance in the north end of the station, which stands on the east side of the Northern Railroad of New Jersey between Demarest and Palisade Avenues.

ENGLEWOOD. Eleva., 8.82 ft.

A cross cut in the summit of a stone at the north end of a culvert, just west of the Northern Railroad of New Jersey, which carries Forest Avenue over a small run.

GARFIELD. Eleva., 12.96 ft.

A cross cut in the east end of the coping stone of the north wing wall of the cast abutment of the bridge which carries Passaic Avenue over Passaic River. This point is outside of hand rail, 0.32 foot from edge, 3.3 feet from east end of wing wall, and 12.85 feet from north end of east abutment.

GARFIELD. Eleva., 34.26 ft.

A cross cut in the northwest corner of the highest step of the west end of the south abutment of the bridge which carries the short cut of the Erie Railroad over Passaic Avenue. The south end of the bridge truss rests upon this step.

HACKENSACK. Eleva., 12.50 ft.

A cross cut in the west end of the sill of the main front door of the First Reformed Church, on Court Street.

HACKENSACK. Eleva., 19.86 ft.

A cross cut in the southeast corner of the east end of the doorsill (2.15 feet from outer edge, 0.36 foot front east side of doorway and 0.13 foot from bronze door saddle) of the most easterly of the three front entrances to the Bergen County Courthouse, which stands on the southeast corner of Main and Court Streets. The courthouse faces Court Street.

HACKENSACK. Eleva., 22.70 ft.

A cross cut in the west end of the doorsill of the entrance to apartments over the store, in a brick building on the north side of Anderson Street, west of Anderson Street depot. This building was erected in 1894 by G. A. Mattjetschenk.

HASBROUCK HEIGHTS. Eleva., 151.27 ft.

A cross cut in the west end of sill of first window east of the front, or Franklin Avenue, entrance of the public school building, which stands on top

of the ridge, on the south side of Franklin Avenue between the Boulevard and Burton Avenue. The window is below the water table and opens into the basement of the building.

HIGHWOOD. Eleva., 48.95 ft.

A cross cut in the northeast corner of the coping of the retaining wall at the east end of the south abutment of the Northern Railroad of New Jersey bridge over a brook, about 500 yards south of the station.

HILLSDALE. Eleva., 52.76 ft.

A cross cut in a brownstone block on the top of the first step (6 inches from the east end and 6 inches from edge) on the east end of the north abutment of the bridge which carries the New Jersey and New York Branch of the Erie Railroad over Pascack Brook, about 1,600 feet south of the station. The north end of the tress of the bridge rests on the first step.

HOHOKUS. Eleva., 194.69 ft.

A cross cut in the southwest corner of the coping of the west parapet of the culvert which carries the Erie Railroad over Hohokus Creek.

KINGSLAND. Eleva., 63.12 ft.

A cross cut in the south end of the coping of the east wing wall of the north abutment of the bridge, which carries Ridge Road over the Delaware, Lackawanna and Western Railroad, about 800 feet west of the station. This cross is about 1 foot from the south end of the wing wall, between the hand rail and the inner edge of the coping.

KINGSLAND. Eleva., 54.93 ft.

A cross in the end of a piece of a railroad rail, standing erect in a concrete foundation, on the north slope of a cut, 40 feet north from the westbound track, 15 feet from top of slope and 25 feet from the east end of the east wing wall of the north abutment of a bridge which carries the Ridge Road over the Delaware, Lackawanna and Western Railroad, about 800 feet west of station. This is probably a railroad bench mark.

LODI. Eleva., 22.37 ft.

A cross cut in the southeast corner of the south end of the west abutment of the bridge which carries Passaic Avenue over Saddle River.

LODI. Eleva., 34.47 ft.

A cross on the south end of the sill of the second window from the south, under the water table, in the wing of Public School Building No, 1, which stands on the southeast corner of South Main and Hunter Streets and faces South Main Street. There is an entrance on each side of the wing in front, on the South Main Street side, and four windows under the water table opening into the basement. The bench mark is on the sill of the second window from the south.

LODI. Eleva., 45.42 ft.

A cross cut in the northwest corner of the west end of the coping of the north wall of the culvert which carries Union Avenue over a small stream, about 2,100 feet east of South Main Street.

LODI TOWNSHIP. Eleva., 30.68 ft.

A cross cut in the coping of the east wall (directly over the middle of the arch) of the bridge which carries Terrace Avenue over a gulley just south of the right of way of the old Lodi Railroad, now abandoned. This arch bridge Is just south of the south boundary of Hackensack.

LYNDHURST. Eleva., 66.56 ft.

A cross cut in the extreme south end (against the face of the brick wall) of the sill of the most southerly door of the two entrances to the Lincoln School, on the west and facing the Ridge Road, between the Delaware, Lackawanna and Western Railroad and Valley Brook Avenue. There are two doors for an entrance with a window between them. The Lincoln School is one of the school buildings belonging to Union Township.

MAHWAH. Eleva., 309.06 ft.

A cross cut in the northeast corner of the east end of the south abutment of the bridge which carries the Erie Railroad over a road leading from Masonicus to Wanamaker's Mills, about three-eighths of a mile south of the station. The cross is on the top of a series of steps, which form a shelf, upon which rests the north end of the I-beam.

MAHWAH. Eleva., 297.76 ft.

A cross cut in the northeast corner of the north end of the retaining wall on the east side of the Erie Railroad. The cross is about 325 feet north of the station.

MAHWAH. Eleva., 274.54 ft.

A cross cut in the east end (near the edge, 1.35 feet from the bedplate and 10.2 feet from the end) of the north abutment of the bridge which carries the Erie Railroad over the Mahwah Creek. The cross is on the stone upon which rests the bedplate of the north end of the most easterly truss. This bridge is 1,400 yards north of the railroad station.

MONTVALE. Eleva., 140.34 ft.

A cross cut in the southwest corner of the south end of the east abutment of the bridge which carries East Avenue over Pascack River, 900 feet west of the railroad station.

MONTVALE. Eleva., 179.25 ft.

A cross cut in the southeast corner of the coping stone, 1.7 feet above the ground, in the west end of the south wall of a small highway culvert, 400 feet north of the station and just west of the Erie Railroad.

NANUET, N. Y. Eleva., 298.16 ft.

A cross cut in the windowsill (3.6 inches from the west end and 4.2 inches from the edge) west of the entrance to the store owned by William Hutton, Jr., on the north side of the road leading from Spring Valley to Nyack, and just east of the crossing of the Piermont and New City branches of the Erie Railroad. The front of the store is divided into three equal parts, the center part has an entrance to the store, with a large window each side. The sills of the windows and door are at the same level.

NANUET, N. Y. Eleva., 293.60 ft.

A cross cut in the northeast corner of the stone cap of the pier upon which rests the northeast of five columns which support the roof of the shed shelter, attached to the east end of the Erie Railroad station.

NEW MILFORD. Eleva., 12.62 ft.

A cross cut in the south end of the doorsill (5.3 inches from south side of doorway and 11 inches from door) of the most southerly entrance, on the west side of the Hackensack Water Company's pumping station. This door is the entrance to the old engine house, now known as Engine House No. 1. Over the arched entrance is the date "1882."

NORDHOFF. Eleva., 9.87 ft.

This bench mark is on the north end of the sill of the most northerly window in the front, or east side, of the lodge at the entrance to the late W. W. Phelps' Teaneck estate.

NORDHOFF. Eleva., 4.25 ft.

A cross cut in the northwest corner of the west end of the south abutment of a bridge which carries the Northern Railroad over a small stream 600 feet north of the station.

NORTH ARLINGTON, Eleva., 128.24 ft.

A cross cut in the center of a brownstone monument standing on the north side of Kearny Avenue on the line between the cemetery and the public school lot.

NORTH ARLINGTON. Eleva., 141.00 ft.

A cross cut in the south end of the bluestone doorsill of the front entrance to the Town Hall, on the east side, one hundred feet back of Kearny Avenue. This building was formerly used as a school house. A new school house has been erected just north, and this building is now used for a town hall.

NORTH HACKENSACK. Eleva., 9.54 ft.

A cross cut in the middle of a series of five steps, on the west end of the north abutment of a bridge which carries the New Jersey and New York Railroad over a small stream, 700 feet south of the station. The stream at this point is the dividing line between the town of Hackensack and Riverside Borough.

NORTHVALE. Eleva., 37.89 ft.

A cross cut in the south end of the north doorsill of the entrance to the waiting room on the west side or back of the station. The station is of brick with stone sills. There are two doors on the west side near the south end and one near the north end, leading into the waiting room. The cross is cut on the sill of this door.

NORTHVALE. Eleva., 33.47 ft.

A cross cut in the northeast corner of the north end of the west wing wall of the north abutment of the bridge which carries the road leading from Northvale to Tappan over Tappan Brook. This bridge is about 375 feet south of the State line.

NORWOOD. Eleva., 32.77 ft.

A cross cut in the cast wall, over the center of the arch, of a culvert which carries the Northern Railroad of New Jersey over a small run, 800 feet north of the station.

ORADEL. Eleva., 16.03 ft.

A cross cut in the south end of the west abutment (4.1 feet below the east end of the south wing wall, and 5.6 feet above the ground) of the bridge which carries Oradell Avenue over Hackensack River. This cross is cut on the shelf of the abutment supporting the west end of the truss. The bridge is about 250 feet east of the depot.

ORANGEBURG, N. Y. Eleva., 113.82 ft.

A cross cut in the east corner of the coping, on top of and at the extreme south end of the long abutment, of the bridge which carries the Piermont Branch of the Erie Railroad over the West Shore Railroad.

PALISADE MONUMENT. Eleva., 460.21 ft.

This bench mark is on the summit of the State-line monument on the top of the Palisades.

PALISADE MONUMENT. Eleva., 453.08 ft.

This bench mark is a cross cut on a rounded knob of the bedrock, 7.8 feet southwest of the monument.

PARK RIDGE. Eleva., 142.26 ft.

A cross cut in the cast end of the sill of the most westerly of the three doorways of the front entrance to the public school building, which stands on the southeast corner of Main Street and Park Avenue.

PASSAIC JUNCTION. Eleva., 53.20 ft.

A cross cut in the southeast corner of the lowest step at the east end of the north abutment of the bridge which carries the Bergen County Short Cut of the Erie Railroad over the New York, Susquehanna and Western Railroad.

PEARL RIVER, N. Y. Eleva., 212.81 ft.

This bench mark is on the cross cut on the State-line monument, 2.8 feet west of the west rail of the New Jersey and New York Branch of the Erie Railroad, about one-half mile south of the station.

PEARL RIVER, N. Y. Eleva., 216.39 ft.
A cross cut in the north end of the east abutment of the bridge which carries Central Avenue over a small stream, about 500 feet west of the railroad.

PEARL RIVER, N. Y. Eleva., 219.83 ft.
A cross cut in the west end of the north concrete wall of a bridge which carries Washington Avenue, or the direct road from Pearl River to Upper Montvale, over a small stream, about 500 feet west of the railroad.

PEARL RIVER, N. Y. Eleva., 224.95 ft.
A cross cut in the top of a boulder, cemented in the west end of the north abutment at the end of the hand rail of the bridge which carries the road leading from Pearl River to Upper Montvale over Pascack Brook, five-eighths of a mile west of Pearl River.

PEARL RIVER, N. Y. Eleva., 225.50 ft.
This bench mark was taken on the cross cut in the new eighth milestone on the State line. This stone is about half way between Pearl River and Upper Montvale. There is an old mile stone here also. The elevation of the top of the old stone is 226.18 feet.

RAMSEY. Eleva., 344.00 ft.
A cross cut in the water table, in front, at the offset, 23.5 feet from the northwest corner of the Dater Building, on the south side of Main Street, giving, on the west, the right of way of the Erie Railroad, and opposite the station.

RAMSEY. Eleva., 339.68 ft.
A cross cut in the northwest corner of the shelf, upon which rests the south end of the truss (7 feet from the most westerly rail of the southbound tracks, 6.9 feet from the end of the wing wall and 4 feet above the brook) of the south abutment of the bridge which carries the Erie Railroad over a brook, 1 3/16 miles north of the depot and 60 feet south of a highway crossing.

RIDGEFIELD. Eleva., 14.35 ft.
A cross cut in the south end of the sill of the front door of the ladies' waiting room of the station of the Northern Branch of the Erie Railroad.

RIDGEFIELD. Eleva., 5.96 ft.
A cross cut in the southwest corner of the west end (at the northwest corner of the draw) of the north abutment of the bridge which carries Bergen Turnpike over Overpeck Creek, half a mile west of the depot.

RIDGEFIELD PARK. Eleva., 6.77 ft.
This bench mark is a cross cut in the northwest corner of the north end of the west wall of a culvert which carries the West Shore Railroad over a small stream, one-third of a mile north of the depot. (Partially destroyed.)

RIDGEFIELD PARK. Eleva., 6.85 ft.
A rounded knob, with the letters "B. M." closely cut, in the southwest corner of the south end of the west wall of the bridge which carries the West Shore Railroad over a small stream, one-third of a mile north of the depot. This bench mark and the one above are on the same wall of the culvert.

RIDGEWOOD. Eleva., 134.55 ft.
A cross cut in the south end of the doorsill, under a bronze tablet, of the corner and main entrance to the Ridgewood Trust Company's building, which is on the southeast corner of Ridgewood Avenue and Prospect Street.

RIDGEWOOD. Eleva., 153.97 ft.
A cross cut in the east end (2 feet from truss, 12.4 feet from end and close to the edge) of the north abutment of the bridge which carries the Erie Railroad over a road, three-quarters of a mile north of the depot. The cross is on a shelf of the north abutment, upon which rests the north ends of the truss.

RIVER EDGE. Eleva., 7.74 ft.
A cross cut in the northwest corner of a shelf upon which rests the east end of the draw, on the north end of the east abutment of the drawbridge which carries a road over the Hackensack River, 300 feet east of the depot. This shelf is 2.6 feet below the top of the west end of the north wing wall of the east abutment and 2.2 feet above a retaining wall along the river.

RUTHERFORD. Eleva., 47.53 ft.
A cross on top of a stone monument located in a small circular flower bed around a flag pole at the junction of streets near the depot.

RUTHERFORD. Eleva., 43.14 ft.
A cross cut in the extreme east end of the doorsill of a double door entrance to the railroad station from the street on the south side. Over this door is the name "Erie Railroad."

RUTHERFORD. Eleva., 76.94 ft.
A cross cut in the south end of the doorsill (under the arch) of the entrance to the Municipal Building, on the west side of Park Avenue, between Franklin Place and Ridge Road.

SUFFERN, N. Y. Eleva., 287.49 ft.
This bench mark is the top of the new fifteen-mile stone of the State line which stands on the east side of Ramapo Avenue, west of the Erie Railroad.

TAPPAN, N. Y. Eleva., 60.03 ft.
This bench mark is the top of a State-line monument on the east side of the road leading from Tappan to Harrington Park, near the German Church.

TAPPAN, N. Y. Eleva., 108.47 ft.
This bench mark is the top, on the cross, of the new three-mile monument of the State line.

TAPPAN, N. Y. Eleva., 109.158 ft.
This bench mark is the top or highest point of the old third monument of the State line.

TENAFLY. Eleva., 48.06 ft.
A cross cut in the south end of the sill of the north front door of the station of the Northern Branch of the Erie Railroad.

WALLLINGTON. Eleva., 9.65 ft.
A cross cut in the northwest corner of the north end of the shelf, upon which rests the east ends of the truss, of the east abutment of the drawbridge which carries the road from Wallington to Passaic over the Passaic River.

WOODRIDGE. Eleva., 136.69 ft.
This bench mark is taken on the hole in the top of a brownstone monument, standing on the west side of Hackensack Avenue, on a line with the north side of Moonachie Avenue (projected.) This monument is evidently a property monument.

WOODRIDGE. Eleva., 188.12 ft.
A cross cut in the north end of the sill, of the first window south of the Hackensack Street entrance, of the public school building on the southwest corner of Hackensack and Union Streets.

WALDWICK. Eleva., 228.41 ft.
A cross cut in the northeast corner of the stone cap, on the concrete base, west of the tracks, upon which rests the most northerly of the pillars supporting the west end of the bridge which carries a highway over the Erie Railroad one-quarter of a mile south of the depot.

WESTWOOD. Eleva., 54.56 ft.
A cross cut in the southwest corner of the north wing wall on the west side of the arch bridge which carries the New Jersey and New York Rail-

road over a brook south of the station. The cross is cut near the end of the first step of north wing wall, 2 inches from the end and 3½ inches from the edge.

WESTWOOD. Eleva., 74.69 ft.

A cross cut in the northeast corner of the east end of the stone doorsill of the Westwood Avenue entrance to the First National Bank building standing on corner of Westwood and Center Avenues.

WOODCLIFF LAKE. Eleva., 96.98 ft.

A cross cut in the west end of the south wall of the concrete culvert which carries the road over Hackensack Water Company's storage reservoir.

ESSEX COUNTY.

BELLEVILLE. Eleva., 32.97 ft.

A cross cut, east of the iron fence, nearly in the center of the first coping stone, at the south end of the west parapet of the bridge which carries Washington Avenue over Second River.

BELLEVILLE. Eleva., 111.63 ft.

A cross cut in the east corner of the sill of the first window west of the front entrance to Montgomery School No. 2, which stands on the north side of Montgomery Avenue, about 500 feet east of the bridge which carries said avenue over the Morris Canal.

BLOOMFIELD. Eleva., 141.32 ft.

A cross cut in the west end of the stone sill of the middle of the three front doors of the old Presbyterian Church.

BLOOMFIELD. Eleva., 132.75 ft.

A cross cut in the extreme northwest corner of a large flat stone in the north end of the east abutment, upon which rests the east end of the north truss of the iron bridge which carries the Greenwood Lake Branch of the Erie Railroad over the Morris Canal.

BLOOMFIELD. Eleva., 181.19 ft.

A cross cut in the northwest corner of the west abutment, about 6 feet 4 inches above the towpath, of the bridge carrying the first road north of plane No. 11 over Morris Canal.

BLOOMFIELD. Eleva., 183.88 ft.

This bench mark is on the northeast corner of the west abutment of a bridge which carries a road over the Morris Canal about 2 3/8 miles north of the old Presbyterian Church. On this corner are two letters cut on the stone: "J. W." The point is on the "W." The west end of the north truss of the bridge rests upon this stone.

BLOOMFIELD. Eleva., 177.52 ft.

A cross cut in the lowest step of the north wing wall of the west abutment of the bridge which carries a road over the Morris Canal at Brookdale.

BLOOMFIELD. Eleva., 168.49 ft.

A cross cut in the most westerly coping stone (5 inches from the iron post of the hand rail) of the south wing wall of the west abutment of the bridge which carries a road over Yantecaw, or Third River, at Brookdale.

BLOOMFIELD. Eleva., 182.19 ft.

A cross cut in the water table, between the two pilasters, to the right of the entrance to the public school building at Brookdale.

BLOOMFIELD. Eleva., I28.97 ft.

A cross cut in the south end of the doorsill of the Broad-street entrance to the Bloomfield National Bank Building, which stands on the northwest corner of Bloomfield Avenue and Broad Street.

BLOOMFIELD. Eleva., 150.46 ft.
This bench mark is the top of a round knob cut in the southeast corner of a brownstone monument standing in front of Christ Episcopal Church, at the junction of Bloomfield Avenue and Liberty Street.

EAST ORANGE. Eleva., 181.86 ft.
A cross cut in the extreme north end of the third stone step from the top (and fourth from the bottom) behind a pilaster on the left of the entrance of the East Orange Free Public Library, which stands on the southeast corner of Main Street and Munn Avenue.

EAST ORANGE. Eleva., 179.02 ft.
A cross cut in the southwest corner of the base of a polished column, standing on the right of the entrance to the Essex County Trust Company's building, which is on the southeast corner of Main Street and Arlington Avenue.

EAST ORANGE. Eleva., 180.52 ft,
A cross cut in the extreme southwest corner of the top step of the most westerly entrance to the First Reformed Church, which stands on the southeast corner of Main and Halsted Streets. This bench mark is vertically below the cross at the peak of the roof.

EAST ORANGE. Eleva., 184.98 ft.
A cross cut in the northwest corner of the base of the most westerly of four columns standing in front of the People's Bank, which is located at the southwest corner of Main and Prospect Streets.

GLEN RIDGE. Eleva., 194.63 ft.
A cross cut in the west end of the stone sill of the most westerly window, on the south or Bloomfield-avenue side of the High School building, which is at the northwest corner of Bloomfield and Ridgewood Avenues.

GLEN RIDGE. Eleva., 187.09 ft.
A cross, with the letters "B. M." cut in the north end of the brownstone coping of the west wall of the arch bridge, which carries Ridgewood Avenue over Second River. This bridge is about 150 feet from Bloomfield Avenue.

GLEN RIDGE. Eleva., 226.10 ft.
A cross cut in the east end, inside of the hand rail, of the north abutment (at the junction with the east wing wall) of the iron bridge which carries the Parkway over Second River and the Delaware, Lackawanna and Western Railroad.

MAPLEWOOD. Eleva., 130.27 ft.
A cross cut in the extreme west end of the north wing wall of the west abutment of a bridge which carries Parker Avenue over the East Branch of the Rahway River.

MAPLEWOOD. Eleva., 118.40 ft.
A cross cut in the east end of the north wing wall of the east abutment of the bridge which carries Oakland Avenue over the East Branch of the Rahway River.

MAPLEWOOD. Eleva., 109.77 ft.
A cross cut in the west end of the coping of the north wing wall of the cast abutment of the bridge which carries Baker Avenue over the East Branch of the Rahway River.

MAPLEWOOD. Eleva., 133.86 ft.
A cross cut in the west end of the doorsill, of the only entrance, on the south or rear side, to the first or main floor of the public school building, which stands on the south side of Baker Avenue, just east of the Delaware, Lackawanna and Western Railroad.

MAPLEWOOD. Eleva., 97.35 ft.
A cross cut in a level place at the west end of the coping of the north wing wall of the west abutment of the bridge which carries Milburn Avenue over the East Branch of the Rahway River.

MILBURN. Eleva., 133.10 ft.
A cross cut in the east end of the coping of the north parapet of the arch bridge which carries Milburn Avenue over the Rahway River, in Milburn.

MILBURN. Eleva., 131.55 ft.
A cross cut in the south end (6 inches from the outer edge) of the doorsill of the Main-street entrance to the banking department of the First National Bank building.

MILBURN. Eleva., 146.24 ft.
A cross cut in the southwest corner of the stone base (near the east street curb) upon which rests the middle of three iron pillars supporting the east end of the bridge which carries the Delaware, Lackawanna and Western Railroad over Main Street.

MONTCLAIR. Eleva., 240.54 ft.
A cross cut in the north wall (near the southwest corner of a concrete post, measuring 2.7 feet x 1.2 feet) at the east end of the concrete bridge which carries Bloomfield Avenue over the Delaware, Lackawanna and Western Railroad. The concrete post is at the junction of the north parapet with the northeast retaining wall.

MONTCLAIR. Eleva., 250.53 ft.
A cross cut in the extreme west end of the stone doorsill (5 inches from a pilaster and near the junction of the west stone balustrade with the building) at the Bloomfield-avenue entrance to the Telephone building, which is on the southwest corner of Bloomfield and Gates Avenues.

MONTCLAIR. Eleva., 296.64 ft.
A cross cut in the northwest corner of the base of the most easterly of two columns standing in front of the Bank of Montclair building, which is located at 491 Bloomfield Avenue, on the north side of the street and about 180 feet west of North Fullerton Avenue. The column, on the base of which the cross is cut, stands between two windows.

MONTCLAIR. Eleva., 298.19 ft.
A cross cut in the east end of the base of a pilaster (4.3 feet from doorway and 1.5 feet above the sidewalk) on the east or left of Bloomfield-avenue entrance to the Young Men's Christian Association building.

MONTCLAIR. Eleva., 333.01 ft.
A cross cut in the south end of the water table (3.25 feet north of pilaster and 2 feet above the ground) on the west or Bell Street side of the Public Service car barns, which stand at the northeast corner of Bloomfield Avenue and Bell Street.

NEWARK. Eleva., 15.84 ft.
A cross cut in the fourth step from the bottom (or the eleventh step from the top) on the south end of the west abutment of the bridge which carries the Lehigh Valley Railroad over Frelinghuysen Avenue.

NEWARK. Eleva., 12.65 ft.
A cross cut in the east end of the doorsill of the Fenwick-avenue entrance to Engine House No. 19 of the Newark Fire Department, which stands on the northeast corner of Frelinghuysen and Fenwick Avenues.

NEWARK. Eleva., 24.62 ft.
A cross cut in the south end of the doorsill of the front entrance to the German Methodist Church, at the northeast corner of Walnut and Mulberry Streets.

NEWARK. Eleva., 38.47 ft.

A cross cut in the west end of the middle step of three at the Academy Street entrance to the Newark Post Office, which stands on the northwest corner of Broad and Academy Streets. The cross is 6 inches from west wall, 4 inches from back, and 8 inches from edge of step.

NEWARK. Eleva., 41.68 ft.

A cross cut in the water table of the Newark City Hall, about 13.5 feet above the street, 2 1/3 feet above the platform of approach, 18 11/12 feet south from the south edge of the most southerly entrance, and 10½ inches north of the junction of the south stone balustrade with the building.

NEWARK. Eleva., 68.07 ft.

A cross cut in the northeast corner of the square marble base of the most northerly of two columns at the north, or left side, of the Hight Street entrance to the Essex County Courthouse. The courthouse is in the triangle formed by junction of High and Market Streets with Springfield Avenue.

NEWARK. Eleva., 109.92 ft.

A cross cut in a brownstone base at the foot of the north end of the east truss of the bridge which carries Summit Street over the Morris Canal, at the upper end of the inclined plane.

NEWARK. Eleva., 119.10 ft.

A cross cut in the northeast corner of the stone on which the east end of the north truss rests, in the end of the east abutment of the bridge which carries Sussex Avenue over the Morris Canal.

NEWARK. Eleva., 132.93 ft.

A cross cut in the south end of the brownstone doorsill of the Jay-street entrance to the First Infantry Armory, which stands on the south side of Central Avenue between Jay and Hudson Streets. This cross is 2½ inches from the south wall of the entrance, 5 inches from edge of sill and 8 inches from door jamb.

NEWARK. Eleva., 120.11 ft.

A cross cut in the southeast corner of the base of the column against the south wall of the building (four feet back from the corner column) of Engine House No. 15 of the Newark Fire Department, which stands on the north side of Park Avenue, between Sixth and Seventh Streets. The cross is on the northeast column of three, at the entrance to the building.

NEWARK. Eleva., 117.61 ft.

This bench mark is the pointed top of a concrete post in the middle of the south parapet of the concrete bridge which carries Bloomfield Avenue over a driveway and stream in Branch Brook Park.

NEWARK. Eleva., 117.58 ft.

This bench mark is the pointed top of a concrete post in the middle of the north parapet of the concrete bridge carrying Bloomfield Avenue over a driveway and stream in Branch Brook Park.

NEWARK. Eleva., 120.13 ft.

A cross cut in the north end of the east abutment (near the east end of the north truss) of the bridge which carries the Orange Branch of the Erie Railroad over the Morris Canal at Forest Hill. The cross is 2.83 feet from the end of truss, 3 inches from edge and 5.42 feet from the northwest corner of the abutment.

NEWARK. Eleva., 103.52 ft.

A cross cut in the north end of the doorsill of the most southerly entrance (near circular tower) to Tiffany and Company's factory, opposite Forest Hill Station of the Greenwood Lake Branch of the Erie Railroad.

NEWARK. Eleva., 187.52 ft.
A cross cut in the north end of the stone doorsill of the most southerly Seventh-street entrance of Fire House No. 11 of the Newark Fire Department, which stands on the northeast corner of Central Avenue and Seventh Street.

ORANGE. Eleva., 195.68 ft.
This bench mark is the extreme northeast corner of the base of the Soldiers' and Sailors' Monument, standing at the junction of Main and South Main Streets, at the intersection of Prince Street.

ORANGE. Eleva., 191.04 ft.
A cross cut in the west end of the doorsill of the Main-street entrance to the Young Men's Christian Association building, which stands on the north side of Main Street, east of Park Street. The entrance is at the west end of the building.

ORANGE. Eleva., 184.64 ft.
A cross cut in the south end of the sill, on Center Street side, of the corner window, formerly an entrance to the Public Service building, which stands on the southeast corner of Main and Center Streets.

ORANGE. Eleva., 190.74 ft.
A cross cut in the southeast corner (0.35 foot from wall, 0.55 foot from end and 3.35 feet from a stone lamp post) of the stone platform at the left of the entrance of the Orange National Bank, which is located one door east of the southeast corner of Main and Cone streets.

ORANGE. Eleva., 196.42 ft.
A cross cut on the west end of the doorsill of the main, or middle, entrance (directly under the steeple) of the First Presbyterian Church, which stands on the northwest corner of Main and Day Streets.

ORANGE. EIeva., 219.84 ft.
This bench mark is a point on the extreme northwest corner of the base of the monument to the "Dispatch Rider of the American Revolution." This monument stands on the northeast corner of the cemetery, at the southwest corner of Main and Scotland Streets.

ORANGE. Eleva., 187.27 ft.
A cross cut in the south end of the doorsill of the left entrance to the waiting rooms of the Highland Avenue Station of the Delaware, Lackawanna and Western Railroad.

SOUTH ORANGE. Eleva., 168.95 ft.
A cross cut in the south end of the coping of the west wall of an arch bridge which carries Scotland Street over a small brook, about 125 feet north of South Orange Avenue.

SOUTH ORANGE. Eleva., 193.15 ft.
This bench mark is a point taken on the east end of doorsill (close to outer edge and 6 inches from east wall of doorway) of the rear entrance from South Orange Avenue to the First Presbyterian Church. This church stands on the point formed by the junction of South Orange and Irvington Avenues with Academy Street.

SOUTH ORANGE. Eleva,, 189.70 ft.
A cross cut in the extreme west end of a stone sill (at a point where it projects from the surface of the wall) of the most westerly window on the north side of the first ell, or wing, north from First Street, of the Columbia School building, which stands on the west side of and facing Academy Street, between Irvington avenue and First Street. There are three wings running back from the main building with two courts. The windowsill on which the bench mark was left is in the rear of the school building on the court side of the first wing north of First Street.

SOUTH ORANGE. Eleva., 154.82 ft.
A cross cut in the concrete foundation, on the Vose Avenue side, between the corner show window and a column supporting the southeast corner of the Decker Building, which stands on the northwest corner of South Orange and Vose Avenues.

SOUTH ORANGE. Eleva., 137.91 ft.
A cross cut in a shelf (7.5 feet above the river and 1.3 feet below the foot path of the bridge upon which rests the east end of I-beam) on the north end of the east abutment of the bridge which carries South Orange Avenue over the East Branch of the Rahway River. There is also another cross cut in the west end of the north wing wall of the east abutment, 1.25 feet higher. This cross is directly above the bench mark, and must not be confused with it.

SPRINGFIELD. Eleva., 105.34 ft.
This bench mark is a point on the southeast corner of the base (close up to the column or shaft) of a statute of a Continental soldier standing in the southwest corner of the Presbyterian Churchyard, on the northeast corner of Morris Avenue and Main Street.

SPRINGFIELD. Eleva., 100.45 ft.
A cross cut in the top of a milestone marked "5½ miles to Elizabeth Town," which is 4.1 feet high, 1,5 feet wide and 0.7 feet thick, and stands at the junction of Morris Avenue and Seven Bridge Road,

SPRINGFIELD. Eleva., 89.59 ft.
This bench mark is the top of the keystone of the most easterly of three arches, on the south side of an arch bridge which carries Morris Avenue over the West Branch of the Rahway River.

SPRINGFIELD. Eleva., 105.99 ft.
A cross cut in the east end of the south wing wall of the west abutment of the bridge which carries Morris Avenue over a raceway, four-fifths of a mile west of the Presbyterian Church and at west junction of Morris Avenue with an old road.

WYOMING. Eleva., 100.44 ft.
A cross cut in the coping, 5 feet from the east end of the north parapet, of an arch bridge wihch carries a road leading from Milburn Avenue to Headleytown over East Branch of Rahway River. This road joins Milburn Avenue 200 feet east of the junction of Ridgewood Road and Milburn Avenue. The bridge is 350 feet southeast from Milburn avenue.

HUDSON COUNTY.

HARRISON. Eleva., 26.03 ft.
A cross cut in the west end of the stone sill of the front door of the small brick office building, at Peter Hauck and Company's brewery, on Harrison Avenue, opposite Washington Street.

HARRISON. Eleva., 31.67 ft.
A cross cut near the southeast corner of the base of the column standing at the right, or east side of the front entrance to the West Hudson Trust Company's building, on the north side of Harrison Avenue, just west of Kearny Avenue.

HARRISON. Eleva., 55.12 ft.
A cross cut in the east end of the south abutment, on a shelf (2.9 feet below the footpath) upon which rests the south end of the east truss, of the bridge which carries Kearny Avenue over the Erie Railroad.

JERSEY CITY. Eleva., 94.93 ft.
A cross cut in the south corner of the upper large square stone step at the main entrance (on Summit Avenue) of the Westminster Presbyterian Church, at the east corner of Summit and Magnolia Avenues.

JERSEY CITY. Eleva., 99.65 ft.
A cross cut in the east end of the sandstone sill of the most westerly of two doors in the Newark Avenue front of the Hudson County Jail, opposite Oakland Avenue.

JERSEY CITY. Eleva., 101.22 ft.
A cross cut in the south end of the doorsill (ten inches from the door jamb, 3.6 inches from the south side of the entrance and 1.3 feet from the outer edge of the sill) of the most easterly of three entrances from Newark Avenue to the Hudson County Courthouse, which stands on the west corner of Newark and Pavonia Avenues.

JERSEY CITY. Eleva., 26.25 ft.
A cross cut in the north end of the east abutment, at the foot of the east end of the north truss of a small viaduct which carries a 3o-inch water main over the tracks of the West Shore or Junction Railroad, just south of the bridge carrying Newark Avenue over the same railroad.

JERSEY CITY. Eleva., 18.65 ft.
A cross cut in the north side of the stone base of the fifth, or last pilaster from Montgomery Street, on the Washington-street side of the Union Trust Company's building, which stands on the southwest corner of Montgomery and Washington Streets.

JERSEY CITY. Eleva., 6.99 ft.
A cross cut in the top of the south wall of Morris Canal lock No. 22. The cross is 14.1 feet from the head, or drop gate, 20.4 feet from the stone steps leading to the street and 0.12 foot from the edge of the wall. This lock is at Washington Street.

KEARNY. Eleva., 121.81 ft.
A cross cut in the first of two steps (0.7 foot from southwest corner of step, 15.5 feet from junction of the west wing wall with the northwest corner of the bridge, and 3.4 feet below the roadbed) in the west end of the north abutment of the bridge which carries Kearny Avenue over the Greenwood Lake Branch of the Erie Railroad, about 1,500 feet west from Arlington Station.

KEARNY. Eleva., 110.24 ft.
A cross cut in the southeast corner of the large stone landing, five steps down from the door, of the entrance to the Town Hall. This cross is in the corner formed by the junction of the south stone balustrade with the building. The Town Hall stands on the east side of Kearny Avenue nearly opposite Grove Street.

NEW DURHAM. Eleva., 7.91 ft.
A cross cut in the lowest of a series of steps (near the edge and close up to the bottom of the next step above) of the north abutment of the bridge which carries the Hackensack Turnpike over the West Shore Railroad at the station.

MORRIS COUNTY.

BOONTON. Eleva., 412.94 ft.
A cross cut in the east corner of the coping stone, level with the railroad, at the north corner of the Delaware, Lackawanna and Western Railroad bridge over the Rockaway River.

BOONTON. Eleva., 485.73 ft.
A cross on the southwest corner of the third stone of the shaft foundation of the soldiers' monument on Main Street. The point is at the top of the curved edge and 2 inches below the base of the shaft.

BOONTON. Eleva., 494.77 ft.
A cross cut in the east end of the granite sill of the east door of the Maxfield Engine House, 713 Main Street.

BOONTON. Eleva., 494.15 ft.
A cross cut in the east end of the north concrete parapet, under iron fence one foot west, of the west end of the wing wall of the Pond Bridge, which carries Main Street over the Rockaway River, above the falls.

CHATHAM. Eleva., 242.84 ft.
A cross cut in the sixth coping stone from the north end, in the center of the east parapet of the Delaware, Lackawanna and Western Railroad bridge over the Passaic River. This coping stone is 6 feet long by 3 feet wide. The cross is 26.1 feet from the north end and 45.6 feet from the south end of the east parapet.

CHATHAM. Eleva., 234.16 ft.
A cross cut in the west end of the sill (2 inches from the edge, 3½ inches from the brick wall and 10 inches from the door saddle) at the entrance to the Mayor's Office and Library at the west end of the Town Hall, which stands on the north side of Fairmount Avenue between the Delaware, Lackawanna and Western Railroad and Main Street.

CHATHAM. Eleva., 261.97 ft.
A cross cut in the stone parapet on the east side of the steps leading to the front entrance of the public school building, which stands on the north side of Fairmount Avenue just west of the Delaware, Lackawanna and Western Railroad. The parapet measures 4 feet by 2.7 feet; the cross is 0.7 foot from the side of the building, 3.3 feet from end of the parapet and 2 feet from the pilaster just east of the entrance.

CHATHAM. Eleva., 209.29 it.
A cross cut in the north post of the west wall of an arch bridge which carries Main Street over a small stream at the junction of Main and Lafayette Streets.

DENVILLE. Eleva., 503.42 ft.
A cross in the granite corner stone, at the west end of the south abutment of the iron bridge which carries a road over Rockaway River. The bridge is 2 miles northeast of Denville Station and 300 feet south of the junction of the Rockaway Valley road with the Rockaway-Boonton (Cook's) road.

DENVILLE. Eleva., 512.86 ft.
A cross cut in the northeast corner of the stone on the top of the south wall of Morris Canal Lock, No. 8, right at the end of the gate, when open.

DENVILLE. Eleva., 505.75 ft.
A cross cut in the south end of the granite coping of the west abutment of the two-span iron bridge which carries the Denville-Piers Lock road over the Rockaway River. This bridge is about a mile north of Denville Station.

DENVILLE. Eleva., 508.77 ft.
This bench mark is on the north abutment of the bridge of the Rockaway branch of the Delaware, Lackawanna and Western Railroad which crosses Den Brook, half a mile north of Denville Station. This point is on the outside corner of the third step from the top of the east end of the abutment.

DENVILLE. Eleva., 515.40 ft.
A cross cut in the bluestone sill of the basement window in the front or west of the building in the ell to the north of the main entrance to the public school.

DOVER. Eleva., 558.64 ft.
A cross in the surface (15 inches south of the northwest corner) of the west concrete sidewalk of the bridge carrying Mercer Street over Rockaway River. This cross is 3 inches east of the west parapet of the bridge.

DOVER. Eleva., 572.99 ft.
A cross cut in the water table at the southeast corner of George Richard's brick building at the northwest corner of Blackwell and Sussex Streets.

DOVER. Eleva., 582.08 ft.
A cross cut in the top and in the northeast corner of the bluestone forming the west side of the bottom step of the main front entrance to the Memorial Presbyterian Church. This mark is close to the base of the chimes tower.

DOVER. Eleva., 571.09 ft.
A cross cut in the top of the granite stone at the top of the wing wall at the northwest corner of the bridge which carries Sussex Street over the Rockaway River.

DOVER. Eleva., 574.02 ft.
A cross cut in the southeast corner of the brownstone sill of the east entrance to the High School which stands on the corner of McFarland and Sussex Streets.

DOVER. Eleva., 537.81 ft.
A cross cut in the outside corner on top of the granite stone forming the north end of the west bridge seat of the girder bridge which carries the Hibernia Mine Railroad over Rockaway River.

LAKE HOPATCONG. Eleva., 925.68 ft.
A cross cut in the northeast corner of the north end of the west wall of the raceway of the Morris Canal lock at the outlet of the lake. This is also a canal bench mark.

LAKE HOPATCONG. Eleva., 908.20 ft.
A cross cut in the top and in the southwest corner of the second step from the top of the west end of the north abutment of the bridge which carries the Delaware, Lackawanna and Western Railroad (cut off) over the Landing and Port Morris road.

LAKE JUNCTION. Eleva., 682.49 ft.
A cross cut in the southeast corner of a large granite stone under the concrete cap of the bridge seat at the south end of the west abutment of the bridge which carries the Delaware, Lackawanna and Western Railroad over Rockaway River, 1 1/5 miles west of Wharton Station.

LAKE JUNCTION. Eleva., 711.98 ft.
A cross cut in the top and in the southwest corner of the south concrete parapet of the four-track bridge which carries the Delaware, Lackawanna and Western Railroad over the Lake Hopatcong Branch of the Central Railroad of New Jersey, 1 3/4 miles west of Wharton Station.

LANDING. Eleva., 933.50 ft.
A cross cut in the northeast corner of the bluestone sill of the front entrance of the block house office building of W. E. King, on the south side of the Landing road.

LANDING. Eleva., 936.55 ft.
A cross in the west end of the south concrete parapet of the concrete bridge, which carries the highway over the Delaware, Lackawanna and Western Railroad and the Morris Canal, about 100 feet west of Hopatcong station. The bench mark is above the west springing line of the arch and 13.5 feet higher and at the east end of the concrete guard.

LANDING. Eleva., 939.67 ft.
A cross cut in the southwest corner of the concrete sill of the west main entrance to the Lake Hopatcong station of the Delaware, Lackawanna and Western Railroad, on the west side of tracks. The bench mark is 1 foot above the road level.

LINCOLN PARK. Eleva., 182.48 ft.
A cross cut in the southwest corner of the stone forming the upper step at the east end of the north wall of Morris Canal lock No. 12, east.

LINCOLN PARK. Eleva., 184.13 ft.
A cross cut in the south end of the bluestone doorsill of the entrance to the public school house on the back river road to Two Bridges.

LINCOLN PARK. Eleva., 178.00 ft.
A cross cut in the south concrete platform of the Delaware, Lackawanna and Western Railroad station. The point is in close to the building at the middle of the south side below the window.

LINCOLN PARK. Eleva., 179.17 ft.
A cross cut in the north side of the foundation (directly over the "9" in "1906") of the water tower, 900 feet west of the Delaware, Lackawanna and Western Railroad station.

MADISON. Eleva., 197.56 ft.
A cross cut in the south end of the sill of the most southerly of the windows in the west side of the Madison Water Works pumping station.

MADISON. Eleva., 205.34 ft.
A cross cut in the west end of the coping of the south parapet of the culvert which carries Main Street over Spring Garden Brook just east of the junction of Main Street and Rosedale Avenue.

MADISON. Eleva., 227.56 ft.
A cross cut in the east end of the sill (near the middle pilaster) of the most westerly window in the front of the brick office and apartment building of Green and Pierson, which stands on the south side of Main Street between Prospect Street and Waverly Place. This point is on the sill of the window to the left of the front entrance to the apartment at the west end of the building.

MADISON. Eleva., 243.77 ft.
A cross cut in the southwest corner of the bluestone platform of the approach to the front entrance to the banking department of the Madison Trust Company's building, which stands on the southwest corner of Main Street and Waverly Place. The point is near the wall and south of the base of the column against the wall at the left of the entrance.

MADISON. Eleva., 252.06 ft.
A cross cut in the east end of the doorsill of the Main Street entrance to the Young Men's Christian Association, on the corner of Main Street and Park Avenue.

MONTVILLE. Eleva., 239.57 ft.
A cross cut in the summit of a very large rounded boulder imbedded in the towpath at the edge of the Morris Canal, 200 yards east of the lower plane.

MONTVILLE. Eleva., 387.87 ft.
A cross cut in a projecting stone on the top of the wall at the south side of the square well into which the water falls, at the top of the upper plane of the Morris Canal.

MONTVILLE. Eleva., 311.55 ft.
A cross cut in the south end of the bluestone doorsill of the main entrance to the Town Hall.

MONTVILLE. Eleva., 316.52 ft.
A cross cut in the northeast corner of the concrete doorsill of the main front entrance to the public school.

MORRISTOWN. Eleva., 403.56 ft.
A cross cut in the east end of the sill, close by the west side, of the most easterly of two wooden pillars at the entrance of the Morris County Courthouse.

MORRISTOWN. Eleva., 376.66 ft.
This bench mark is on the flat surface, directly under the carved stone cannon, at the west corner of the base of the soldiers' monument in the city park.

MORRISTOWN. Eleva., 369.72 ft.
A cross cut in the southwest corner of the middle granite step (6 inches below the water table), of the Methodist Episcopal Church, on Park Place.

MORRISTOWN. Eleva., 366.95 ft.
A cross cut in the south end of the bluestone doorsill of the southerly entrance from Speedwell Avenue to the Police Headquarters building, on the corner of Speedwell Avenue and Water Street.

MORRISTOWN. Eleva., 373.83 ft.
A cross cut in the southeast end of the granite step (at the level of the granite doorsill and 6 inches above the sidewalk) of the First National Bank building on Park Place. The point is at the base of the ornamental stone door jamb of iron grill.

MOUNT TABOR. Eleva., 502.06 ft.
A cross cut in the northwest corner of the coping of the wall over the north end of a culvert, under the Morris and Essex Railroad, for carrying off the overflow of a pond, 1 mile east of Mount Tabor.

MT. ARLINGTON. Eleva., 782.84 ft.
A cross cut in the southeast corner of the south concrete parapet of the bridge which carries the Delaware, Lackawanna and Western Railroad over the Kenville-Mt. Arlington road. The bridge is 600 feet west of the station.

NETCONG. Eleva., 874.13 ft.
A cross cut in the northeast corner of the bluestone sill of the entrance at the east end of Stanhope-Netcong station of the Delaware, Lackawanna and Western Railroad.

PORT MORRIS. Eleva., 892.66 ft.
A cross cut in west end of bluestone sill of the basement window on the north side of the tower of the Methodist Episcopal Church.

PORT MORRIS. Eleva., 890.18 ft.
A cross cut in the south end of the bluestone sill of the south basement window on the east side of the public schoolhouse.

POWERVILLE. Eleva., 494.31 ft.
A cross cut in the west end of the bluestone doorsill of the north entrance to the concrete engine-house, of Field, White & Company's paper mills.

POWERVILLE. Eleva., 495.53 ft.
A cross cut in the south end (at the end of two trusses) of the bluestone top of the center pier supporting the two spans of the highway bridge over the Rockaway River, at the paper mills.

ROCKAWAY. Eleva., 523.18 ft.
This bench mark is on the northeast corner of the flange of the cast-iron footplate at the northeast corner of the iron bridge over the Morris Canal, at the foot of the plane.

ROCKAWAY. Eleva., 527.50 ft.
A cross cut in the outside corner of the north end of the west abutment of the Main Street bridge over the Rockaway River.

ROCKAWAY. Eleva., 533.63 ft.
A cross cut in the east end of a bluestone doorsill of the easterly Main-street entrance to the municipal building.

ROCKAWAY. Eleva., 563.87 ft.
This bench mark is a point taken on the northeast corner of the flat portion of the top of the bluestone sill of the cast front window of Strait's store, on Main Street. The bench mark is indicated by an arrow cut in the flagging about 4 inches below the point.

SHIPPENPORT. Eleva., 873.54 ft.
The bottom of a square hole cut in the west end of the bridge seat of the south concrete abutment of the four track Delaware, Lackawanna and Western Railroad bridge over Morris Canal.

SHIPPENPORT. Elcva., 874.78 ft.
A cross cut in the southeast corner of the wrought iron bedplate of the south end of the east girder of the four track Delaware, Lackawanna and Western Railroad bridge over the highway.

SHIPPENPORT. Eleva., 864.57 ft.
A cross cut in the southeast corner of the east coping stone of the north wing wall of the overflow on the cast side of the Morris Canal, a short distance north of the Delaware, Lackawanna and Western Railroad.

TOWACO. Eleva., 226.56 ft.
A cross cut in the west end of the doorsill of the entrance near the west end and on the south side of the Delaware, Lackawanna and Western Railroad station.

TOWACO. Eleva., 243.39 ft.
A cross cut in the top of a brownstone block which forms the northeast corner of the foundation of the Methodist Episcopal Church, which stands near the tracks and about 1,000 feet east of the Delaware, Lackawanna and Western Railroad station.

TOWACO. Eleva., 224.11 ft.
A cross cut in the west abutment of the bridge which carries the Delaware, Lackawanna and Western Railroad over the highway west of the station. The point is on the concrete bridge seat, 4 feet below the track level, and 3 feet north of the north rail.

TOWACO. EIeva., 194.46 ft.
A cross cut in the northwest corner of the bridge seat of the west concrete topped abutment of the bridge which carries the Delaware, Lackawanna and Western Railroad over a road at the foot of plane No. 10 east. This point is one foot south of the north end of the abutment, 3 feet below, and 25 feet north of the north rail of the two track line.

WHARTON. Eleva., 612.60 ft.
A cross cut in the outside corner of the upper step at the north end of the western abutment of the Delaware, Lackawanna and Western Railroad bridge over the Rockaway River, three-quarters of a mile southeast of Wharton.

WHARTON. Eleva., 602.35 ft.
A cross cut in the outside corner of the lowest step at the south end of the western abutment of the bridge which carries the High Bridge Branch of the Central Railroad of New Jersey over the Rockaway River, three-quarters of a mile southeast of Wharton.

WHARTON. Eleva., 666.25 ft.
A cross cut in the west end of the south abutment of the bridge which carries the High Bridge Branch of the Central Railroad of New Jersey over the Delaware, Lackawanna and Western Railroad. This cross is cut on the granite stone at the end of the bridge seat.

WHARTON. Eleva., 694.96 ft.
A cross cut in the top of and in the south end of the bluestone sill of the Main-street entrance of Wharton Public School.

PASSAIC COUNTY.

ATHENIA. Eleva., 183.78 ft.

A cross cut in the northeast corner of the west abutment at the north end of the bridge which carries the highway leading from Athenia Station on the Delaware, Lackawanna and Western Railroad, to Montclair, over the Morris Canal.

ATHENIA. Eleva., 179.50 ft.

This bench mark is on a small cut in a projecting stone, 4.6 feet above the ground, at the west end of the north abutment of the road bridge over the Morris Canal, 1 mile south of Athenia. The paint is indicated by an arrow head.

ATHENIA. Eleva., 164.80 ft.

A cross cut in the southeast corner of the west end of the culvert which carries a highway leading from Athenia Station (Erie R. R.) to Montclair, over a small stream, about 800 feet northeast from the Morris Canal.

HAWTHORNE. Eleva., 41.83 ft.

A cross cut in the top of the granite coping (6 inches back from the southeast corner) of the east wing wall of the north abutment of the bridge which carries the Erie Railroad over the Passaic River. The point is 5 feet below the track level.

LITTLE FALLS. Eleva., 174.67 ft.

A cross cut in the stone coping at the end of the iron railing on the west side of the Passaic River, of the Morris Canal aqueduct.

LITTLE FALLS. Eleva., 194.90 ft.

A cross cut in the northwest corner of the stone doorsill of the main front entrance of the Reformed Church.

LITTLE FALLS STATION (TOTOWA). Eleva., 194.56 ft.

This bench mark is at the point of an arrow on the water table at the northeast corner of the Little Falls depot of the Delaware, Lackawanna and Western Railroad.

MOUNTAIN VIEW. Eleva., 172.62 ft.

A cross cut in the top of the north concrete wing wall (9 inches back from the north corner) of the east abutment of the bridge which carries the highway over the Pompton River. This bridge is 800 feet west of the Erie Railroad Station and 300 feet south of the Morris Canal aqueduct.

MOUNTAIN VIEW. Eleva., 175.74 ft.

A cross cut in the north corner of the west end of the coping of the circular wall at the north end of the west abutment of the aqueduct by which the Morris Canal crosses the Pompton River.

MOUNTAIN VIEW. Eleva., 180.57 ft.

A cross cut in the east end of the concrete doorsill of the south entrance of the Delaware, Lackawanna and Western Railroad station.

PASSAIC. Eleva., 56.69 ft.

A cross cut in the south end of doorsill of the front entrance of the Passaic Trust and Safe Deposit Company's building, which stands on the west side of Main Street between Academy and Bloomfield Avenues.

PASSAIC. Eleva., 60.31 ft.

A cross cut in a raised projection, in front of the wall, on the extreme south end of the doorsill of the entrance to the municipal building standing on the northwest corner of Howe Avenue and Prospect Street. This entrance is between two fire engine rooms.

PASSAIC. Eleva., 26.51 ft.
A cross cut in the extreme southwest corner of the west end of the coping of the north wall of the arch bridge which carries Passaic Avenue over the tailrace from the mills. This bridge is a short distance west of the New York, Susquehanna and Western Railroad.

PATERSON. Eleva., 99.45 ft.
A cross cut in the south end of the Main-street entrance to St. Boniface Church, at the southeast corner of Main and Slater Streets.

PATERSON. Eleva., 80.12 ft.
A cross cut in the east end of the doorsill of the main front entrance to the Market Street M. E. Church.

PATERSON. Eleva., 88.82 ft.
A cross cut in the west end of the doorsill of the main entrance to the municipal building on the corner of Market and Union Streets.

PATERSON. Eleva., 99.15 ft.
A cross cut in the north end of the doorsill of the main entrance to the First Presbyterian Church, on the corner of Main and Ward Streets.

PATERSON. Eleva., 103.18 ft.
A cross cut in the top of the second cheek stone from the bottom, at the northwest corner of tile base of the second pillar from the north end of the Hamilton-street entrance to the Passaic County Courthouse.

PATERSON. Eleva., 181.24 ft.
This point is on the East Jersey Water Company's bench mark at Stony road reservoir, Grand Street and Reservoir Avenue, and is a cross cut in outcrop rock, one foot north of the concrete wall on the Grand-street side and 36 feet east of the middle of the intake pipes near the corner of the streets.

PATERSON. Eleva., 187.69 ft.
A cross cut in the north corner of the concrete facing of the east abutment of the Delaware, Lackawanna and Western Railroad bridge over the Passaic River, known as High Bridge. This bridge is between Paterson and Little Falls.

RICHFIELD. Eleva., 182.56 ft.
A cross cut in the north end of the east abutment of the bridge over the Morris Canal. The point is at the end of the timber on which the bridge rests.

RICHFIELD. Eleva., 183.11 ft.
A cross cut in the east end of the bluestone sill of the window, between cornerstone marked "1907," and the main entrance to St. John's German Lutheran Church.

RICHFIELD. Eleva., 186.72 ft.
This bench mark is the bottom edge of the corner-stone, marked "1907," of St. John's German Lutheran Church.

RICHFIELD. Eleva., 191.84 ft.
A cross cut in the east end of the bluestone sill of the front basement window, nearest the east side, of Public School No. 2.

TOTOWA. See Little Falls Station.

SUSSEX COUNTY.

ANDOVER. Eleva., 638.05 ft.
This bench mark is on the large gneiss rock on the bank, on the east side of the Sussex Railroad, 145 yards north of the station and 9 yards north of cattle pens.

ANDOVER. Eleva., 648.15 ft.
A cross cut in the top of the north end of Bluestone sill of the middle one of three basement windows of the bell tower of the Methodist Episcopal Church. Window is on west side of tower.

ANDOVER. Eleva., 611.84 ft.
This bench mark is indicated by an arrow on the top of a brownstone corner-stone at the southwest corner of the Presbyterian Church.

ANDOVER JUNCTION. Eleva., 579.16 ft.
A cross cut in the northwest corner of the bed-plate at the south end of the west girder of the bridge carrying the Sussex Branch of the Delaware, Lackawanna and Western Railroad over the Pequest River, just north of Andover Junction.

BRANCHVILLE. Eleva., 526.77 ft.
A cross cut in the center and 1 foot from the west edge of a large stone in the top course on the west end of the north abutment of the Sussex Branch of the Delaware, Lackawanna and Western Railroad bridge over Dry Brook, 25 yards south of crossing over the railroad of the road to Augusta, and southeast of the entrance of the road to Swartswood. (The bench is not on the single stone which is upon the top of the wall.)

BRANCHVILLE. Eleva., 578.04 ft.
A cross cut in the northeast corner of a limestone corner-stone inscribed "Presbyterian Church of Branchville A. D. 1856." This stone is set in east side of building in the middle one of three attached pillars.

BRANCHVILLE. Eleva., 573.43 ft.
The top of exposed corner-stone bearing inscription Branchville M. E. Church 1864-78. Point is indicated by an arrow.

BRANCHVILLE. Eleva., 535.16 ft.
A cross cut in the northwest corner of bed-plate at north end of west girder of Delaware, Lackawanna and Western Railroad bridge over Dry Brook just south of station and northeast of Borden's creamery.

BRANCHVILLE JUNCTION. Eleva., 577.25 ft.
A cross cut in the top surface of the concrete foundation just south of the "9" in 1905 of the pipe homing of the Delaware, Lackawanna and Western Railroad water tower on the west side of the track and south of the station.

BRANCHVILLE JUNCTION. Eleva., 560.67 ft.
This bench mark is on the east side of the Sussex Branch of the Delaware, Lackawanna and Western Railroad and the north rail of the New York. Susquellanna and Western Railroad at their crossing.

CARPENTER'S POINT. Eleva., 452.30 ft.
This bench mark is the top of State line monument on the road which runs from Port Jervis to Montague.

CARPENTER'S POINT. Eleva., 421.36 ft.
This bench mark is the top of the State line monument on the east shore of the Neversink River.

CARPENTER'S POINT. Eleva., 480.93 ft.
This bench mark is on the State line monument on the cast side of the turnpike to Deckertown, at the Two-States Hotel.

CARPENTER'S POINT. Eleva., 414.99 ft.
This bench mark is on the Tri-State monument at the meeting of the boundary lines of New Jersey, New York and Pennsylvania, on the extreme point at the forks of Delaware and Neversink Rivers.

COLEVILLE. Eleva., 908.30 ft.
A cross cut in the large boulder at the entrance of the road to Sand Pond about 1 mile northwest of Coleville.

COLEVILLE. Eleva., 807.87 ft.
A cross cut in face of 1887 corner-stone of the M. E. Church just below and between the two "8's". Elevation is at intersection of cross.

COLEVILLE. Eleva., 781.28 ft.
A cross cut in the top of the west end of the south girder of highway bridge over the brook 200 feet west of the school house. Mark is about 6 inches west of the west face of west iron rail post.

CULVER'S GAP. Eleva., 915.35 ft.
This bench mark is on the summit of a conglomerate boulder an the northeast corner of the roads meeting in the gap.

CRANBERRY LAKE. Eleva., 777.05 ft.
The summit of the most westerly of the two spurs of gneiss rock at the northeast corner of the road from Stanhope and a road running northeast at the north end of the Cranberry Reservoir (not marked).

CRANBERRY LAKE. Eleva., 766.73 ft.
A cross cut in top of west coping, directly over keystone, of the stone arch culvert over the brook 400 yards south of Cranberry Station. The coping is the only course of masonry above the arch, and the mark is 2.80 feet higher than the crown of the arch.

EMMONS. Eleva., 468.77 ft.
A cross cut in the top of limestone that is at the northwest end of the bridge seat of the southwest abutment of girder bridge No. $^{73}/_{26}$, carrying the New York, Susquelanna and Western Railroad over the Freedon-Middleville road, and a brook. The point is 1 foot back from the exposed corner of the stone.

FRANKLIN FURNACE. Eleva., 560.13 ft.
This bench mark is on the stone water table at the southwest corner (front corner towards New Furnace) of the company's brick store and office

FRANKLIN FURNACE. Eleva., 565.91 ft.
A cross cut in the north end of the limestone sill of the front entrance of the Catholic Church. The building is of limestone and was built in 1902.

FRANKLIN FURNACE. Eleva., 557.49 ft.
A cross cut in the northwest end of the granite sill of the front entrance to the public school.

HAINESVILLE. Eleva., 639.29 ft.
A cross cut in the top of an imbedded rock with rounded summit, on the east side of the road, 40 yards north of the corner of roads, at which the church and schoolhouse stands.

HAINESVILLE. Eleva., 651.83 ft.
A cross cut in surface of the concrete porch of the Dutch Reformed Church. This point is on the north end of the northerly of the two front entrances.

HAINESVILLE. Eleva., 660.15 ft.
A cross cut in the white limestone corner-stone, bearing the inscription "M. E. Church 1911," at the southeast corner of the building. This mark is on the flat surface back under the baseboard.

HALSEY. Eleva., 609.28 ft.
A cross cut in the south coping (1 foot from the east end) of the concrete culvert (Nos. 68-14) just west of Halsey Station of the New York, Susquehanna and Western Railroad.

HALSEY. Eleva., 576.53 ft.
A cross cut in the surface, 1 foot from northeast end, of coping of northwest concrete wall of culvert No. $^{69}/_{00}$ carrying New York, Susquehanna and Western Railroad over a brook 1 mile southwest of Halsey Station.

HIGH POINT. Eleva., 1800.21 ft.
This bench mark is the highest point of the bed-rock on the summit of the mountain.

HIGH POINT. Eleva., 1804.30 ft.
This bench mark is a cross cut on the top of a boulder on the summit of the mountain. This is the highest point in New Jersey.

LAFAYETTE. Eleva., 549.94 ft.
This bench mark is on the summit of a limestone boulder, indicated by an arrow, at the east corner of the main crossroads in the village.

LAFAYETTE. Eleva., 512.60 ft.
A cross cut in the southeast corner of the limestone on top of the south abutment on the east side of the Sussex Railroad track, where it crosses above the wagon road, just east of the crossroads and about 1 mile north of the village.

MONTAGUE. Eleva., 520.82 ft.
A cross cut in the rought stone water table near the bar room door of the Brick House Hotel.

MONTAGUE. Eleva., 527.22 ft.
A cross cut in top surface of concrete abutment, close to the girder, about 1 foot south of the north end of west girder of small road bridge just south of the Brick House Hotel. The bench mark, which is at the elevation of the bottom of the girder, is also indicated by all arrow cut in the lower flange of the girder, near its edge.

NEWTON. Eleva., 648.68 ft.
A cross cut in the east end of the outside of the limestone doorsill at the entrance of the Sussex County Courthouse.

NEWTON. Eleva., 650.02 ft.
This bench mark is indicated by an arrow cut in the granite of the lowest of the stepped stones forming the base of the Soldiers' Monument. The point is at the highest part of the northwest corner of the lowest stone directly at the base of the second stone.

NEWTON. Eleva., 656.56 ft.
A cross cut in top and at north end of limestone sill of main entrance of Newton Trust Company's building.

NEWTON. Eleva., 649.63 ft.
A cross cut in the east end of the limestone sill of the north door of the Clerk's and Surrogate's office building.

NEWTON. Eleva., 678.46 ft.
A cross cut in the east end of the stone doorsill at the corner of the jamb of the entrance to the Presbyterian Church.

NEWTON. Eleva., 601.24 ft.
A cross cut in the limestone sill of the most northerly of three doors (baggage room) in the east side of the Newton station of the Sussex Railroad.

NEWTON. Eleva., 602.36 ft.
A cross cut in the northwest corner of the bedplate at the south end of the west girder of the single track bridge carrying the Sussex branch of the Delaware, Lackawanna and Western Railroad over the road leading from Newton to Mulford Station, at Drake's Pond, 1 mile south of Newton.

STANHOPE. Eleva., 864.15 ft.
A cross cut in the outside corner of the coping at the west end of the north wall of the Morris Canal lock, at outlet of the reservoir. This is a canal bench mark.

STANHOPE. Eleva., 958.51 ft.
A cross cut in the south end of bluestone sill of basement window facing west, in L at west of south entrance to High School.

SWARTSWOOD STATION. Eleva., 502.58 ft.
A cross cut in the top, about foot back from the outside corner, of the first limestone step below the bridge seat, at the northwest end of the northeast masonry abutment of the track bridge carrying the New York, Susquehanna and Western Railroad over the Newton road.

STILLWATER. Eleva., 476.30 ft.
A cross cut in the second limestone step from the top at the northwest end of the southwest abutment of small field culvert (No. $^{74}/_{77}$) 275 yards northeast of the creamery and 1 mile northeast of station.

STILLWATER. Eleva., 471.31 ft.
A cross cut in a small shelf on the northeast side, 6 inches below the summit of a 5-foot white limestone boulder on the northwest side of the New York, Susquehanna and Western Railroad at the southwest end of the retaining wall of the cut, 650 yards northeast of the station.

STILLWATER. Eleva., 460.39 ft.
A cross cut in the southeast end of the concrete doorsill of the entrance at the southwest end of the McDermott creamery.

SUSSEX. Eleva., 440.92 ft.
A cross cut in the south end of the stone doorsill of the brick store building on the northwest corner of the streets, on the south corner of the open triangle opposite Goble's Hotel.

SUSSEX. Eleva., 482.37 ft.
A cross cut in the south end of the bluestone sill of the basement window near the south end of the west side of the Public School.

SUSSEX. Eleva., 419.31 ft.
A cross cut in the bluestone porch of the First Baptist Church. The point is near the west end of the westerly of the two front entrances.

TUTTLE'S. Eleva., 756.87 ft.
This bench mark is on the summit of a large boulder on the northwest corner of the roads meeting about three-quarter mile south of Tuttle's Corner.

WARBASSE. Eleva., 559.22 ft.
A cross cut in surface of the south end of west concrete abutment, 1 foot back from face of the abutment and 1 foot north of the angle line of the abutment and wing wall of single track bridge carrying the New York, Susquehanna and Western Railroad over Paulinskill just west of station.

WATERLOO. Eleva., 652.79 ft.
A cross cut in the outside corner of gneiss rock forming the top of south end of west abutment of highway bridge over outlet of Waterloo Pond, 200 yards below dam. It is an iron bridge and near foot of canal plane.

WATERLOO. Eleva., 633.57 ft.
A cross cut in east end of lowest bluestone step of the stone stairs leading up from the road to the level of church yard at the Methodist Church. The point is 6 inches north of outside face of retaining wall.

WATERLOO. Eleva., 642.71 ft.
A cross cut in the middle of the piece of the bluestone cap of the east parapet that is directly over the middle pier of the two-span masonry arch highway bridge (Kinney's bridge) over the Musconetcong River 1 mile west of Waterloo.

WHITEHALL. Eleva., 705.58 ft.
This bench mark is on a small rounded summit, marked by an arrow on the coping stone, 2 inches back from the face of the wall and directly over the center of the keystone of the east side of the stone arch bridge carrying the Sussex Railroad over the wagon road, just north of Whitehall and about 1 mile south of Andover.

UNION COUNTY.

ELIZABETH. Eleva., 32.83 ft.

This bench mark is a point taken on the northeast corner of the third step from the top (to the right and in the rear as the monument faces) of the Soldiers' and Sailors' Monument, which stands in a triangle formed by the intersection of North Broad, Prince and Magnolia Streets.

ELIZABETH. Eleva., 30.44 ft.

A cross cut in the south end of the stone sill of the main front door of the First Presbyterian Church.

ELIZABETH. Eleva., 27.74 ft.

A cross cut in the southeast corner of the bottom step of the series of steps of the east retaining wall of the north abutment of the bridge which carries the Pennsylvania Railroad over West Jersey Avenue. This bench mark is at the foot of a stairway leading to the south end of the east platform of the railroad station.

ELIZABETH. Eleva., 31.02 ft.

A cross cut in the extreme south end of the stone platform of the entrance to the Union County Courthouse, on the west side of South Broad Street opposite Elizabeth Avenue. There are four fluted columns at the entrance, with their bases resting on the platform. The cross is cut in front of the most southerly of the four columns and near the pilaster at the south side of the entrance.

ELIZABETH. Eleva., 14.29 ft.

A cross cut in coping, 1.55 feet north of a line perpendicular to the center of the keystone of the middle arch, of the east parapet of an arch bridge which carries South Broad Street over the Elizabeth River.

ELIZABETH. Eleva., 38.71 ft.

This bench mark is on the cross on top of a property monument at the northeast corner of Linden Avenue and the road leading to Lorraine. This bench mark is about 1½ miles southwest of Elizabeth.

LINDEN. Eleva., 19.83 ft.

A copper bolt set in the northeast wing wall of the northwest abutment of a bridge which carries the Pennsylvania Railroad over Morse's Creek, about 1¼ miles east of Linden. This is probably a railroad bench mark. It is marked thus: $\overset{22}{([.])}$

LINDEN. Eleva., 18.08 ft.

A cross cut in the southeast corner of the south end of the east abutment of a bridge which carries the Baltimore and Ohio Railroad over Linden Avenue, about 1¼ miles east of Linden. This bench mark is 4.2 feet above the ground.

LINDEN. Eleva., 35.03 ft.

A cross cut in the south corner of the southeast end of bridge seat of the northeast concrete abutment of a bridge which carries the Pennsylvania Railroad over Wood Avenue.

LINDEN. Eleva., 23.36 ft.

A cross cut in the center of the middle coping stone of the northwest parapet of an arch bridge which carries Linden Avenue over the South Branch of Morse's Creek, about 1¼ miles west of the station.

LINDEN. Eleva., 26.42 ft.

A cross cut in the south end of the east abutment of the concrete bridge which carries the Pennsylvania Railroad over Stiles Street, 700 yards west of the station.

RAHWAY. Eleva., 18.17 ft.
A cross cut at the foot of the lamp post end of the iron railing on west end of the coping of the north parapet of an arch bridge which carries Elizabeth Avenue over Rahway River.

RAHWAY. Eleva., 18.81 ft.
A cross cut in the stone foundation at the northwest corner of the Second Presbyterian Church. A niche in the buttress at this corner exposes the foundation for an area about 6 inches square; on this is the cross.

RAHWAY. Eleva., 24.42 ft.
A cross cut in the stone base of the pilaster (between the entrance and the most southerly window) on the west side of the Rahway National Bank, which is on Irving Street just west of its junction with Lewis Street.

RAHWAY. Eleva., 2o.18 ft.
A cross cut in the east end of the north abutment of a bridge which carries the Perth Amboy Branch of the Pennsylvania Railroad over the South Branch of the Rahway River, 1 1/3 miles west of station.

RAHWAY. Eleva., 11.96 ft.
A cross cut in the southwest corner of a stone in the west end of the north abutment, which supports the north foot of the west truss, of a bridge which carries Georges Avenue over the South Branch of the Rahway River. This bridge is about 1 mile west of Rahway and is on the line between Union and Middlesex Counties.

SUMMIT. Eleva., 194.63 ft.
This bench mark is the highest point on the extreme west corner of the keystone in the south end of the arch of a bridge which carries Springfield Avenue over a small stream, about 1¼ miles east of Summit. This stream empties into a pond south of the road.

SUMMIT. Eleva., 227.70 ft.
A cross cut in the east end of coping of the south wall of a culvert which carries Morris Avenue over a small stream. This culvert is about 150 feet west of the junction of Springfield and Morris Avenues.

SUMMIT. Eleva., 261.93 ft.
A cross cut in the east end of coping of the south wall of a small culvert which carries Morris Avenue over a small waterway between Orchard Street and the turnpike.

SUMMIT. Eleva., 324.19 ft.
A cross cut in the southwest corner of the concrete base of the east iron pillar of the two pillars on the north side of the road, supporting the bridge which carries the Rahway Valley Railroad over Morris Avenue.

SUMMIT. Eleva., 390.61 ft.
A cross cut in the east end of the bridge seat of the south concrete abutment of a bridge which carries Summit Avenue over the Delaware, Lackawanna and Western Railroad, just east of the station. This point is 1.3 feet from the end and 1.47 feet from the edge of the abutment, 1.5 feet from back wall and 3.5 feet below the platform of the bridge.

SUMMIT. Eleva., 393.66 ft.
A cross cut in the east end of the stone sill of the window in the middle arch in the front of the Municipal Building on Springfield Avenue near the corner of Summit Street.

SUMMIT. Eleva., 396.35 ft.
A cross cut in the west end of the doorsill of the side entrance, on Springfield Avenue, of the Summit Bank building, on the northeast corner of Springfield and Beechwood Avenues. This is the entrance to apartments above the banking rooms.

SUMMIT. Eleva., 382.07 ft.
A cross cut in a concrete retaining wall, at change of level, near the west end of south abutment of a bridge which carries Springfield Avenue over the Delaware, Lackawanna and Western Railroad.

SUMMIT. Eleva., 260.25 ft.
A cross cut in the bridge seat (0.55 foot from bed plate of truss) at east end of south concrete abutment of a bridge which carries the Delaware, Lackawanna and Western Railroad over the Boulevard.

WARREN COUNTY.

BELVIDERE. Eleva., 257.40 ft.
The top of a copper bolt, around which a square is cut, set in a limestone block at the northwest end of the northeast bridge seat of field bridge (P. R. R.) No. 87, just northeast of the railroad bridge over the highway, 1 1/8 miles southwest of station. This is a railroad bench mark.

BELVIDERE. Eleva., 290.45 ft.
A cross cut in the north end of the granite sill of the southerly of the two entrances on the west side of the public school.

BELVIDERE. Eleva., 289.88 ft.
Cross cut in the northeast corner of the brownstone sill of the middle, or tower door of the First Presbyterian Church, which stands on the west side of the city park.

BELVIDERE. Eleva., 286.01 ft.
A cross cut in the west end of the brownstone doorsill of the Surrogate's office. This is the most westerly of the four doors in the front of the Warren County Courthouse.

BELVIDERE. Eleva., 265.44 ft.
A copper bolt around which a square is cut, set in the top of the square dressed stone, on which rests the south end of the west girder of the single track (P. R. R.) bridge, No. 91, The bolt is 6 inches northeast of the corner of the bedplate.

BELVIDERE. Eleva., 262.36 ft.
A copper bolt, around which a square is cut, set in a limestone block in the northwest coping of the Pennsylvania Railroad stone arch bridge over the brook, 300 yards south of the station. This bolt is in the top surface of the coping and above the crown of the arch of bridge No. 88.

BELVIDERE. Eleva., 286.00 ft.
The bottom of a square cavity cut in the west end of the bluestone sill of the door of the County Clerk's Office; said door being the easterly of the four doors in the front of the courthouse.

BELVIDERE. Eleva., 287.03 ft.
A cross cut in top and at the north end of the brownstone sill of the main front entrance of the Methodist Episcopal Church, on the east side of the park.

BLAIRSTOWN. Eleva., 349.73 ft.
A cross cut in the southwest corner of the upper of two square dressed granite blocks, on which rests the east end of the south truss of the single track bridge (No. 81/88), carrying the New York, Susquehanna and Western Railroad over Paulinskill. This bridge is three-fourths miles east of the station,

BLAIRSTOWN. Eleva., 347.38 ft.
A cross cut in the west end of the doorsill of the tower entrance to the Presbyterian Church.

BLAIRSTOWN. Eleva., 346.13 ft.
A cross cut in the west end of doorsill of the entrance to the People's National Bank.

BLAIRSTOWN. Eleva., 348.03 ft.
A cross cut in the square limestone base of the most easterly of the three pillars in front of the First National Bank.

BROADWAY. Eleva., 350.56 ft.
A cross cut in the top and east end of the north concrete parapet of the bridge which carries the turnpike over Mill Brook. The point is 6 inches above concrete floor of bridge.

BROADWAY. Eleva., 351.93 ft.
A cross cut in the east end of the concrete doorsill of the tower entrance to Broadway Methodist Episcopal Church.

BROADWAY. Eleva., 345.84 ft.
This bench mark is the top of the seventh course of brick of the chimney on the west side of the schoolhouse. The top of this course is above the bottom of the woodwork of the building. The point is marked by an arrow on the face of the chimney towards the road, and near the southwest corner.

BROADWAY. Eleva., 434.73 ft.
This bench mark is on the southwest corner of a square-dressed stone (2½ feet from the wooden sill lying thereon) at the south side of the floodgate of the Morris Canal, just south of the road leading from Broadway to Montana.

BUTTSVILLE. Eleva., 346.47 ft.
A cross cut in the northwest corner of the south abutment of the iron bridge which carries the highway over Pequest River, 1 mile west of the railroad station. The stone is a conglomerate.

BUTTSVILLE. Eleva., 382.24 ft.
A cross cut in the northwest corner of the top surface of the bedplate at the north end of the west truss of the bridge, which carries the highway over Pequest River, 225 yards east of the Lehigh and Hudson River Railroad.

BUTTSVILLE. Eleva., 382.70 ft.
A cross in a circle cut in the northwest concrete wing wall (at the end of the lattice guard rail) of the truss bridge which carries the highway over Pequest River east of the station.

BUTTSVILLE. Eleva., 423.40 ft.
A cross cut in the outer edge of the coping stone on the south side of the Delaware, Lackawanna and Western Railroad track, and directly over the keystone of the center arch of the stone bridge over the Pequest River and the Lehigh and Hudson River Railroad, east of Buttsville station.

COLUMBIA. Eleva., 294.77 ft.
A cross cut in the southeast corner of the square dressed granite block on which rests the west end of the south truss of the single track bridge which carries the New York, Susquehanna and Western Railroad over Paulins Kill. This bridge is one-half mile east of Columbia.

COLUMBIA. Eleva., 308.91 ft.
A cross cut in the east end of the bluestone sill of the basement window in the front of the M. E. Church, and just west of the tower.

COLUMBIA. Eleva., 310.53 ft.
The bottom of the corner-stone inscribed "M. E. Church, 1840-1892." The point is at the exposed corner.

COLUMBIA. Eleva., 286.69 ft.
A cross cut in the northwest corner of the bedplate at the east end of the north truss of the bridge which carries the highway over Paulins Kill at its mouth.

DELAWARE. Eleva., 284.67 ft.

A cross cut in the northwest corner of the bedplate at the southeast corner of the two-track, five-span bridge, which carries the Delaware, Lackawanna and Western Railroad over the Delaware River, 1 mile north of Delaware. The mark is on the new or northerly bridge.

DELAWARE. Eleva., 288.34 ft.

The top of stone slab in front of the Presbyterian Church.

DELAWARE. Eleva., 290.47 ft.

This bench mark, indicated by an arrow, is at the bottom of the middle of front face of corner-stone (without inscription) at the southeast corner of St. James Church.

EASTON. PA., U. S. C. S. Eleva., 214.401 ft.

This bench mark is the bottom surface of a square cavity cut on top of a pier (north side of the New Jersey Central Railroad track) of the bridge across the Lehigh River at Easton. It is on the pier at the west end of wide part of bridge. It is marked thus: B $\frac{\text{U.S.}}{\text{XIX}}$ M

EASTON. PA., U. S. C. S. Eleva., 357.186 ft.

This is the bottom of a square cavity cut in the foundation stone at west corner of the jail at Easton. The front of the jail is built of red sandstone and the foundation of blue limestone.

EASTON. PA., U. S. C. S. Eleva., 363.488 ft.

This bench mark is the bottom surface of a square cavity cut on the sill of a blind window on the east side of Easton Courthouse. This side of the courthouse has two blind windows, but the one used is the one nearest to the front of the building. It is marked thus: B $\frac{\text{U. S. C. \& G. S.}\ \text{H}}{1881}$ M

EASTON, PA. Eleva., 196.55 ft.

A cross cut in the southeast corner of the post-office building, which stands at corner of Ferry and Second streets. The front is an alcove between the two sides at base of corner pillar and level with the top step at the entrance.

EASTON, PA. Eleva., 235.10 ft.

A cross cut in the northwest corner of the granite sill under the outer arch of the main entrance of the public school building.

FOUL-RIFT. Eleva., 252.02 ft.

A cross cut 8 inches back from the outside corner (at the north end) on the concrete wall over the arch at the west end of the concrete road culvert No. 84, 400 yards south of the railroad station. The mark is on the top face of wall and is about 6.6 feet higher than and 8 inches north of the crown of the arch. This culvert is south of the highway culvert.

HACKETTSTOWN. Eleva., 567.67 ft.

A cross cut in the northeast corner of the northeast concrete pier of the pipe housing of the water tower, just east of the Delaware, Lackawanna and Western Railroad Station.

HACKETTSTOWN. Eleva., 570.37 ft.

Bluestone water table at the northeast corner of the Peoples National Bank.

HACKETTSTOWN. Eleva., 562.60 ft.

A cross cut in the southeast end of the brownstone sill of the entrance to the Hackettstown National Bank.

HACKETTSTOWN. Eleva., 553.82 ft.
A cross cut in the southeast end of the brownstone sill of the lower entrance of the Methodist Episcopal Church.

HACKETTSTOWN. Eleva., 556.05 ft.
A cross cut in the east corner of the bluestone sill of the southerly Washington-street entrance of the public school.

HACKETTSTOWN. Eleva., 597.63 ft.
This bench mark is on the sandstone water table at the base of the brick work, at the northeast corner of the main building (directly over the corner-stone dated "Dec. 1, 1900") of the Centenary Collegiate Institute (unmarked).

HACKETTSTOWN. Eleva., 573.06 ft.
A cross cut in the southwest corner of the granite stone on which rests the west end of the south girder of the bridge which carries the Delaware, Lackawanna and Western Railroad over the turnpike just south of Warren Furnace. Stone referred to is on the bridge seat of west abutment.

HAINESBURG. Eleva., 329.03 ft.
This bench mark is the bottom of the corner-stone (at the exposed corner) of the church marked "M. E. Church, A. D. 1892." The point is indicated by an arrow.

HAINESBURG. Eleva., 306.43 ft.
A cross cut in the limestone at the east end of the south abutment of the southerly of the two iron highway bridges. The point is 1 foot west of the angle of the abutment and wing wall.

HARMONY STATION. Eleva., 199.65 ft.
A cross cut in the northeast corner of the fourth sandstone step from the bottom, on the east wing wall of the south abutment of the stone arch bridge which carries the Pennsylvania Railroad over a farm road to the river. The bridge (No. 72) is just south of mile post $^{14}/_{54}$ and is locally known as Arney's culvert.

HARMONY STATION. Eleva., 216.25 ft.
The northeast corner of a sandstone post about 9 inches square, set 6.7 feet west of the west rail of the single track, on the Belvidere Branch of the Pennsylvania Railroad, 300 yards south of the station and 35o yards north
J B
of mile post $^{13}/_{56}$. The stone is marked: 4/09 (the east face is marked: 54).

HARMONY STATION. Eleva., 215.69 ft.
This bench mark is the bottom of a slot 4 inches long, ½ inch wide (formed by a drill hole) 4 inches north of the southeast corner of the top of the square dressed granite stone on which rests the north end of the west girder of railroad bridge No. 77, 550 yards north of the station.

HAZEN. Eleva., 409.72 ft.
A cross cut in the northeast corner of the projecting foundation stones at the southeast corner of the brick Presbyterian Church, at Oxford Church. The point is at the southeast corner of the attached brick column that rests on the stones.

HUTCHINSON. Eleva.. 219.34 ft.
A cross cut in the top and at the outside corner of the northeast end of the sandstone coping over the arch at the southwest end of stone culvert No. 80 which carries the single track of the Belvidere Branch of the Pennsylvania over Buckhorn Creek, about 175 yards west of the station.

HUTCHINSON. Eleva., 225.76 ft.
A cross cut in the southwest corner of the south wall (over the crown of the arch) of a stone culvert which carries the Pennsylvania Railroad over a farm road to the Delaware River. This culvert is 100 yards east of mile post $^{9}/_{59}$ and about o.6 miles west of the station. The stone is a speckled sandstone 6 feet above and 10 feet west of the crown of the bridge.

LOPATCONG. Eleva., 262.986 ft.
This bench mark is the bottom surface (center) of a square cavity cut in the coping stone at the east end of the north parapet of the stone bridge of the Central Railroad of New Jersey, over the Morris Canal, about 1½ miles east of Phillipsburg. It is marked thus: B ☐ M.
1881

LOPATCONG. Eleva., 218.95 ft.
A cross cut in the summit of the most westerly stone in the coping of the north wall of the upper lock of the Morris Canal.

MARKSBORO. Eleva., 422.70 ft.
The highest point (indicated by an arrow cut in the top surface) of the exposed spigot end of an iron pipe at the northwest end of a flood culvert, with concrete end walls, under the New York, Susquehanna and Western Railroad, 1½ miles northeast of the station. (Bridge No. $^{79}/_{24}$.)

MARKSBORO. Eleva., 402.66 ft.
A cross cut in the west corner of the bedplate at the northeast end of the northwest truss of the bridge which carries the New York, Susquehanna and Western Railroad over Paulins Kill, three-fourths miles northeast of the station.

MARKSBORO. Eleva., 393.58 ft.
A cross cut on limestone (1 foot back from the exposed corner) at the northeast end of the northwest abutment of the highway bridge over the Pauline Kill at the station.

MARKSBORO. Eleva., 371.45 ft.
A cross cut in the south corner of the square dressed granite stone on which rests the east end of the south truss of the New York, Susquehanna and Western Railroad bridge over Paulins Kill. This bridge is No. $^{80}/_{67}$ and is 1 mile west of the station.

MARTIN'S CREEK. Eleva., 226.95 ft.
Top of bolt, around which a square is cut, set in a granite stone in the top of the east side of the circular wall of the turntable at the east end of the railroad bridge over the Delaware River at Martin's Creek.

MARTIN'S CREEK. Eleva., 219.95 ft.
A cross cut in the southeast corner of the higher part of the most easterly of the five stone piers supporting the railroad bridge over the Delaware River. There are two bridge rests on this pier, the mark being on the easterly and higher one.

MARTIN'S CREEK. Eleva., 324.15 ft.
A cross cut in the northeast end of the concrete sill of the basement window, that is in the northwest side of the part of the public school building, on which the bell tower is, and which contains the hall of the main front entrance.

NEW VILLAGE. Eleva., 435.36 ft.
A cross cut in the rounded summit of the coping stone on the west side of the south wall of the Morris Canal lock, west of the village. The summit is 1.5 feet from the end of the wall, and about 3 yards from the tail-gates.

NEW VILLAGE. Eleva., 374.95 ft.
A cross cut in the surface of concrete porch of Thatcher's store. The mark is about 2 feet east of the northwest corner of the porch and directly north of the coal chute. This building is on the turnpike, at the old Stewartsville road.

NEW VILLAGE. Eleva., 439.98 ft.
A cross cut in the northeast corner of the east bedplate of the north truss, on the east concrete abutment of the bridge which carries the trolley road on Morris Canal.

NEW VILLAGE. Eleva., 426.87 ft.
A cross cut in the east end of the south concrete parapet of a small highway bridge over the canal feeder that is just west of the canal lock, 1 mile west of the village.

OXFORD FURNACE. Eleva., 479.77 ft.
A cross cut in the east end of the stone sill of the front door of the Oxford Iron and Nail Company's brick store, on the north corner of the streets, just south of the railroad station.

OXFORD FURNACE. Eleva., 501.84 ft.
A cross cut in the south end of the stone doorsill of the front door of the Second Presbyterian Church.

OXFORD FURNACE. Eleva., 570.42 ft.
A cross cut in the granite water table at the north end of the doorsill of the public school.

PAULINA. Eleva., 346.78 ft.
A cross cut in the bluestone coping of the east end of the north abutment (the one nearest the railroad) of the highway bridge over Paulins Kill.

PEQUEST FURNACE. Eleva., 439.32 ft.
Bottom of a square cavity cut in the top surface of the granite stone at the north end of the west coping of the Delaware, Lackawanna and Western Railroad stone arch culvert, 1½ miles north of Oxford Furnace Station. This culvert is over Furnace Brook.

PHILLIPSBURG. Eleva., 207.87 ft.
A cross cut in the southwest corner of the lowest step (close to the bottom of the second step) of the east wing wall of the north abutment of the girder bridge which carries the Lehigh Valley Railroad over South Main Street, just west of Center Street.

PHILLIPSBURG. Eleva., 215.18 ft.
This bench mark is the bottom of a square cavity cut 6 inches back from the southwest corner of the fourth from the top, of the square dressed stones forming the series of steps of the south wing wall, of the east abutment of a two-track bridge which carries the Central Railroad of New Jersey over the Delaware River, just north of the Lehigh Valley Railroad bridge. The point is on a sandstone block and its top surface is 2.5 feet above the bridge seat.

PHILLIPSBURG. Eleva., 232.60 ft.
A cross cut in the east end of the bluestone doorsill of the Main-street entrance to the Second National Bank, at the corner of Main and Market Streets.

PHILLIPSBURG. Eleva., 195.56 ft.
A cross cut in the northwest corner of the stone water table under the column on the east side of the north entrance of the Pennsylvania Railroad station, at the east end of the cantilever highway bridge over Delaware River.

PHILLIPSBURG. Eleva., 194.21 ft.
A cross cut in the northwest corner of the square dressed sandstone coping of the north end of the east abutment (New Jersey side) of the cantilever bridge which carries the highway over the Delaware River, between Phillipsburg and Easton, Pa. The point is about the elevation of the concrete sidewalk of the bridge.

PHILLIPSBURG. Eleva., 197.60 ft.
A cross cut in the top of the concrete foundation at the northeast corner of the building (and east of the doors opening towards the turntable) of the Lehigh and Hudson River Railroad roundhouse, near the north end of the Phillipsburg freight yards.

PHILLIPSBURG. Eleva., 199.36 ft.
The top of a bolt head set in the sandstone coping near the middle of the west wall of the small stone road culvert at the north end of the Lehigh and Hudson River Railroad, Phillipsburg yards. A square is cut around the head of the bolt. This is a railroad bench mark.

PHILLIPSBURG. Eleva., 201.70 ft.
Head of a bolt set in a granite stone of the bridge seat near the west end of the north abutment of the single track girder bridge No. 70, which carries the Pennsylvania Railroad over a farm road. This bridge is just north of the mile post $^{15}/_{53}$ and northeast of a small brick school house on the Pennsylvania side of the Delaware River. This is a railroad bench mark.

PLEASANT VALLEY. Eleva., 500.40 ft.
This bench mark is the top of the bottom course of brick at the southwest corner of the Pleasant Valley brick schoolhouse. The point is marked by a vertical arrow set in brick.

PORT COLDEN. Eleva., 569.98 ft.
This bench mark is on the southeast corner of the masonry at the gates of the flume, at the head of plane No. 6, west of Morris Canal.

PORT COLDEN. Eleva., 526.54 ft.
A cross cut in the east end of the granite doorsill of the main entrance to the brick schoolhouse.

PORT COLDEN. Eleva., 522.85 ft.
This bench mark is the top of the white limestone corner-stone of the church, inscribed "Port Colden M. E. Church 1893." Elevation taken at top of stone and at bottom of wooden baseboard.

PORT COLDEN. Eleva., 525.63 ft.
A cross cut in the southwest corner of the top granite step at the west end of the north abutment of the concrete bridge which carries the Hacketts-town-Washington highway over the Delaware, Lackawanna and Western Railroad.

PORT MURRAY. Eleva., 644.54 it.
A cross cut in the south end of the bluestone sill of the basement window just south of the triple memorial window, and north of the main entrance, of the McCrea Memorial M. E. Church.

PORT MURRAY. Eleva., 607.44 ft.
A cross cut in the northwest corner of the top granite step at the west end of the south abutment of the wooden bridge which carries the road over the Delaware, Lackawanna and Western Railroad, about 500 feet west of the station.

PORT MURRAY. Eleva., 630.99 ft.
This bench mark is on the north corner of masonry of the gates at the head of the flume of Morris Canal plane No. 5, west.

PORT WARREN. Eleva., 334.39 ft.
This bench mark is the southeast corner of the bottom step of a series forming the end of the foundation wall, at the southwest corner of the wheelhouse of Morris Canal plane No. 9, west.

PORT WARREN. Eleva., 281.05 ft.
A cross cut in the northeast corner of the dressed granite stone which forms the bottom step of the west wing wall at the north end of the double arch stone culvert which carries the highway and Lopatcong Creek under the Delaware, Lackawanna and Western Railroad.

PORT WARREN. Eleva., 280.04 ft.
A cross cut in the northeast corner of the bedplate at the northwest corner of the girder bridge which carries the turnpike over Lopatcong Creek. It is just east of the intersection of the turnpike with the Port Warren road.

ROCKPORT. Eleva., 648.55 ft.
A cross cut in the northeast corner of the stone porch of the Presbyterian Church. The point is on a granite stone, level with the bottom of the wooden baseboard.

ROXBURY STATION. Eleva., 244.20 ft.
The top of a copper bolt, around which a square is cut, set in a block of sandstone at the west end of a small girder bridge (No. 83) over the highway at the north end of the station. This is a railroad bench mark.

ROXBURY STATION. Eleva., 265.05 ft.
A cross cut in the southeast corner of the north abutment of a wooden truss bridge which carries the highway over the Belvidere Branch of the Pennsylvania Railroad, about 250 yards east of the station.

SAXTON FALLS. Eleva., 637.69 ft.
A cross cut in the coping of the west lock wall, just back of the middle of a groove for temporary repair dam, just above the chamber for the head gate of the Morris Canal guard lock No. 5, west.

SAXTON FALLS. Eleva., 618.71 ft.
A cross cut in top and northeast corner of a granite coping stone at the north end of the west abutment of the girder bridge which carries the Delaware, Lackawanna and Western Railroad over the Musconetcong River.

SAXTON FALLS. Eleva., 642.86 ft.
A cross cut in the corner of a stone in which the west tail-gate is anchored, close to the south side of the quoin, Morris Canal, lock No. 4.

SAXTON FALLS. Eleva., 605.65 ft
A cross cut in the northwest corner of a granite stone on top of the north end of the east abutment of the iron bridge over Mucsonetcong River. The point is 1½ feet below the bridge floor.

STEWARTSVILE. Fiesta., 405.83 ft.
A cross cut in the foundation at the east corner of the wheelhouse at the Morris Canal plane No. 8, west.

STEWARTSVILE. Eleva., 341.51 ft.
A cross cut in the top of a limestone block, in which rests the post of the southeast end of the southwest iron rail of a small highway bridge (with concrete floor) southeast of the Stewartsville road bridge over the canal. The point is about 15 feet southeast of the middle of the bridge.

STEWARTSVILE. Eleva., 333.68 ft.
A cross cut in the northwest corner of the concrete porch of the northerly of the two entrances of the brick schoolhouse. The point is close to the foundation and 6 inches lower than the bottom of the lowest course of brick.

STEWARTSVILE. Eleva., 322.66 ft..
A cross cut in the top of the brownstone base on which rests the northerly of the two detached wooden columns at the front of the First Lutheran Church. The mark is at the southwest corner of the column.

STEWARTSVILE. Eleva., 374.28 ft.
This bench mark is on the northeast corner of the square dressed stone on which the bedplate of the truss rests, at the south end of the east abutment of the Morris and Essex Railroad bridge over the Morris Canal, east of the station.

STEWARTSVILE. Eleva., 320.40 ft.
A cross cut in the top surface of the brownstone cheek stone at the north end of the stone steps of the front entrance of the Presbyterian Church. The mark is at the level of the stone entrance floor and at the middle of the square wooden column which rests on the stone and which is attached to the building.

VAIL. Eleva., 345.95 ft.

A cross cut in the north face of a block of limestone set in the foundation at the northeast corner of the D. B. Kaiser gristmill, which stands opposite the station. Elevation is at the intersection of the cross and 0.58 feet below the bottom of baseboard.

VAIL. Eleva., 311.06 ft.

A cross cut in the top surface of the bluestone coping at the east end of the south abutment of the bridge which carries the Polkville-Walnut Valley highway over Paulins Kill, 1 mile west of Vail and at the cross-roads of the Walnut Valley-Polkville and Blairstown-Hainesburg roads. The bench mark is 7.0 feet above water level.

WASHINGTON. Eleva., 488.62 ft.

A cross cut in the east coping of the wing wall of the south abutment of the bridge which carries the Delaware, Lackawanna and Western Railroad over the highway, about 2 miles north of Washington Station. The mark is at the angle in the wall, 5.5 feet east of the east rail.

WASHINGTON. Eleva., 489.89 ft.

A cross cut in the north end of the brownstone doorsill of the main front entrance of the public school. The mark is by the corner of the brickwork.

WASHINGTON. Eleva., 485.53 ft.

A cross cut in the east end of the brownstone doorsill of the spire entrance (on Church street) of the Presbyterian Church.

WASHINGTON. Eleva., 508.08 ft.

This bench mark is on the northwest corner of the north end, on top of the wall supporting the wooden flume at the head of Morris Canal plane No. 7, west. The point is also a canal bench mark.

WASHINGTON. Eleva., 463.05 ft.

A cross cut in the southeast corner of the highest of three bluestone steps at the entrance of the First National Bank, on the northwest corner of Belvidere and Washington Avenues.

WASHINGTON. Eleva., 462.01 ft.

This bench mark is on the corner of a stone under the iron column at the northeast corner of the Beatty Building, which stands at the southwest corner of Belvidere and Washington Avenues.

WASHINGTON. Eleva., 467.54 ft.

This bench mark is on the stone water table of the Windsor Hotel, a brick building facing on Washington Avenue. The point is on the rear corner of a wing, with three windows, extending back from the main building on Belvidere Avenue.

PUBLICATIONS.

The appended list makes brief mention of all the publications of the present Survey since its inception in 1864, with a statement of the editions now out of print. The reports of the Survey are distributed without further expense than that of transportation. Single reports can usually be sent more cheaply by *mail* than otherwise, and requests should be accompanied by the proper postage as indicated in the list. Otherwise they are sent *express collect. When the stock on hand of any report is reduced to 200 copies, the remaining volumes are withdrawn from free distribution and are sold at cost price.*

The maps are distributed only by sale, at a price, 25 cents per sheet, to cover cost of paper, printing and transportation. In order to secure prompt attention, requests for both reports and maps should be addressed simply "State Geologist," Trenton, N. J.

CATALOGUE OF PUBLICATIONS.

GEOLOGY OF NEW JERSEY. Newark, 1868, 8 vo., xxiv+899 pp. Out of print.

PORTFOLIO OF MAPS accompanying the same, as follows:

1. Azoic and paleozoic formations, including the iron-ore and limestone districts ; colored. Scale, 2 miles to an inch.
2. Triassic formation, including the red sandstone and trap-rocks of Central New Jersey; colored. Scale, 2 miles to an inch.
3. Cretaceous formation, including the greensand-marl beds; colored. Scale, 2 miles to an inch.
4. Tertiary and recent formations of Southern New Jersey; colored. Scale, 2 miles to an inch.
5. Map of a group of iron mines in Morris County; printed in two colors. Scale, 3 inches to 1 mile.
6. Map of the Ringwood iron mines; printed in two colors. Scale, 8 inches to 1 mile,
7. Map of Oxford Furnace iron-ore veins; colored. Scale, 8 inches to 1 mile.
8. Map of the zinc mines, Sussex County; colored. Scale, 8 inches to 1 mile.

A few copies can be distributed at $2.00 per set.

REPORT ON THE CLAY DEPOSITS of Woodbridge, South Amboy and other places in New Jersey, together with their uses for firebrick, pottery, &c. Trenton, 1878, 8vo. viii+381 pp., with map. Out of print.

A PRELIMINARY CATALOGUE of the Flora of New Jersey, compiled by N. L. Britton, Ph.D. New Brunswick, 1881, 8vo., xi+233 pp. Out of print.

FINAL REPORT OF THE STATE GEOLOGIST. Vol. I. Topography. Magnetism. Climate. Trenton, 1888, 8vo., xi+439 pp. Out of print.

FINAL REPORT OF THE STATE GEOLOGIST. Vol. II. Part I. Mineralogy. Botany. Trenton, 1889, 8vo., x+642 pp. Unbound copies, postage, 25 cents. Bound copies, $1.50.

FINAL REPORT OF THE STATE GEOLOGIST. Vol. II. Part II. Zoology. Trenton, 1890, 8vo., x+824 pp. (Postage, 30 cents.)

REPORT ON WATER-SUPPLY. Vol. III. of the Final Reports of the State Geologist. Trenton, 1894, 8vo., xvi+352 and 96 pp. (Postage, 21 cents.)

REPORT ON THE PHYSICAL GEOGRAPHY of New Jersey. Vol. IV. of the Final Reports of the State Geologist. Trenton, 1898, 8vo., xvi+170+200 pp. Unbound copies, $1.00; cloth bound, $1.35, with photo-relief map of State, $2.85. Map separate, $1.50.

REPORT ON THE GLACIAL GEOLOGY of New Jersey. Vol. V. of the Final Reports of the State Geologist. Trenton, 1902, 8vo., xxvii+802 pp. (Sent by express, 35 cents if prepaid, or charges collect.)

REPORT ON CLAYS AND CLAY INDUSTRY of New Jersey. Vol. VI. of the Final Reports of the State Geologist. Trenton, 1904, 8vo., xxviii+548 pp. (Price, $1.60.)

REPORT ON IRON MINES AND MINING in New Jersey. Vol. VII. of the Final Report of the State Geologist. Trenton, 1910, 8vo., xv+512 pp., with two maps in a separate envelope. (Postage, 25 cents.)

BRACHIOPODA AND LAMELLIBANCHIATA of the Raritan Clays and Greensand Marls of New Jersey. Trenton, 1886, quarto, pp. 338, plates XXXV. and Map. (Paleontology, Vol. I.) (To residents of New Jersey, by express, charges collect; to non-residents, $1.50, charges prepaid.)

GASTEROPODA AND CEPHALOPODA of the Raritan Clays and Greensand Marls of New Jersey. Trenton, 1892, quarto, pp. 402, Plates L. (Paleontology, Vol. II.) (To residents of New Jersey, by express, charges collect; to non-residents, $1.40, charges prepaid.)

PALEOZOIC PALEONTOLOGY. Trenton, 1903, 8vo., xii+462 pp., Plates LIII. (Paleontology, Vol. III.) (Price, $1.00.)

CRETACEOUS PALEONTOLOGY. Trenton, 1907, 8vo., ix+1106 pp., Plates CXI. (Paleontology, Vol. IV.) (Price, $2.70.)

ATLAS OF NEW JERSEY. The complete work is made up of twenty sheets, each about 27 by 37 inches, including margin. Seventeen sheets are on a scale of 1 inch per mile and three on a scale of 5 miles per inch. Sheets numbered 21 to 37 replace old sheets numbered 1-17, which cannot longer be furnished. These sheets each cover the same territory as eight of the large maps, on a scale of 2,000 feet per inch.

No. 19. New Jersey Relief Map. Scale, 5 miles to the inch. Hypsometric.

No. 20. New Jersey Geological Map. Scale, 5 miles to the inch. (Out of print.)

No. 21. Northern Warren and Western Sussex counties. Replaces Sheet 1.

No. 22. Eastern Sussex and Western Passaic counties. Replaces Sheet 4.

No. 23. Northern Bergen and Eastern Passaic counties, to West Point, New York. Replaces northern part of Sheet 7.

No. 24. Southern Warren, Northern Hunterdon and Western Morris counties. Replaces Sheet 2.

No. 25. Morris and Somerset counties, from Lake Hopatcong to Somerville and New Brunswick. Replaces Sheet 6.

No. 26. Vicinity of Newark and Jersey City—Paterson to Perth Amboy. Replaces in part Sheet 7.

No. 27. Vicinity of Trenton—Raven Rock to Palmyra, with inset, Trenton to Princeton. Replaces Sheet 5.

No. 28. Trenton and Eastward—Trenton to Sayreville. Replaces Sheet 8.

No. 29. Monmouth Shore, with the interior from Ernston to Lakehurst. Replaces Sheet 9.

No. 30. Parts of Gloucester and Salem counties, from Paulsboro on the north, to Quinton and Deerfield on the south, with adjacent portions of Pennsylvania and Delaware.

No. 31. Vicinity of Camden, to Mount Holly, Hammonton and Elmer. Replaces Sheet 11.
No. 32. Part of Burlington and Ocean counties, from Pemberton and Whitings to Egg Harbor City and Tuckerton. Replaces Sheet 12.
No. 33. Southern Ocean County—Tuckerton to Tom's River and Chadwicks. Replaces Sheet 13.
No. 34. Western Cumberland county, including Bridgeton, with Delaware bay and adjacent portion of Delaware.
No. 35. Vicinity of Millville, from Newfield to Port Norris and Cape May Court House.
No. 36. Parts of Atlantic and Cape *May counties*—Egg Harbor City to Townsend's Inlet, with inset of New Inlet and Great Bay.
No. 37. Cape May—Cape May City to Ocean City and Mauricetown.
No. 38. *New Jersey State Map.* Scale, 5 miles to the inch. Shows all municipalities. (Out of print.)

All the maps are sold at the uniform price of twenty-five cents per sheet, either singly or in lots. Since the Survey cannot open small accounts, and the charge is merely nominal, remittance should be made with the order. Order by *number* of the State Geologist, Trenton, N. J.

TOPOGRAPHIC MAPS, NEW SERIES.

These maps are the result of revision of the earlier surveys, and contain practically all of the features of the one-inch per mile maps, with much new material. They are published on a scale of 2,000 feet to an inch. and the sheets measure 26 by 34 inches. The Hackensack, Paterson, Boonton, Dover, Jersey City, Newark, Morristown, Chester, New York Bay, Elizabeth, Plainfield, Pluckemin, Amboy, New Brunswick, Somerville, Navesink, Long Branch, Shark River, Trenton, Camden, Mt. Holly, Woodbury, Taunton and Atlantic City sheets have been published and are now on sale. The price is twenty-five cents per sheet, *payable in advance.* Order by *name* any of the sheets above indicated as ready, of the State Geologist, Trenton, New Jrsey.

GEOLOGIC ATLAS OF NEW JERSEY.

The State Geological Survey, in co-operation with the U. S. Geological Survey, is engaged in the publication of a Geologic Atlas of New Jersey. It will be issued in several parts, each part containing a complete discussion of the geography and geology for the region covered. Each volume will comprise (1) pages of descriptive text, (2) a topographic map, (3) geologic maps showing the distribution and structure of the various rock formations, the occurrence of all mineral deposits of economic importance, and (4) in some cases pages of half-tone illustrations. The following folios are now ready:

THE PASSAIC FOLIO, which covers the region from Morristown to Jersey City, and from Perth Amboy and New Brunswick to Pompton and Westwood, comprising 945 square miles: scale, 2 miles to an inch. It includes 27 pages of text, a topographic map, 3 geologic maps and a page of illustrations. Price, 25 cents; postage, 15 cents; if sent by express, charges collect.

THE FRANKLIN FOLIO caters the territory from Branchville and Newton, on the west, to Stockholm on the east, and from Andover and Petersburg, on the south, to Libertyville on the north, or 235 square miles; scale, 1 inch to a mile. In addition to the regular text and maps it includes a special study and description of the famous zinc deposits at Franklin Furnace, and of the white crystalline limestones. Price, 25 cents; postage, 15 cents extra; if sent by express, charges collect.

THE PHILADELPHIA FOLIO covers parts of New Jersey and Pennsylvania adjacent to Philadelphia. It is a double folio (scale, 1 inch per mile), having four topographic maps, four geologic maps, two maps showing, by means of cross sections, the geological structure and the relation of the various rock formations to each other below the surface, a page of illustrations and twenty-four pages of descriptive text. Price, 50 cents; postage, 15 cents extra; if sent by express, charges collect.

THE TRENTON FOLIO describes the region around Trenton as far as Stockton, Millstone, Hightstown, New Egypt, Mount Holly, Delanco and Newtown, Pa., an area of 911 square miles. It contains descriptive text and three maps (scale, 2 miles per inch). It is published in two forms, the folio size (21 3/4 by 18½ inches) and a pocket or octavo size (9 1/4 by 6 inches). In the latter the maps are on thin paper, are folded and in a pocket. This size is more convenient for field use than the folio size. Price, folio edition, 25 cents, postage 15 cents extra; pocket edition, 50 cents, postage 10 cents extra. If sent by express, charges collect.

Other folios will be prepared and issued from time to time until the entire State is covered.

Orders for these folios should be addressed to the State Geologist, Trenton, N. J., and *remittance must accompany the order.*

ANNUAL REPORTS.

REPORT OF PROFESSOR GEORGE H. COOK upon the Geological Survey of New Jersey and its progress during the year 1863. Trenton, 1864. 8vo., 13 pp. Out of print.

THE ANNUAL REPORT of Prof. Geo. H. Cook, State Geologist, to his Excellency Joel Parker, President of the Board of Managers of the Geological Survey of New Jersey, for the year 1864. Trenton, 1865, 8vo., 24 pp. Out of print.

ANNUAL REPORT of Prof. Geo. H. Cook, State Geologist, to his Excellency Joel Parker, President of the Board of Managers of the Geological Survey of New Jersey, for the year 1865. Trenton, 1866. 8vo., 12 pp. Out of print.

ANNUAL REPORT of Prof. Geo. H. Cook, State Geologist, on the Geological Survey of New Jersey, for the year 1866. Trenton, 1867, 8vo., 28 pp. Out of print.

REPORT OF THE STATE GEOLOGIST, Prof Geo. H. Cook, for the year 1867. Trenton, 1868, 8vo., 28 pp. Out of print.

ANNUAL REPORT of the State Geologist of New Jersey for 1869. Trenton, 1870, 8vo., 57 pp., with maps. Out of print.

ANNUAL REPORT of the State Geologist of New Jersey for 1870. New Brunswick, 1871, 8vo., 75 pp., with maps. Out of print.

ANNUAL REPORT of the State Geologist of New Jersey for 1871. New Brunswick, 1872, 8vo., 46 pp., with maps. Out of print.

ANNUAL REPORT of the State Geologist of New Jersey for 1872. Trenton, 1872, 8vo., 44 pp., with map. Out of print.

ANNUAL REPORT of the State Geologist of New Jersey for 1873. Trenton. 1874, 8vo., 128 pp., with maps. Out of print.

ANNUAL REPORT of the State Geologist of New Jersey for 1874. Trenton, 1874, 8vo., 115 pp. Out of print.

ANNUAL REPORT of the State Geologist of New Jersey for 1875. Trenton, 1875, 8vo., 41 pp., with map. Out of print.

ANNUAL REPORT of the State Geologist of New Jersey for 1876. Trenton, 1876, 8vo., 56 pp., with maps. Out of print.

ANNUAL REPORT of the State Geologist of New Jersey for 1877. Trenton, 1877, 8vo., 55 pp. Out of print.

ANNUAL REPORT of the State Geologist of New Jersey for 1878. Trenton, 1878, 8vo., 131 pp., with map. Out of print.

ANNUAL REPORT of the State Geologist of New Jersey for 1879. Trenton, 1879. 8vo., 199 pp., with maps. Out of print.

ANNUAL REPORT of the State Geologist of New Jersey for 1880. Trenton, 1880, 8vo., 220 pp., with map. Out of print.

ANNUAL REPORT of the State Geologist of New Jersey for 1881. Trenton, 1881, 8vo., 87+107+xiv. pp., with maps. Out of print.

ANNUAL REPORT of the State Geologist of New Jersey for 1882. Camden, 1882, 8vo., 191 pp., with maps. Out of print.

ANNUAL REPORT of the State Geologist of New Jersey for 1883. Camden, 1883, 8vo., 188 pp. (Price, 5o cents.)

ANNUAL REPORT of the State Geologist of New Jersey for 1884. Trenton, 1884, 8vo., 168 pp., with maps. (Postage, 8 cents.)

ANNUAL REPORT of the State Geologist of New Jersey for 1885. Trenton, 1885, 8vo.. 228 pp., with maps. (Postage, 9 cents.)

ANNUAL REPORT of the State Geologist of New Jersey for 1886. Trenton, 1887, 8vo., 254 pp., with maps. (Postage, 9 cents.)

ANNUAL REPORT of the State Geologist of New Jersey for 1887. Trenton, 1887, 8vo., 45 pp., with maps. (Postage, 5 cents.)

ANNUAL REPORT of the State Geologist of New Jersey for 1888. Camden, 1889, 8vo., 87 pp., with map. (Postage, 5 cents.)

ANNUAL REPORT of the State Geologist of New Jersey for 1889. Camden, 1889. 8vo., 112 pp. (Postage, 6 Cents.)

ANNUAL REPORT of the State Geologist of New Jersey for 1890. Trenton, 1891, 8vo., 305 pp., with maps. (Postage, 10 cents.)

ANNUAL REPORT of the State Geologist of New jersey for 1891. Trenton, 1892, 8vo., xii+270 pp., with maps. Out of print.

ANNUAL REPORT of the State Geologist of New Jersey for 1892. Trenton, 1893, 8vo., x+368 pp., with maps. (Price. $1.55.)

ANNUAL REPORT of the State Geologist of New Jersey for 1893. Trenton, 1894. 8vo., x+452 pp., with maps. (Postage, 18 cents.)

ANNUAL REPORT of the State Geologist of New Jersey for 1894. Trenton, 1895, 8vo, x+304 pp., with geological map. (Postage, 11 cents.)

ANNUAL REPORT of the State Geologist of New Jersey for 1895, Trenton, 1896. 8vo., xl+198 pp., with geological map. (Postage, 8 cents.)

ANNUAL REPORT of the State Geologist of New Jersey for 1896. Trenton, 1897, 8vo., xxviii+377 pp., with map of Hackensack meadows. (Postage, 15 cents.)

ANNUAL REPORT of the State Geologist of New Jersey for 1897. Trenton, 1898, 8vo., xl+368 pp. (Postage, 12 cents.)

ANNUAL REPORT of the State Geologist for 1898. Trenton, 1899, 8vo., xxxii+244 pp., with Appendix, 102 pp. (Postage, 14 cents.)

ANNUAL REPORT of the State Geologist for 1899 and REPORT ON FORESTS. Trenton, 1900, 2 vols., 8vo., Annual Report, xliii+192 pp. FORESTS, xvi+327 pp., with seven maps in a roll. (Postage, 8 and 22 cents.)

ANNUAL REPORT of the State Geologist for 1900. Trenton, 1901, 8vo., xl+ 231 pp. (Postage. 10 cents.)

ANNUAL REPORT of the State Geologist for 1901. Trenton, 1902, 8vo., xxviii+178 pp., with one map in pocket. (Postage, 10 cents.)

ANNUAL REPORT of the State Geologist for 1902. Trenton, 1903, 8vo., viii+155 pp. (Postage, 6 cents.)

ANNUAL REPORT of the State Geologist for 1903. Trenton, 1904, 8vo., xxxvi+132 pp., with two maps in pocket. (Price, 40 cents.)

ANNUAL REPORT of the State Geologist for 1904. Trenton, 1905, 8vo., x+317 pp. (Postage. I2 cents.)

ANNUAL REPORT of the State Geologist for 1905. Trenton, 1906, 8vo., x+338 pp., with three maps in a pocket. (Price, 55 cents.)

ANNUAL REPORT of the State Geologist for 1906. Trenton, 1907, 8vo., vii+192 pp. (Postage, 10 cents.)

ANNUAL REPORT of the State Geologist for 1907. Trenton, 1908, 8vo., ix+192 pp. (Postage, 12 cents.)

ANNUAL REPORT of the State Geologist for 1908. Trenton, 1909, 8vo., xi+159 pp. (Postage, 8 cents.)

ANNUAL REPORT of the State Geologist for 1909. Trenton, 1910, 8vo., vii+123 pp. (Postage, 6 cents.)

BULLETINS.

In 1910 the series of Annual Reports was replaced by a series of Bulletins, each being a separate report upon some subject. Up to date seven Bulletins have been issued.

BULLETIN 1.—Administrative Report of the State Geologist of New Jersey for 1910. Trenton, 1911, 43 pp. (Out of print.)

BULLETIN 2.—A report on the Approximate Cost of a Canal between Bay Head and the Shrewsbury River, by H. B. Kümmel. Trenton. 1911, 20 pp., 1 map.

BULLETIN 3.—The Flora of the Raritan Formation, by Edward W. Berry. Trenton, 1911, v+233 pp. and xxix plates.

BULLETIN 4.—A Description of Fossil Fish Remains of the Cretaceous, Eocene and Miocene Formations of New Jersey, by Henry W. Fowler. Trenton, 1911, 192 pp.

BULLETIN 5.—The Mineral Industry of New Jersey for 1910, by H. B. Kümmel and S. Percy Jones. Trenton, 1911, 24 pp. (Out of print.)

BULLETIN 6.—Admimstrative Report of the State Geologist for 1911, including a report on Shark River Inlet by C. C. Vermeule. Trenton, 1912. 82 pp. and iv plates.

BULLETIN 7.—The Mineral Industry of New Jersey for 1911, by Henry B. Kümmel. Trenton, 1912, 37 pp.

March 4th 1913.

INDEX.

A.

PAGE.

Administrative Report, ... 7
Archæologic work, progress of, ... 33
Asphalt, testing of, ... 29
Assistants on the Survey—
  appointments, ... 9
  list of, ... 10
  resignations, ... 9

B.

Bench marks, ... 17, 58
  cost of establishing, ... 18
  list of—
    Bergen County, ... 58
    Essex County, ... 65
    Hudson County, ... 70
    Morris County, ... 71
    Passaic County,..... 77
    Sussex County, ... 78
    Union County, ... 83
    Warren County, ... 85
Bergen County, bench marks in, ... 58
Board of Managers of Survey—
  appointments to, ... 9
  list of, ... 3
vacancies on, ... 9
Butler, water in gneiss rock near, ... 24

C.

Chemical Laboratory, work at, ... 28

E.

Essex County, bench marks in, ... 65
Expenditures and receipts, ... 8

F.

Forked River, well near, ... 28

G.

Gage, R. B., work by, ... 28

H.

Hudson County, bench marks in, ... 70

J.

Jennings, Henry, work by, ... 32

L.

PAGE.
Laboratory rooms, ... 16
Letter of Transmittal, ... 5
Library, ... 12

M.

Maps, revision of sheet 37, ... 19
Mineral production, ... 23
Morris County, bench marks in, ... 71

N.

Note recording, ... 12

O.

Oil, testing of, ... 29,31
Organization, ... 9
Oxford Furnace, ground water near, ... 26

P.

Passaic County, bench marks in, ... 77
Pleistocene formations in South Jersey, report on, ... 21
Publications, ... 10
list, complete, ... 95
list of reports sold, ... 12

R.

Receipts and expenditures, ... 8

S.

Salisbury, R. D., work of, ... 21
Schrabisch, Max, work by, ... 34
Shark River Inlet, ... 19, 37-53
appropriation for, ... 20
borings at, ... 43
changes in bulk-head lines, ... 46
construction of jetties, ... 48
engineer's report, ... 42
estimate of cost, ... 48
location of jetties at, ... 45
movement of sand at, ... 49
report by committee, ... 39
report by engineer, ... 42
resolution by Board of Managers, ... 41
southeast trend of, ... 52
south jetty, ... 51
Shark River Marl, ... 21
Skinner, Alanson, work of, ... 34
Soil, analytical work on, ... 29
Soil survey, progress of, ... 32
Stanhope, water in gneiss near, ... 26
State Geologist, meetings attended, ... 35
State Prison, wells at, ... 25
Survey rooms, ... 14
Sussex County, bench marks in, ... 78

T.

PAGE.
Transcontinental Geographical Excursion, ... 35
Trenton, water in gneiss at, ... 25

U.

Underground water, ... 24
Union County, bench marks in, ... 83

V.

Vermeule, C. C., work of, ... 17
reports by, ... 42,56

W.

Warren County, bench marks in, ... 85
Well records, ... 24