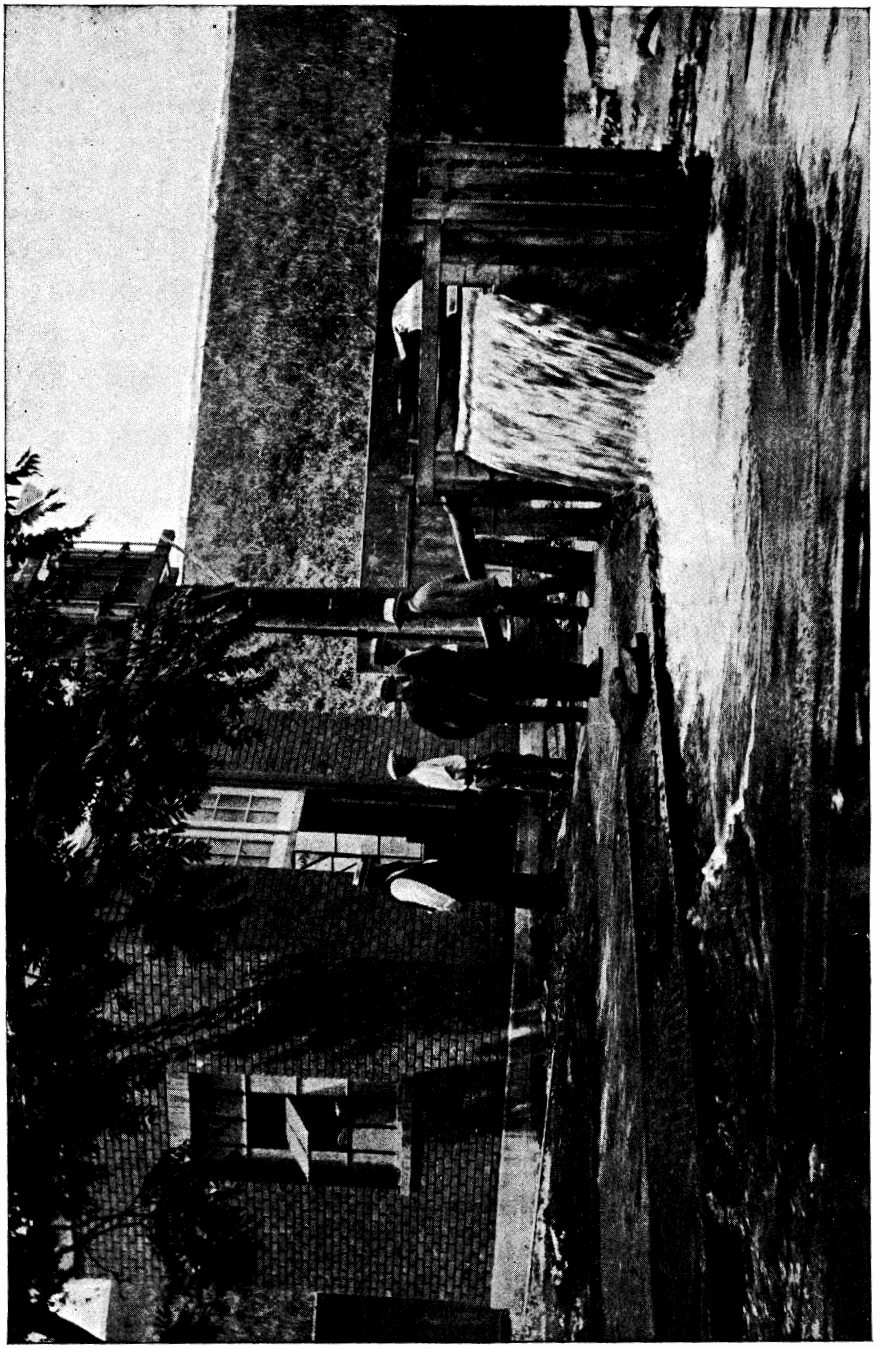

Fig. 1. Artesian well under test. Camden water supply. (p. 11)

REPORTS OF THE

DEPARTMENT OF CONSERVATION AND DEVELOPMENT

STATE OF NEW JERSEY

ANNUAL REPORT

For the Years Ending June 30
1922 and 1923

Department of
Conservation and Development

Administering

GEOLOGY, SOILS, WATER RESOURCES, FORESTRY,
FOREST FIRE SERVICE, STATE MUSEUM,
TESTING LABORATORY, STATE
PARKS, LAND REGISTRY

TRENTON, N. J.
PUBLISHED BY THE STATE
1923

Letter of Transmittal

To His Excellency, George S. Silzer, Governor.

Sir—For your information and for transmittal to the Legislature as required by law, I have the honor to submit the annual report of the Department of Conservation and Development for the fiscal years 1922 and 1923, ending June 30, 1923. Reports by the Board, the State Geologist, the State Hydraulic Engineer, the State Forester, the State Firewarden and the office of Land Registry and Publicity are included.

By direction of *the Board of Conservation and Development.*

Very respectfully yours

Henry B. Kümmel,

Director.

State House, December 29, 1923.

NOTE.—This Report as originally written covered the fiscal year 1921-1922. Owing to delays in printing after it was in type, for which the Department was in no way responsible, it has seemed best to combine with it the report for the year ending June 30, 1923. This report, therefore, as here presented, covers the two years July 1, 1921 to June 30, 1923.

LIST OF ILLUSTRATIONS.

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The Department of Conservation and Development

OFFICE, STATE OFFICE BUILDING, TRENTON.

BOARD MEMBERS

JOHN A. WATERS, *President*.....Gloucester City
PERCIVAL CHRYSTIE .....High Bridge
W. EDWIN FLORANCE .....New Brunswick
HOWARD F. McCONNELL .....Montclair
SIMON P. NORTHRUP .....Newark
JOHN L. KUSER.....Bordentown
HENRY CROFUT WHITE .....North Plainfield
OWEN WINSTON .....Mendham (P. O. Gladstone)

TECHNICAL STAFF

HENRY B. KÜMMEL.....*State Geologist and Director*
M. W. TWITCHELL.....*Assistant State Geologist*
J. VOLNEY LEWIS.....*Consulting Geologist*
H. T. CRITCHLOW .....*Hydraulic Engineer*
CHARLES P. WILBER.....*State Forester and State Firewarden*
W. M. BAKER.....*Associate Forester*
A. D. LA MONTE*.....*Assistant Forester*
R. B. GAGE.....*Chemical Engineer*
KATHRYN B. GREYWACZ.....*Acting Museum Curator*
TAYLOR O. COOK .....*Chief, Land Registry*
L. L. LEE.....*Senior Soil Classifier*
WILLIAM LINDSAY.....*Deputy State Firewarden*
LEONIDAS COYLE.....*Deputy State Firewarden*
JOSEPH E. ABBOTT, P. O., Toms River.....*Division Firewarden*
LEROY S. FALES, P. O., Newfoundland.....*Division Firewarden*
JOSEPH B. SHARP, Jr., P. O., Bridgeton.....*Division Firewarden*
PAUL B. HAINES, P. O., Branchville.....*Forest Supervisor*
LAWRENCE E. TERHUNE, P. O., New Gretna.....*Forest Ranger*

*Resigned Apr. 1, 1923.

REPORT OF THE BOARD OF CONSERVATION AND DEVELOPMENT.

"The Department of Conservation and Development represents the interest of the people of New Jersey in geology, forestry, potable waters, idle lands and all undeveloped resources. It publishes maps and detailed information, and offers advice about minerals, soils, streams, wells, forests, shade trees. It conducts the State Testing Laboratory, Museum, Forest Fire Service and Land Registry." The above caption on the Department's letterheads, is a concise summary of its manifold activities, and the diverse character of the problems with which it deals.

During the two years ending June 30, 1923, notable progress has been made in three directions—the publication of a comprehensive report by Hazen, Whipple, and Fuller on the water-supply problem of the State with alternative plans for its ultimate solution; the acquisition of the historic McKonkey ferry house at Washington Crossing, and legislation pledging appropriations for the immediate development of the Washington Crossing Park; and third, legislation approving and providing for adequate extension of the Forest Fire Service. Others of the Board's plans remain in abeyance, lacking the necessary appropriations.

The more important phases of the Departmental activities are summarized in this report; fuller details are given in the reports of the administrative officers that accompany it.

MEMBERSHIP

There have been no changes in the Board, Messrs. John L. Kuser and Howard F. McConnell were reappointed in 1922, and Mr. Kuser was elected President for the year beginning July 1, 1922. Messrs. William E. Florance and Owen Winston were reappointed in 1923, and Mr. John A. Waters was elected President for the year beginning July 1, 1923.

PERSONNEL

On February 1, 1922, Mr. Alfred Gaskill, at his earnest request, was relieved of his duties as Director, and Henry B. Kümmel, State Geologist, was chosen by the Board to fill the unexpired term. In June 1923, Mr. Kümmel was elected Director for the ensuing four

years. Later in the year Mr. Gaskill filed an application for retirement under provisions of the State Retirement System, and on June 30, 1922, he severed his connection with the Department, much to the regret of the Board and his associates. As Forester to the Forest Park Reservation Commission, State Forester, and later as Director of Conservation and Development, Mr. Gaskill had guided wisely, first, the forestry problems of the State and, later, the broader conservation and development work of the Department. It is the conviction of the Board, and, we believe, of many with whom he has come in contact, that the State has rarely enjoyed the service of a man so unselfishly devoted to its interests or of such breadth of vision and ability. His constructive counsel and effective administration will be greatly missed.

Charles P. Wilber was appointed State Forester on the resignation of Mr. Gaskill, and, Leonidas Coyle on July 1, 1923 became State Firewarden.

OFFICES

The new quarters in the State office building were occupied in October, 1922, and for the first time in several years the Department has had space for work somewhat commensurate for its needs.

LEGISLATION

The legislature of 1922 passed two joint resolutions of great importance to the Department. One approved the Board's plans for the development of the Washington Crossing Park, and pledged appropriations for the immediate development of a portion of the park; the other endorsed extension of the Forest Fire Service as planned by the Department. Last year funds were appropriated to enable the Department to begin these two lines of work.

LAND REGISTRY AND PUBLICITY

The effort to attract farmers to our soil has met with an encouraging measure of success in spite of the discouragement of all agricultural expansion by reason of the deflation in prices of farm products. The industrial opportunities of New Jersey were made known in a most striking and effective manner by the publication and distribution of a booklet so carefully prepared and so exhaustive that it has not only received widespread favorable comment as a means of attracting attention to the State, but has been issued in special edition by the Commissioner of Education for the use of the schools—a testimonial to the value of the subject matter and its manner of presentation. A small amount of newspaper and magazine advertising of the State's resources has been carried, and has elicited inquiries fully commensu-

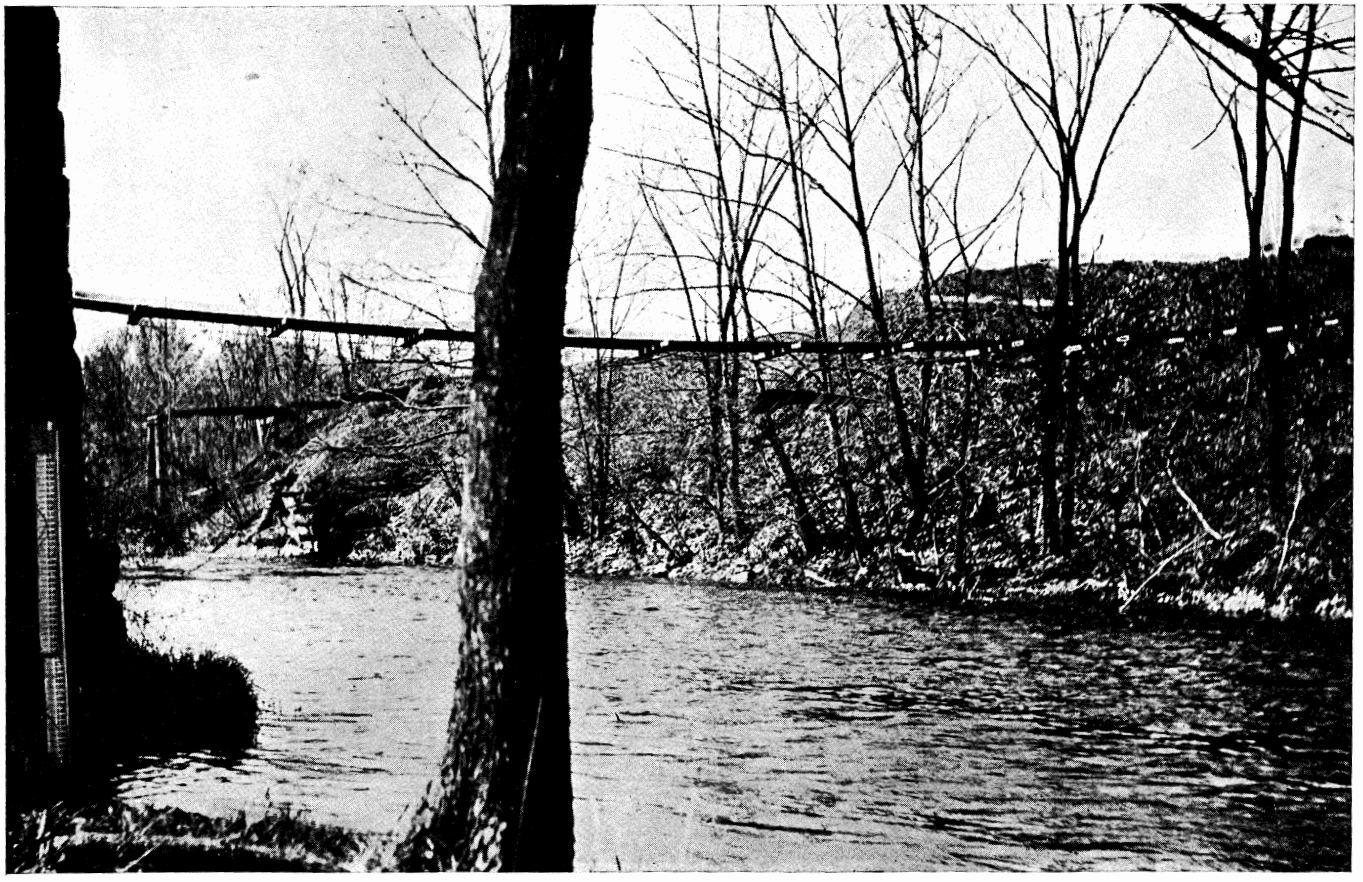

Fig. 2. Stream gaging station on Pequest River at Pequest Furnace, showing staff gage and foot bridge for making discharge meausrements. (p. 72)

rate with the money expended. Current information of the departmental activities has been furnished the press and technical papers.

It is difficult to estimate the direct returns from work of this character. The results, so far as they can be appraised, prove the value of this work, but to obtain the best results, larger expenditures are inevitable. Ten thousand dollars a year for a term of years can profitably be spent in the preparation, publication and distribution of matter advertising the State. To make known adequately our agricultural, industrial, or recreational advantages through the medium of the weekly and monthly magazines, trade papers, etc., would entail the expenditure of larger sums. Public interest in the effort to advertise the State was evidenced by the introduction of bills in 1923 to spend $50,000 per year in this class of newspaper advertising.

WATER RESOURCES

Diversion requests. The water resources branch of the Board's work is constantly assuming greater importance. During the two years 26 applications for permission to divert surface or underground waters were heard and decided (see p. 46). Of these that of Bayonne for the Ramapo watershed was the most important, and to its determination the Board gave much thought and study. The conditions which were attached to the approval fully protected the interests of the State, preserved the rights of other municipalities, and in effect placed upon Bayonne the obligation of developing the watershed not solely for its own benefit, but as trustee for all municipalities which might, hereafter, need a share of these waters. Moreover, the Board's approval carried with it the express conditions that the entire development must be turned over to the State or its agent at cost, less depreciation, in the event that State administration of the water supply for the metropolitan district should, hereafter, be adopted. The decision was promptly attacked in certiorari proceedings which were pending at the close of the year.*

The Board again fixed the minimum rate of $1.00 per million gallons as the basis for the excess water-diversion tax for the years 1921 and 1922. The amounts certified to the Comptroller were $23,261.79 for 1921, and $25,572.62 for 1922. Record of the amounts paid and due on this account are shown on pages 55 and 56.

The constitutionality of the Act under which these charges are made and the validity of the Board's interpretation of its provisions has again been upheld by the Court of Errors and Appeals. The case

*The Supreme Court upheld the action of the Board and dismissed the proceedings, but the Court of Errors and Appeals revised this ruling and set aside the Board's decision.

against the cities of Newark and Trenton for collection of unpaid diversion charges was decided in favor of the State, and on appeal to the U. S. Supreme Court, was in 1923 decided in favor of the State. As a result of this decision the sum of $21,371.42 was collected from Newark and $16,947.61 from Trenton.

Water-supply Fund.—This fund is maintained by the excess water diversion tax. From it appropriations are made by the Legislature for water-supply investigations and water conservation. On July 1, 1923, the balance in this fund was $63,421.29, from which expenditures amounting to $25,000 have been authorized for the fiscal year 1923-24.

Stream-gaging.—Twenty-eight stream-gaging stations were established during the two years and records commenced. Five others were continued. Of these thirty-three stations, seventeen have automatic gages which furnish a continuous record; the balance are read twice a day by local observers.

At many of the stations enough stream measurements have been taken at different heights of water to construct a rating curve from which the rate of flow for all gage heights can be determined. Daily flows have been computed for the periods covered by the gage records at these stations and copies can be obtained by those interested. The work will be continued during the new year (see p. 61).

Dam Inspection.—Inspection of dams (see p. 58) has revealed some structures in need of repair; whereas some, of which complaint was made, are in good condition. None were found in a dangerous condition. During the two years, 147 existing structures were inspected and seven sets of plans for alterations or for new structures were approved.

STATE WATER POLICY

At hearings before the Board reference has sometimes been made to a State Policy in water-supply matters, and the Board has been strenuously urged not to act in opposition to that policy. It may, therefore, be well to point out briefly to what extent a State policy has been formulated, and its nature.

Policy as defined by law.—The following fundamentals of a State policy have been established by law.

1. Neither surface nor subsurface waters shall be diverted for use in other states (p. 461, Laws of 1905, and Chap. 69, Laws of 1910).

2. No surface or subsurface water shall be diverted for a public water supply without the consent of the Board of Conservation and Development, which is charged with a general supervision of all sources of supply in order that they may be prudently and economi-

cally developed. Before this consent can be given, the applicant must establish (1) the public necessity; (2) the non-interference with supplies, present or potential, of other municipalities; (3) no undue injury to public or private interests by the reduction of the dry-season flow of any stream.

3. Under the Home Rule Act, municipalities, subject to the consent of the Board of Conservation and Development, may obtain a water supply in one of five ways:

a. By contract with a district water-supply commission which then acts as its agent, but which has no power except in accordance with the contracts it makes.
b. By contract with another municipality for a period not exceeding 15 years.
c. By contract with any private corporation which may own or control water works.
d. By purchase or lease of an existing water works.
e. By acquiring lands, water rights, etc., and constructing its own supply, either surface or underground. (Home Rule Act, Art. xxxii, Chap. 152 p. l. 1917.)

4. The Board of Conservation and Development may attach reasonable terms and conditions to its permits. In effect this gives it power to create precedents, and by consistent decisions complete the structure of a policy for which the statutes supply the framework. The extent to which this has been done will be indicated below.

5. Payment shall be made to the State by water companies and municipalities for the water used over and above a certain amount. This penalizes waste and provides a fund to be used for water supply conservation and control.

6. The maintenance of a dry-season flow of streams is required and penalties provided when it is diminished.

7. By the creation of water-supply districts and provision for the appointment of district boards, the legislature has furnished an agent by which one or more municipalities may acquire and operate water supplies. The importance and advantage of municipal cooperation is thus recognized, and in North Jersey where the District Water Supply Commission is functioning, the consent of that body must be obtained before any municipality may apply to the Board of Conservation and Development for approval of its plans to develop its own supply.

Policy as established by precedent—A State water policy determined by precedent differs materially from that fixed by law. The former is less definite, more changeable, and subject to growth as conditions develop, and perhaps as the personnel of the decision-making body

changes. A single decision cannot be said to establish a State policy, but at least it forms a starting point. Subsequent decisions along the same lines give to it the force of custom and then of policy.

In the following particulars the decisions of this Board, as well as its predecessor, have been so consistent that they constitute guideposts along the road to a permanent State policy.

1. All permits given to private corporations are for limited periods only, and cannot be transferred without the consent of this Board.

2. Non-use within specified periods or abandonment of the source of supply abrogates the permit and all rights revert to the State.

3. Encouragement of cooperation between different water-supply systems for mutual assistance in times of shortage or accident.

4. The dry-season flow of streams must be maintained by discharge from the storage reservoirs to amounts fixed by this Board.

5. In distributing water supplies, the Board holds that the needs of cities and towns located within any given watershed must have first consideration; that second to them is the reasonably anticipated future need of any community which, although not located within the watershed, yet has acquired rights therein and is already drawing its supplies therefrom; that ordinarily no other municipalities should be given rights therein unless it is evident that there is a surplus supply after providing for these prior claims. In all cases the rights of adjacent municipalities are guarded when necessary by special conditions. In accordance with this general policy the rights of Bound Brook and New Brunswick were protected in the grant to the Elizabethtown Water Company; of Jersey City in the Wharton case; and of Dover, Boonton, Rockaway and Jersey City in the Montclair case.

6. In the Bayonne case the Board adopted in effect the principle that an important watershed like the Ramapo may be developed by a single municipality only as the trustee for all municipalities which could naturally be supplied from it; that the partial development of an important watershed by a single community in its own interest to the exclusion of other communities which might need the water must not be permitted.

7. Finally, in all recent grants provision has been made whereby the State or its agent may hereafter take over at cost (less depreciation) all rights and property acquired under any permit of this Board, if in the future the management and development of potable water supplies become a State function. The Board considers this a very important provision.

THE NEXT STEP

The Board of Conservation and Development is by law "charged with a general supervision over all sources of potable and public water

supply to the end that the same be economically and prudently developed for the use of the people of the State." Through legislative appropriation therefor, the Board has caused to be made by the eminent engineering firm of Hazen, Whipple and Fuller, an exhaustive study of the water-supply problem, with particular reference to the needs of the metropolitan district. This report sets forth, among other things, the following facts:

The metropolitan district, comprising the counties of Bergen, Essex, Hudson, Middlesex, Passaic, and Union, is served by 33 different water-supply systems. Even if these supplies were pooled, the present surplus of supply over demand is too narrow for safety. There is some loss of water by waste. With complete metering, a saving equivalent to the normal increase of five years would result.

The early completion of the Wanaque reservoir will add 50,000,000* gallons daily to the reserve supply, but under existing contracts this will not be available except to certain portions of the district. Bayonne's plan to develop the Ramapo up to 50,000,000 gallons daily for itself and other municipalities, has been blocked by court decision and in no event could this supply be ready before 1929, and perhaps not then. Even with these new supplies the district as a whole will be short of water by 1935 unless additional provision is made.

Moreover, that part of the district now most urgently in need of an additional supply,—namely Union and Middlesex Counties, cannot be readily and economically served from these new sources. Furthermore, some of the sources now being used must probably be abandoned in the course of a few years because of increasing pollution.

On the other hand, the report shows that the undeveloped sources of potable water in northern New Jersey are more than ample for every need. Further development, however, must be on a large scale and the expense will be beyond the ability of any single municipality. The delays which attend every effort to secure voluntary cooperative municipal action render it more than doubtful if the future needs can be met by this means.

Year by year the small municipalities in the metropolitan district find greater difficulty in providing for their necessities by individual plants. Moreover, beyond a certain point, the development of individual systems, each with its reservoirs, pipe lines and pumping plants, is economically unsound, owing to the duplication of equipment involved. Additionally, in many instances the partial development of

*Since this was written revised plans have been made for the Wanaque and it is planned to develop it to its maximum capacity which is variously estimated at 62,000,000 to 100,000,000 gallons daily.

an important watershed by several small plants may prevent its later utilization to full capacity and thereby be wasteful not only of capital but of water.

Existing legislation vests in this Board supervision over diversion of both surface and ground waters and provides for the equitable distribution of sources of supply, but furnishes no means by which distant sources can be developed for common use. The law creating the district water-supply commissions and defining their powers does not meet the situation. At present, the North Jersey District Water Supply Commission is only the agent of one or more cooperating municipalities, in the erection and operation of a plant. Its means and powers are limited by its contracts with the municipalities. It has no power to initiate development in advance of the needs of the municipalities which may choose to use its services. The delays and difficulties which have attended the Wanaque development indicate in some degree the weakness of the present situation.

In the light of these facts this Board emphasizes the fact that it is not too soon to consider the needs of the entire district for the next 25 to 50 years. The present laws are not adequate and present agencies have not the power, legal or financial, to solve this great problem.

For the reasons set forth above the Board of Conservation and Development recommends that ample powers, both legal and financial, be granted to a State agency (a) to acquire and develop, from time to time, all those sources of supply which hereafter may be needed for the metropolitan district, to issue bonds and to sell water wholesale at cost including amortization to any municipality therein; and (b) to acquire and consolidate into a single system such existing systems, both municipal and private, as it may from time to time decide to be necessary in working out an efficient and economical water supply for the entire metropolitan district.

The credit of the State must be behind the bonds issued, and this will necessitate either a favorable referendum vote or a constitutional amendment, exempting water-supply bonds from the State debt provision. But the requirement should be made that any plan adopted shall result in the ultimate recovery of all expenditures from the operation itself, and that rates must be fixed and adjusted from time to time to this end.

In general, the Board endorses the plan of procedure outlined by Mr. Hazen in his report. It believes that the plan so successfully carried out in Massachusetts under the Metropolitan Water Board can, with such modification of detail as conditions here may demand, be applied with equal success to the solution of the problem in New

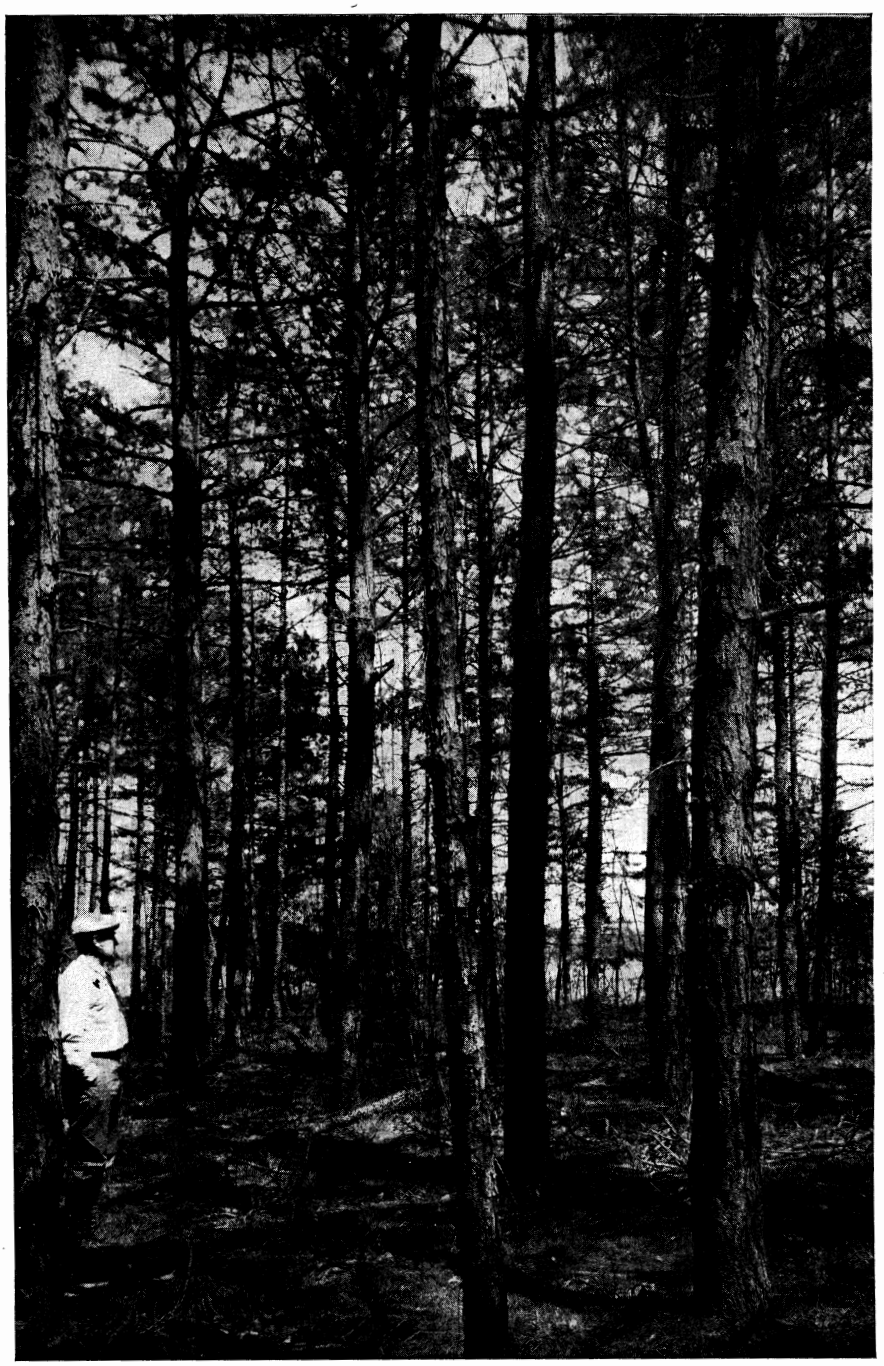

Fig. 3. THIRTY YEAR OLD PITCH PINE
which has come in naturally on an old field now stands 46 cords or 12,000 feet B. M. per acre. Fire protection always will make this possible on a great part of South Jersey's sands.

Jersey. It urges consideration of this important matter by those charged with the enactment of legislation and the determination of State policy, and stands ready in all things to cooperate.

FORESTRY

The forest policy in New Jersey developed during the past 15 years under the efficient administration of the former State Forester will not be departed from in any essential aspects. Its aim is to make all of the forest land of the State fully productive, hence profitable to both the owner and the community. The means to achieve this end are two, first, protection from forest fires, and second, better methods of handling the forest crop. The action of the 1923 Legislature in providing for a large expansion of the Forest Fire Service is the most important single step in forestry progress since forestry has been a part of the State's program. The next vital step is State acquisition of large areas of wild land in the State as State Forests, to serve as permanent timber producing areas, as demonstration areas to private owners of the possibility of profitable timber growing and as permanent public out-of-doors recreation areas for our rapidly increasing population.

State Forests.—There has been no change in the area of the State Forests during the year (see p. 81). Two thousand acres on Lebanon, 200 on Bass River, and 200 on Penn forest were burned during the severe epidemic of fires in April and May, 1922. Stokes Forest was threatened several times, but was saved by the efficient work of the wardens and rangers. Fortunately on none of the forests were the plantations or experimental work damaged. The Board wishes to put on record its appreciation of the faithful and efficient work of those in charge of protecting the State Forests in their handling of a very dangerous situation.

A rapid expansion of the State Forest holdings is urged as an essential step in the redemption of the vast areas of now idle land and the immediate beginning of an adequate home grown timber supply, in addition to the educational and recreational value of such areas.

The recommendations repeatedly made in previous reports that a great public forest be created on Kittatinny Mountain in Warren and Sussex Counties have been partly realized. The State's previous holding of 7231 acres of this land in the Stokes Forest has been increased by the gift of Mr. and Mrs. A. R. Kuser of the High Point property, comprising about 10,000 acres. This tract is not under the control of the Department, but its acquisition by the State is a real step toward the fulfillment of the recommendations of the Board of Conservation and Development.

Unfortunately about the same time that this tract at the north was acquired, a large holding in Warren County which is essential to the whole plan, passed into the hands of real estate speculators. The State should at once put the Department in a position to forestall further encroachment of this nature.

Forest Fires.—The State Firewarden's report (see p. 90) gives in detail the facts of the seasons covered by this report. It is clear that the forward step made possible by the 1923 Legislature was emphatically needed to provide reasonable protection to the woodlands in the State. Without protection from fire better forest practice or timber growing at all is not possible. The reorganized Forest Fire Service which will begin its work in the next fiscal year promises to mark a new era of efficiency in this work. Its success, however, cannot be completed without hearty and active public interest and support.

Shade Trees.—The charm of many a New England village and town is in the beautiful shade trees which border its streets. Many New Jersey municipalities suffer by comparison. The Department has repeatedly urged the appointment of shade tree commissions in municipalities and so far as its facilities permitted has cooperated with shade-tree interests. More could be accomplished if funds were available to permit the employment of an arborist to give his whole time to this work. The Board again urges that highway authorities, both State and County, make provision for proper tree shade along all improved roads and strongly endorses the Forester's recommendations in this respect (see p. 86). The ultimate gain to the State in beauty and attractiveness will be immeasurable.

WASHINGTON CROSSING PARK

The old Ferry house and a narrow frontage on Delaware River has been added to the park property at Washington Crossing. Plans have been perfected for restoration of the building and an option obtained on most of the land necessary to carry out the plan originally proposed. Legislative support for the immediate development of the property near the river was assured by the passage by the 1922 legislature of Joint Resolution No. 1. A revival of interest in this project throughout the State is evident and the Board is a unit in its determination to proceed with the development as rapidly as funds are provided. The plans of the Pennsylvania Commission include the acquisition of the land along the river where the army embarked, the "Valley of Concentration," where it assembled, portions of its camp ground at Neeley's Mills, and the construction and marking of memorial roads connecting these and other historic spots in the vicinity. Much progress has been made toward their consummation. Each commission is of course

working independently, within its own field, as it receives legislative support, but their plans harmonize, and both look forward to the erection of a memorial bridge under National auspices.

The battle at Trenton has long been recognized as the critical period in the War for Independence, and no event of that war has appealed in so marked a degree to the imagination of our people, as the historic crossing of the river and the march to Trenton on Christmas night amid the darkness and storm. It is altogether fitting that the two States of Pennsylvania and New Jersey and the National Government should unite in perpetuating the memory of these illustrious acts by the establishment of parks on either side and the erection of a memorial bridge.

STATE MUSEUM.

During the year 1922 the limitation of space in the State House continued to restrict the exhibit work of the Museum and the attendance fell off greatly. The loan work, however, grew enormously. Orders filled increased nearly 50 per cent; 61,662 lantern slides were circulated and shown to 395,901 persons; 1,810 motion picture films were loaned and viewed by 1,272,838; more than double the number of mounted pictures were sent to schools. Similar expansion took place during the next school year.

Packing the exhibits preparatory to moving to new quarters in the State Office Building superseded all other work late in the year, and the Museum was not open to visitors until August, 1923. The loan work, however, did not suffer interruption. The new rooms, although not large enough to permit any expansion of exhibits, are a great improvement on the old.

TESTING LABORATORY.

As in previous years the Testing Laboratory was occupied chiefly with work for the State Highway Commission. Besides this, coal was tested for all state institutions and building material for the State Architect. The fullest possible use of the laboratory is desired and it is the wish of the Board to make its facilities available to all State departments. The expense of the cooperative work is carried by the department for which it is done.

SOIL SURVEY.

During 1921-22, 131 square miles of the Trenton area and 280 square miles of the Salem area have been covered. In April 1922 work was commenced in non-municipal districts of Essex and Bergen Counties

and 120 square miles covered by the end of the fiscal year. Field work has outrun publication and reports on the Bernardsville, Chatsworth and Trenton areas are unpublished. The following year, the field work was completed except for the revision of some areas in which the earlier classifications were not in accord with the later work.

PUBLICATIONS.

The Board makes an annual report of departmental activities. In addition it publishes from time to time, maps, leaflets, and reports. Part of the Department's work is investigation and research; another part, State publicity; results are not attained if funds to publish results are not provided. The Board's requests for this work have been modest, but have been met only in part. A plea is made for more liberal appropriations. There is no true economy in not providing for the publication of matter in the preparation of which considerable sums have been spent.

The Board has in this report several times urged the need of larger appropriations. It has done so because it believed that the importance of the work intrusted to it warranted these requests, but in thus emphasizing the need for expansion in various lines, it would not appear unmindful of the support which its work has hitherto received, and the measure of public confidence which it enjoys, and which it will ever strive to retain.

THE BOARD OF CONSERVATION AND DEVELOPMENT.

John A. Waters, *President.*

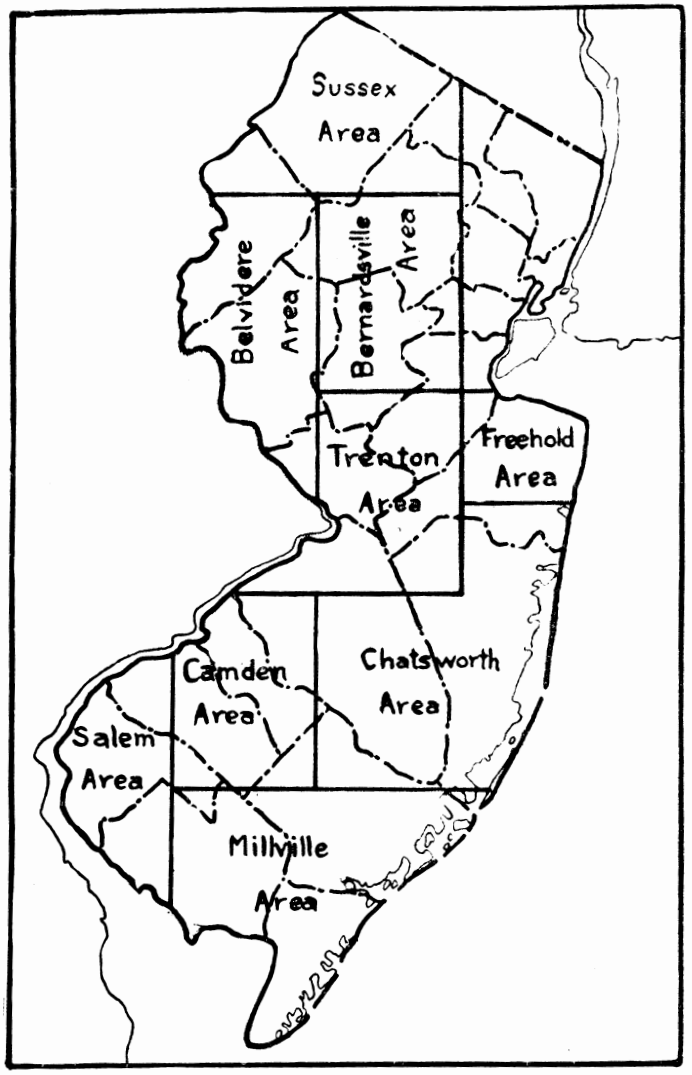

Fig. 4. Map Showing Progress of Soil Survey.

REPORT OF THE STATE GEOLOGIST

Henry B. Kümmel

The work of the Division of Geology and Waters, including the Testing Laboratory and the State Museum, for the years 1921-1922, and 1922-1923 is summarized in the following paragraphs:

TOPOGRAPHY AND ENGINEERING.

Revision of topographic maps.—During the two-year period covered by this report it was necessary to revise and issue new editions of many of the topographic sheets. A more liberal appropriation for map work was made by the Legislature and a competent engineer engaged for field and office work. Owing to the vast amount of labor entailed in compiling data necessary for revision, transcribing, corrections and preparing copy for the Engineer, and then in making corrections on the engraved stones, the revision work goes on but slowly, and only a few sheets can be revised each year.

SOIL SURVEY.

The work of making a detailed inventory of the soils of New Jersey proceeded during the year in cooperation with the Bureau of Soils, U. S. Department of Agriculture. The progress of the work is shown by the accompanying map, figure 4. Reports and maps of the Sussex, Freehold, Camden, Belvidere and Millville areas have been published. Manuscripts of the Chatsworth and Bernardsville areas are now in the hands of the printer*. During the fall of 1921 field work was carried on until December 24 in the Trenton and Salem areas, the Trenton area being practically completed. During the winter the report on this area was written and the maps are nearly ready to be submitted. About April 13, 1922, field work was commenced by the State men and a little later by the Bureau of Soils men in the Salem area and in the Bergen County area. These areas were both completed at the close of the fiscal year, June 30, 1923 and some progress had been made in revising some of the other work. This is necessary since there has been some change in standards and classification during the progress of the work, due partly to changing personnel, and partly to a better knowledge of the problem and refinement of methods. During the year 1922 the progress of the work was somewhat delayed by changes in the personnel both of the State and Bureau of Soils men. Mr. William Seltzer of the Department staff resigned in February,

*Since this report was written these reports have been delivered and copies may be obtained on application.

Mr. J. E. Tine being appointed at the opening of the field season in April to fill his place. Mr. Linwood L. Lee of the Department staff continued in charge of the State work and he was assisted by Messrs. R. T. A. Burke, J. Thorpe, and R. L. Gillette of the Bureau of Soils. During the year 131 square miles were surveyed in the Trenton area, 124 in the Bergen area and 280 in the Salem area, a total of 535 square miles. The entire cost of the soil work for the year ending June 30, 1922 including the office work at Trenton during the winter was $10,665.16, of which this Department paid $5,601.88, the Bureau of Soils, Washington $5,063.28. The figures for the year 1923 were approximately the same. In addition to its contribution to the field work the National organization undertakes the cost of printing the report and maps, this Department being privileged to purchase at cost an edition for its own distribution. The National organization also supervises the execution of the work on the technical side, establishes the standards and checks the classifications so as to secure uniformity with surveys in other states in so far as the soils are alike. With the completion of this work there will have been collected data of great value to the experts of the Agricultural Experiment Station, the Department of Agriculture, County Farm Agents, and the experts of this Department, as well as to all persons who need information regarding the soils of New Jersey.

TESTING LABORATORY.

The work of the Testing Laboratory under the direction of Mr. R. B. Gage, Chemical Engineer, has been along the same lines as in previous years. The work performed has exceeded in volume and variety that of any previous year, and as heretofore it has been chiefly for the State Highway Department, but a considerable amount of work was also done for the Department of Institutions and Agencies, both in testing coal purchased for the use of institutions and also in testing building material used in construction under the direction of the State Architect. To meet the cost of the cooperative work performed, the sum of $2,180.00 was transferred to the account of this Department, and as, heretofore the State Highway Commission paid directly the salaries of the assistants employed in the laboratory, on its work, as well as the general expenses connected therewith.

OIL PROSPECTING.

Drilling for oil at Jacksons Mills, in Monmouth County was finally abandoned in 1923, after a complete failure to find oil. The crystalline rocks underlying the cretaceous beds were penetrated for several hun-

dred feet in two wells. The position consistently maintained by the experts of this Department, that there are no known facts nor any well-founded hypothesis, which warrant the belief that oil will be found in commercial quantities in this State, has been abundantly justified.

MINERAL RESOURCES.

The geologists of the Department in various ways endeavor to keep in touch with mining and mineral interests of the State. Lists of producers are kept, statistics of production are collected; mines, quarries, pits, etc. are visited. As a result of this work the Department is in a position to answer the numerous inquiries relating to the occurrence of raw materials; and to save inquirers the expense of searches which in some instances could result only in failure. During the year about 125 visits of this character were made.

Mineral statistics.—In the collection of statistics, the Department has cooperated as in previous years with the U. S. Geological Survey and the U. S. Census Bureau. The latter organization has taken over the statistics relating to the pottery, brick and tile industries—an arrangement which still results in considerable delay in the receipt of the figures.

Detailed figures regarding the value of the mineral products are given on p. 37.

Conditions and developments.—In general 1921-1922 were unfavorable years for the mineral industry, a reflection of the general business depression which affected the entire country.

The zinc and iron mines were less active and there was a marked decrease both in the quantity and value of their product. The North Jersey Steel Company, however, which had recently leased and was operating the old Beach Glen Mine near Rockaway, Morris County, reports a substantial production at a time when many of the iron mines were practically idle.

The use of concrete has of recent years very seriously affected the building-stone industry and many of the sandstone quarries formerly worked are now idle. A notable exception is found in the case of the Lockatong argillite, quarried particularly at Princeton but found at many other localities in the Triassic area. The rock is a hardened shale, occurring in regular layers and showing various shades of red, brown, green, and gray. In the quarry it is separated into blocks with smooth faces, many of them coated with a thin white layer of calcite or quartz. Very pleasing effects are obtained by the use of this stone with its varied colors and it is growing in popularity, at least locally. It has been used in several of the newer buildings at Princeton University as well as elsewhere. It is sometimes called "Princeton" stone.

A plant for the production of hydrated lime has been constructed at Carpentersville, and this form of lime is now being produced from the blue dolomitic limestone quarried in that locality.

In the sand and gravel industry there were decreases along practically all lines except the grades for paving and road making purposes. In both of these the statistics showed largely increased production.

New Jersey has gained an enviable reputation for the quality of its molding sand. Inquiries have been received by this Department from points as far distant as Ohio, seeking to arrange either for shipments or the purchase of deposits. The most important area commercially is that near Lumberton and Mount Holly. Here the molding sand or loam forms a relatively thin layer immediately below the soil. This is stripped off and the layer of loam removed. Frequently no effort is made to redistribute the soil, so that the removal of the molding sand destroys the agricultural value of field after field.

The shortage of potash during the war directed much attention to the greensand marls as a source of this important ingredient of commercial fertilizers, and several projects for its recovery were started. All of these have been abandoned. In the meantime considerable effort has been directed towards building up a demand for the marl as a lawn dressing. It is dried, bagged, and sold at prices which, altho perhaps not more than the cost of production warrants, are nevertheless high when the quantity and availability of the potash content is considered in relation to that in commercial fertilizers. In the last analysis the price of such material will be determined not by the cost of production, but by the price at which other fertilizers of equal or greater value can be purchased. If production costs cannot be established on this basis, no wide and lasting market for this material can be built up.

The most promising development in the use of marl is in the manufacture of water softeners. A large marl pit at Birmingham has been purchased and the marl is being actively dug for this purpose.

A new use for abandoned mines.—A new use for abandoned mines has been found recently and several inquiries have been received for the location of mines suitable for this use. The even temperature, moist air, and semi-darkness of many mines have made them excellent places for growing mushrooms. The old copper mine at Arlington has been so used, and perhaps some others in the State. Only those mines which are not flooded and which can be entered by tunnel or slope rather than a shaft can be readily used.

Information.—Many requests for information regarding the State's resources are received. Some of these can be answered by mailing

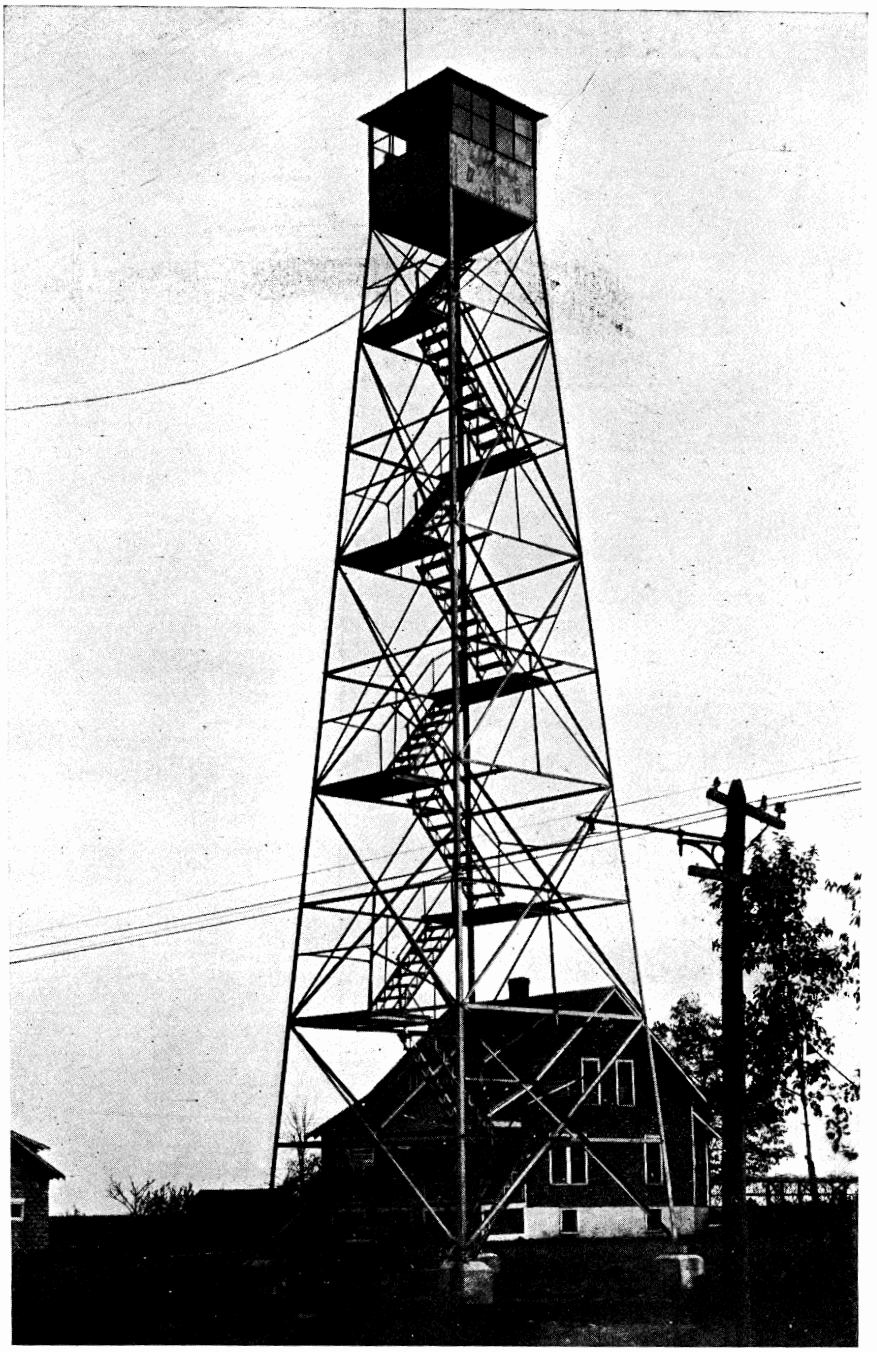

Fig. 5. NEW MILLVILLE FOREST FIRE LOOKOUT TOWER

These 60 foot steel towers are not expensive and should be provided to cover the entire forest area. Without these fire alarm boxes prompt action on fires is haphazard and forest fires cannot be kept small.

some publication of the Department covering the subject; others can be disposed of by a letter readily dictated because of facts already in mind; some require careful thought and more or less research in geologic and technical literature; a few cannot be properly or completely answered without special field investigation.

It is impossible to lay down any hard and fast rules as to what inquiries shall be answered and what not. The geologists are here to serve the people of the State to the utmost extent of their ability. In some instances this service can be rendered by assistance to individuals, but in cases where requests for this individual service encroach upon time which should be given to investigation and study of matters of larger general interest, or the accumulation of information without which no inquiries could be answered, refusal must be made. To be more specific it may be said that it is not possible to make chemical analyses or special field examinations for private parties, except in those cases where the information to be obtained is of sufficient public importance to warrant the expenditure of time and effort, in which case the results become part of the public records of the Department. On the other hand, since valuable geologic information is constantly being secured from records of drilled wells, for which the Department is dependent upon private cooperation, reciprocity demands that inquiries as to ground-water conditions be answered fully and carefully, even though this may necessitate considerable study.

Requests for information regarding ground-water supplies are more numerous than any other class, and range from supplies for cities like Rahway, Salem, and Freehold to those for the individual manufacturer and householder. In this connection one point should be emphasized. It is better to ask for information before beginning, than after a well has been drilled and the expected supply not obtained.

UNDERGROUND WATER SUPPLY

Importance.—Ground-water supplies for public and private use are being sought in constantly increasing amounts. In 1921 about 700,000 people were furnished 70,852,000 gallons daily of ground water by 141 public systems (p. 57). In addition about 340,000 persons drew from combination surface and underground supplies, and approximately. 260,000 people used private wells. Moreover it is estimated that about 40,000,000 gallons per day from private wells are used industrially in the metropolitan district of the State.* In view of this wide-spread use and the interest evidenced by the frequent inquiries

*Hazen, Whipple and Fuller, Report on Water Resources of the State and their Development. p. 18.

for information, a few fundamental facts, familiar to all ground-water engineers, but frequently overlooked by others, may be emphasized.

Amount of ground-water available for wells.—At the outset it is important to recognize the fact that all the water found in the shallower parts of the earth's crust and reached by wells is water which has fallen as rain, been absorbed by the ground, and is held in storage. An inch of rainfall is equivalent to 27,155 gallons per acre. The normal rainfall of the State, about 45 inches, is equivalent to 1,221,975 gallons per acre. If it were possible to draw from the ground all the water which falls during a normal year, the yield would be about 2,122,000 gallons per day per square mile. Manifestly this is impossible. Part of the rain immediately runs off the surface into the streams. Part of it is evaporated from the surface in the first few hours, or days after a storm. Of that which sinks into the ground, a large part returns to the air by evaporation both from the ground and through plants. The difference between the rainfall and the storm run-off plus the evaporation is the amount retained in the ground, which is available to maintain the flow of streams in the intervals between storms and to supply wells. Careful studies of the flow of surface streams has shown that in New Jersey in an average year 1,000,000 gallons per day per square mile and in the driest year 660,000 gallons per day per square mile are the maximum amounts which are available for feeding surface streams. The amount available to feed wells cannot be greater than this.

While these are maximum amounts it by no means follows that these maxima can be obtained. Where the topography of the surface favors a rapid run-off of the rain, or compact soil and dense underlying rock are unfavorable to absorption, or where the topography and geologic structure favor a rapid escape of the ground water to streams, the actual draft from wells per square mile will be less than these amounts. Some very successful groups of wells in New Jersey are not yielding more than 550,000 gallons per square mile. On Long Island, where conditions are extremely favorable for obtaining the maximum, the yield has been estimated at between 800,000 and 900,000 gallons per square mile. On the other hand, temporarily it may be possible to draw greater amounts than these by encroaching on the permanent ground storage. This of course results in a lowered ground-water level, and a diminution in the supply, and cannot continue indefinitely.

Source of supply.—For most wells drilled in northern New Jersey, the drainage area is the region immediately surrounding the well. The water is not derived from any distant source. In South Jersey, however, all the deeper wells draw from water-bearing strata which in the vicinity of the wells are shut off from the surface by non-perme-

able beds, and which receive their supplies from a distant source where they reach the surface. Thus the deep wells at Atlantic City pass through a thick bed of clay and draw from a sand bed, which reaches the surface 20 to 30 miles inland.

Temporary yield.—The yield of any well on a pumping test and the amount which may be continuously drawn from a given area are of course two entirely separate things. The former is determined primarily by the rate at which the ground water can pass through the material immediately around the well and shows only the rate at which the well is capable of taking from the reservoir as long as the supply lasts. This may be a day, a week, a year, or permanently, according to the supply. The permanent yield is dependent on the rate at which the ground supply is replenished and as explained above is a function of the annual rainfall, and slope of surface, and absorptive powers of the soil.

The rate of inflow is determind by the number and size of the water-carrying passages and the head, or slope of the water surface towards the well. In material like loose sand or porous rock, the water occurs in innumerable pore spaces between the grains. The larger the pore spaces, the less friction and the more rapid the ingress of the water. It has been determined experimentally that it is the size of the finest 10 per cent of the material which determines the rate of movement, so that if any portion of this finest material can be removed from immediately around the well, the rate of inflow can be greatly increased.

In many rocks, however, the water occurs in cracks and crevices and only to very slight extent in pore spaces. Here the yield depends upon the number and size of these openings, which happen to be intersected by the well tube.

It is important to recognize the fact that the *temporary* yield is no indication of the *permanent, continuous* yield. It may be and frequently is greatly in excess, since for a time drafts may be made on the accumulated ground storage. But if these excessive drafts are maintained the ground water level is permanently lowered, the head decreased, and the rate of inflow is lessened, with resulting diminution of the yield. A case has recently come to the attention of the writer where 6 wells are now yielding about 485,000 gallons per day, whereas 6 years ago 3 of them yielded 730,000 gallons. In the meantime the ground-water level has been lowered about 70 feet.

Variation in the rainfall.—Since many wells draw from their immediate vicinity and not from distant sources, yearly variations in the local rainfall may be of some importance in this connection. It is a

well-known fact that shallow wells often fail in dry weather, owing to the seasonal difference in the level of the ground water, although deeper wells are not affected. It is important to recognize, however, that the rainfall for any locality may for a number of consecutive years be much more or less than the average. The accumulated deficiency in a series of dry years may greatly deplete the ground storage, lower the ground-water level, diminish the head, and decrease the yield of wells which are being pumped to their full capacity, whereas, a succeeding series of years with excessive rainfall will restore the ground-water and increase the yield.

The rainfall records for Trenton for the last 19 years afford a striking illustration of this. From January 1, 1904 to November 1, 1922 there have been but three years, 1907, 1911, and 1914, when the rainfall exceeded the normal. For each of the other sixteen years, it was less than the average, the accumulatd deficiency to November 1, 1922 being nearly 92 inches, only a little short of a full two year's supply. It is manifest that this shortage must inevitably have caused some lowering of the ground-water level in that vicinity and affected the yield of wells.

FLOWING WELLS IN TRAP ROCK

Description.—An interesting group of wells in trap rock has recently been brought to the attention of the Department. They are located in the valley southwest of Verona, near the base of the westward slope of the trap-rock ridge known as First Watchung Mountain, the crest of which rises about 320 feet above the level of the wells.

Five holes were drilled to depths of 290, 312, 331, 355, and 840 feet respectively; four of them being 10 inches in diameter and one, 12 inches.

The 840-feet well (No. 1) passes through 27½ feet of glacial drift, 475 feet of trap rock and 338 feet of red sandstone. None of the other wells reach the sandstone under the trap. In the upper part of this well the trap is firm and dense, but from 140 to about 317 feet it is vesicular, soft, and full of seams. Below 317 feet it is hard and dense. Practically all the water obtained was found in the porous trap between 140 and 317 feet. A small additional amount was found in the red sandstone at about 682 feet. At 141 feet the well overflowed at the rate of 11 gallons per minute. A capacity test at 300 feet lowered the water level 75 feet and produced 108 gallons per minute. Another test at 682 feet lowered the water level 110 feet and increased the yield from 108 to 145 gallons per minute. A portion of this increased yield came from the water-bearing sandstone beds at this depth, but the larger portion was probably due to the increased flow into the

well from the porous layers between 140 and 317 feet, because of the increased head. An effort to increase the yield by "shooting" the well was unsuccessful, and a final 48-hour test indicated a capacity of 105 to 110 gallons per minute. The yield of this well has decreased to 60 gallons per minute in six years service, most of the decrease taking place in the first three years.

The small amount of water in the first 300 feet of sandstone under the trap rock is significant. The dense rock from 317 to 502 feet forms an impervious mass through which very little water can percolate. The small amount in the sandstone at 682 feet represents the percolation down the dip from the outcrop of the sandstone east of Eagle Rock, a mile and a quarter distant.

The 331-feet well (No. 3) passes through alternating layers of dense and porous trap, but did not obtain much water from the rock. It is 175 feet distant from the 840-feet well, but gave only 10 to 12 gallons per minute when finally tested.

The 312-feet well (No. 4), about 200 feet north of the deep well (No. 1) struck water at several horizons in soft porous trap. The upper 63 feet of rock is very hard and dense, and forms a cover bed for the water in the porous layers below. It overflowed from the 242-feet level at the rate of 18 gallons per minute. When first tested this well yielded 90 gallons per minute with water level down to 85 feet, but after running for about four years, the yield has fallen to about 75 gallons per minute when No. 1 is in service.

The 239-feet well (No. 6), located about 200 feet east of No. 4, penetrated alternating layers of dense and porous trap, finding water under pressure in the porous beds, particularly at 190 to 205 feet. From this horizon it overflowed about 40 to 50 gallons per minute, when the other wells were not in service. After completion it yielded 220 gallons per minute on an 8-hour test, run on three successive days, when Nos. 1 and 4 were being pumped. This well has not been used continuously, but its yield will probably fall off, as did the others.

The 355-feet well, (No. 7), located about 350 feet east of No. 6, flowed 4 gallons per minute from a depth of 160 feet, and on an 8-hour pump test, yielded 40 gallons per minute with Nos. 1, 4, and 6 in service. There is a close connection between all these wells, since all overflow when not in use but when one is pumped all the others immediately cease flowing.

From the geologic point of view this 355-feet well (No. 7) is the most interesting, because a 12-inch core drill was used, and a complete section from top to bottom is accessible for study. This core disclosed several interesting facts regarding conditions under which the trap sheet was formed. From the bottom of the hole at 355 feet upward

to about 253 feet (102 feet) the rock is very dense, fine-grained, blue-black trap (basalt), changing to a dark green near the top. At about 253 feet this dense rock grades upward into a green porous rock, some cavities being ½ inch in diameter, which extends to 226 feet. From 226 feet upward to 196 feet the rock is a dense, greenish-black basalt, which grades upward into porous vesicular rock to 160 feet. At 160 feet dense trap appears for about 15 feet, the upper part of which grades into porous vesicular rock from 145 feet to 95 feet. This rock is a brownish to greenish in color and extremely porous, some parts being almost sponge-like in the abundance of the cavities. From about 95 feet to the top of the rock at 11 feet, the core shows a most complicated inter-mingling of dense, bluish trap with a soft greenish mixture of angular fragments of volcanic glass and secondary minerals. This portion of the core represents a section through a mass of lava of peculiar form, which has been described in detail by J. Volney Lewis.* under the term "pillow" lava.

Origin of the trap rock.—It has long been recognized by all geologists that the Orange of Watchung Mountains are the outcropping edges of thick lava sheets which in Triassic time spread successively over the surface of a broad lowland lying between high mountain ranges. After the eruptions ceased each sheet was in turn deeply buried by the masses of sand and mud carried into this region by rivers, which flowed from the mountain ranges on the northwest and on the southeast. The present Highlands of New Jersey are the much eroded remnants of one of these ancient ranges, but the one on the southeast has entirely disappeared, altho its deep-lying roots are now exposed in the crystalline rocks on Manhattan Island, at Trenton, and in similar rocks beneath the sand and clay deposits here and there revealed by deep borings in southern New Jersey.

The well core described above throws some interesting light on the record of events during the first of these great periods of eruption. In this region the first flow was apparently a sheet of lava approximately 275 feet thick, which, except for about 27 feet at its upper surface and perhaps for a thin layer at its base, cooled into a fine-grained, dense rock. So long as the lava sheet is in a mobile, liquid condition the imprisoned gases rise and readily escape into the air from the more or less frothy surface. As the upper portion becomes thicker and pasty, their escape is retarded, and as it slowly freezes the upper portion of the sheet becomes a solidified rock froth. The porous beds between 226 and 253 feet are the frothy portion of this earlier flow. A second flow, 66 feet in thickness (160-226 feet), fol-

*Annual Report of the State Geologist for 1914, p. 51 et seq.

lowed after a very brief interval, its lower portion forming a hard dense rock, its upper half (36 feet) being very spongy and porous. There was a third flow, 65 feet in thickness (45 to 160 feet), all frothy except the lower 15 to 20 feet. Finally there was a series of small intermittent flows of pillow lava, to a thickness of at least 85 feet. The present surface of the rock is not necessarily the top of the original flow, since its surface has been removed by subsequent erosion to a depth probably not exceeding 50 feet.

All the wells show the occurrence of several layers of porous rock, although there are differences in details and the thicknesses given apply only to the section shown by well No. 7. These variations in the sections and the differences in the yield of the wells indicate local irregularities in the succession of flows of which the First Mountain is composed. They also indicate that wells drilled elsewhere along the back slope of their ridge may not reveal the same conditions of rock structure and yield, although the facts do give reasonable ground for the expectation that similar porous beds will be found elsewhere along the back slope of First Mountain, at least at localities not very remote from this.

Gathering ground for these wells.—The average westward dip of the sandstone beds on which the trap sheet rests is close to 10 degrees. Assuming that the inclination of the trap sheet is parallel to the sandstone beds, and all known facts support this assumption, and that the porous layers are inclined parallel to the general slope of the whole mass, the porous layers will come to the surface (beneath the glacial drift) in a belt about 2,000* feet in width and about 900 feet up the hill from well No. 7, allowance being made for the slope of the hillside.

The outcrop of these porous beds beneath the glacial drift, along the crest and back slope of the ridge, forms the only gathering ground for the water which they contain, except that they probably receive some water from the drift which overlies the dense trap rock on the east and higher up the slope. This water, not being able to penetrate the dense rock, will tend to flow down the slope in the lower part of the drift and along the rock surface, until it reaches the porous beds where it is absorbed. At the most, however, the gathering ground cannot extend east of the crest of the ridge, a distance of about 5,400 feet.

In all wells, no water was found in the upper dense layers of rock. In well No. 3 the yield was only 10 to 12 gallons per minute after the surface water had been cased off, although the yield was much more than this so long as there was opportunity for seepage of surface water.

*Part of the width of this belt is occupied by the outcrop of the dense layers separating the porous beds. These dense layers may occupy from 25 to 40 per cent of the space.

These facts demonstrate that the surface water in the glacial drift overlying the rock around the wells, does not penetrate to the porous beds. Since these beds nowhere approach the surface to the westward, but pass to greater depths, they can obtain no water in that direction. Their drainage area lies only to the east.

Possible yield.—Since the gathering ground is at the most a belt not more than 3,500 to 4,000 feet in width and may be less, and as the slope favors a large storm run-off, the continuous yield probably cannot exceed 400,000 gallons per day per linear mile along the ridge within the drainage area of these wells. When first drilled the wells could be pumped at the rate of about 600,000 gallons per day, but after several years of service the obtainable yield has fallen off to about 450,000 gallons. Whether or not this can be maintained will depend upon whether they can make their influence felt for more than half a mile in both directions along the outcrop of the porous strata.

Well in trap at Milltown.—The Michelin Tire Company in 1922 drilled a well at their plant in Milltown, Middlesex County. The first 28 feet was in sand and clay but at that depth a gray, trap rock (diabase) was struck, in which the well was continued to a depth of 200 feet. At this point water was struck which rose to 35 feet from the surface. On pumping with an air lift a yield of 150 gallons per minute is obtained. In this case no porous beds were found, but evidently a water-bearing fissure was struck. Whether or not this yield can be permanently maintained has not yet been demonstrated. It probably cannot unless the well can capture the available yield of from 220 to 320 acres. The rock penetrated is part of the buried diabase mass which is known to extend from Bergen Point on the Kill-von-Kull to near Dean's Station, and which has been reached by a number of wells in this interval. At most localities it has yielded very little water.

THE STATE MUSEUM.

The work of the New Jersey State Museum has continued along the same lines as were followed during the past few years, since the conditions continued which made development along exhibiting lines practically impossible. However, the loan department has made still further advancement—even beyond the remarkable strides made last year. This continued progress convinces us that not only a worth while and much needed work is being done, but a work that has great possibilities for future growth and development, especially since the project method of teaching is recommended to the schools by the State Department of Public Instruction. It can readily be seen that a vast field is open if only adequate funds can be made available to carry out the work on a larger scale.

Exhibits.—In October, 1922, the Museum was moved from the State House to new quarters in the State Office Building. Preparation for the moving, and the work of reinstalling the exhibits in the new cases provided, made it necessary to close the exhibits to the public for nearly a year, but the lending work was not interrupted. A collection of about 3,000 New Jersey Indian relics was purchased by the Museum from Max Schrabisch of Paterson.

Previous to moving the following special exhibits were prepared and displayed:

Edible and Non-Edible Tree Fungi.—Collected by Mr. E. B. Sterling.

This exhibit proved to be most effective and interesting.

Work done by the New Jersey Blind.—

The work was exhibited for two weeks in February, and demonstrations were given by the blind, three days each week.

Exhibit of Material Loaned by the Museum.—

This included new sets of pictures, as well as charts, natural history cases and Riker mounts of insects recently added to the Museum's collections. Some of the new sets of lantern slides were also shown in the corridor through the Deparament's stereomotorgraph.

Visual instruction material.—Requests for lantern slides, motion picture films, natural history specimens, stereographs, mounted pictures, industrial process charts and exhibits increased to such an extent, that almost 1,000 more orders were filled each year, than in the preceding. In fact, it was impossible for the Museum to supply all the demands for lending material as there were not sufficient funds available to permit the purchase of the necessary duplicate collections. The staff of workers, also, was too small to take care of the rapid growth of this work as well as the Museum would like to have it done.

The following statistics, showing the circulation of visual instruction material for the two years 1921-22 and 1922-23, will perhaps best explain the cooperation that exists between the Museum and the schools, community centers, and other organizations throughout the State.

Material	Number Circulated	
	1921-22	1922-23
Lantern slides	61,662	68,808
Motion picture films	1,810	1,947
Natural history specimens	1,190	1,310
Mounted pictures	5,566	7,270
Industrial charts	1,136	1,416
Health and agriculture charts	435	650
Stereographs	6,816	10,103
Stereoscopes	604	670
Total number of objects loaned	79,219	92,174

Lantern slides and films.—The total number of people reached through the showing of lantern slides and motion picture films, borrowed from the Museum during the two years, was 3,120,896. One of the most important divisions of the Museum's educational work is the lending of lantern slides. A few years ago its collection of slides consisted of about 4,000 miscellaneous views, many of which were old and not colored. The present collection, in addition to the above subjects, includes about 7,000 slides arranged in lecture sets; and the majority of them are high-grade, colored views. Many of these slides have been given or loaned to the Museum by various organizations for circulation throughout New Jersey, and others have been purchased. Because of the rapid growth of the use of lantern slides, there is still a need of enlarging the present collection, for there are many new subjects, as well as duplicates, that are needed to meet the demands. The lending of motion picture films has also become a very important division in the educational work of the Department, even though it was started only four years ago. It would be almost impossible to carry on this branch of work were it not for the courtesy and generosity of the many firms and organizations who lend their educational reels to the Museum for circulation in New Jersey, as the high cost of purchasing and renting motion picture films would make the work prohibitive. There were nearly 250 reels of film available for use last year, covering subjects on travel, industries, nature study, agriculture, history, health and hygiene, safety and Americanization. Below is given a comparative report of the statistics for the circulation of lantern slides and films for the past few years.

	'17-'18	'18-'19	'19-'20	'20-'21	'21-'22	'22-'23
Slides circulated	3,671	7,314	27,662	42,856	61,662	68,808
Films circulated	....	....	336	1,500	1,810	1,947

Attendance at	'20-'21	'21-'22	'22-'23
Slide showings	318,488	395,901	401,123
Film showings	817,397	1,272,838	1,051,034
Total attendance	1,135,885	1,668,739	1,452,157

The striking growth of this work surely signifies the great value of visual instruction as a method of education.

Miscellaneous collections.—There was also an increase in the use of industrial process charts, natural history collections, stereographs and mounted pictures. Although it was practically impossible to prepare many new subjects to add to these collections, it was necessary to make up a number of new charts and natural history cases to replace

old ones, as well as to purchase new sets of stereographs and mounted pictures to supply some of the material wanted. A comparative report of the circulation of this material follows:

	'18-'19	'19-'20	'20-'21	'21-'22	'22-'23
Charts	500	745	849	1,136	2,066
Natural History Cases....	29	56	91	119	131
Stereographs	...	...	1,118	6,816	10,103
Mounted Pictures	866	1,121	2,078	5,566	7,270

Special educational work.—In order that instruction might be given to teachers in the correct use of visual instruction material, the Museum sent large exhibits of its collections to the summer schools at Rutgers College, Ocean City, Columbia University, Newton, Madison, Collingswood, Newark, and Elizabeth. Weekly shipments of material were also sent to summer camps at Frenchtown, Andover and New Egypt. The pupils of the State Normal School at Trenton made use of the Museum's lending sets throughout the entire school year, as they were required to give demonstrations of the use of visual instruction material in the classroom. The following talks on the State Museum and its work were given by Mrs. Greywacz:

October 21, 1921.....Teacher's Institute of Hudson County, held at West Hoboken,

December 8, 1921.....Meeting of County and City Superintendents, Supervising Principals and Helping Teachers of the southern Counties, held at Atlantic City,

May 2, 1922.....Burlington County Rural Teachers' Conference, held at Mount Holly,

March 2, 1923.....Annual meeting of New Jersey and Pennsylvania Library Association at Atlantic City.

Attendance.—The attendance at the Museum for the fiscal year 1921-22 is low when compared with the number of visitors when it is possible to hold special exhibits. However, it is hoped that this work may be resumed in the new quarters.

1921-22

Month	Attendance.	
July	996	
August	1,414	
September	1,151	
October	1,139	
November	955	
December	1,124	
January	1,260	
February	1,155	
March	1,212	
April	1,117	
May	1,016	
June	973	
	13,512	
Average attendance per day	48	
Average attendance per month	1,126	
Number of classes for the year	38	
Attendance for the year		13,512
People reached by circulation of lending material		1,668,739
Total number of people reached by Museum		1,682,251

Fig. 6. DO YOU OWN WOODLAND?

Care like this thinning pays for itself, and usually makes a profit beside. It means bigger profit from the final crop always. It pays.

The Mineral Industries of New Jersey in 1921 and 1922.

M. W. Twitchell, Assistant State Geologist.

General condition of the mineral industries.—Following the period of inflated prices and large production that prevailed during 1920, a sharp reaction set in which led to a great decrease both in quantity and value of the total mineral output in New Jersey in 1921; but in 1922 conditions once more improved along most lines and it became evident that the greatly depressed condition of the previous year was of but a temporary character.

Cooperation in collection of statistics.—In the collection of the mineral statistics for 1921 and 1922 as given in this report the Department of Conservation and Development cooperated with the United States Geological Survey and with the United States Census Bureau. The cooperation with the Census Bureau related to the clay-working industries only. This cooperative collection of statistics by the three organizations avoids duplicate requests to the producers, tends to greater completeness and accuracy of the returns and is otherwise advantageous and satisfactory.

Total value of mineral products.—For 1922 the total value of the mineral products of New Jersey was $70,283,159. With the exception of 1920, when the total was $82,022,509, this is the highest record attained by the State. There was a considerable decrease in 1921, compared with 1920; but in 1922 the industry nearly recovered the ground lost the previous year.

General Summary.—In the following table there is given a general summary of the total quantity and total value for 1921 and 1922 in the case of the principal mineral products. Details regarding the individual industries will be given in the pages that follow.

MINERAL PRODUCTS OF NEW JERSEY IN 1921 AND 1922

Products	Producers.	1921 Quantity	1921 Value	1922 Quantity	1922 Value
Zinc ore	1	400,080 s. t.	(a)	512,290 s. t.	(a)
Iron ore (b)	5	115,132 l. t.	$ 551,688	90,374 l. t.	$ 400,356
Portland Cement (c)	2	2,840,699 bbls.	4,820,538	(c)	(c)
Stone (d)	57	1,680,940 s. t.	2,634,738	1,903,840 s. t.	2,850,557
Sand and Gravel (d)	70	3,568,780 s. t.	2,436,298	4,854,433 s. t.	3,425,013
Clay (d)	42	263,178 s. t.	1,049,748	313,360 s. t.	1,206,947
Brick and tile (d)	65	(d)	11,294,374	(d)	17,243,445
Pottery (d)	51	(d)	15,329,995	(d)	20,881,443
Peat (e)	4	12,051 s. t.	94,269	39,095 s. t.	193,940
Mineral Waters	8	250,295 gal.	25,960	290,508 gal.	30,800
Greensand Marl (f)	3	(f)	(f)	7,885 s. t.	56,800
Miscellaneous (f)	16		9,398,184		23,993,858
Total, all products	321		$47,635,792		$70,283,159

(a) Value included under "Miscellaneous". The value so included is a special estimate of the recoverable zinc content of the ore; while in previous years it was the value of the crude ore only. The change makes our policy more nearly in accord with the policy of the U. S. Geological Survey.

b. Shipments to furnaces; practically all magnetite. The quantity mined was 58,589 long tons in 1921 and 90,359 tons in 1922.

c. Special permission is given to publish these figures of shipments for 1921, but the figures for 1922 are not available for publication. The value of the shipments in 1922 is included under "Miscellaneous", and in the total for all products.

d. Details in special table below.

e. Chiefly for use as a fertilizer, or ingredient of fertilizers.

f. Includes for 1921 fuel briquets, coke, greensand marl, lime, ground quartz, slate, ground talcose rock, argillite, serpentine, iron ore sold for paint and the recoverable zinc content of the zinc ore mined. For 1922 includes the same list except that argillite, serpentine, greensand marl and iron ore sold for paint are omitted and cement is added.

The zinc mining industry.—The Franklin Furnace mine and Ogdensburg mine were operated in 1922 and 512,290 short tons of zinc ore mined. This makes a grand total of 10,965,684 tons taken from the New Jersey mines since 1880. As the amount mined in 1921 was 400,080 short tons, there was an increase of 112,210 tons. The ore was of the usual character mined in New Jersey, consisting essentially of a mixture of the three zinc minerals zincite, willemite and franklinite with white calcite as the gangue. Further details regarding the zinc industry will be found in previous reports by this Department.

The iron mining industry.—Inasmuch as the *value* of the iron ore mined in New Jersey was greater in 1920 than it had been for many years, it is not surprising that there was a falling off in 1921. However, the actual decrease was much greater than one would have anticipated, even when general business conditions were taken into consideration. From $2,595,949 to $551,688, a decrease of $2,044,261, is certainly discouraging. The decrease in *quantity* of ore shipped was from 417,100 long tons to 115,132 tons, or 301,968 tons. Both in quantity and value the figures for 1921 were much less than for many years, a reaction after the recent prosperous years that is very pronounced indeed. It is discouraging to note that the shipments of iron ore in New Jersey in 1922 were only 90,374 long tons and the value only $400,356, which means that the downward trend in 1921 continued into 1922. The active operators in 1922 were the Replogle

Steel Co., operating the Replogle mine; the Empire Steel and Iron Co., operating the Mt. Hope and Washington mines; the Ringwood Co., operating the Cannon and Peters mines; the North Jersey Steel Co., operating the Beach Glen mine and the Thomas Iron Co., operating the Richard mine.

The following extract from a letter from one of the leading iron-ore producers in New Jersey sheds some light on the difficulties with which this industry has been forced to contend.

"The blast furnaces near the seaboard are mainly inactive for the reason that foreign pig iron can be delivered to those who are normally their customers at a less price than their cost of manufacture. Such furnaces near the seaboard remaining in operation can, under present conditions, obtain foreign iron ore at a less price than the cost of producing iron ore from New Jersey mines. The discrimination in freight rates against the New Jersey mines to which we referred in our former report has been modified to some extent, but discrimination in freight rates to a lesser extent still exists, and common sense, justice and the greatest good to the greatest number require the removal of such discrimination."

The iron ore *mined* in New Jersey in 1921 was 58,589 long tons, and in 1922, 90,359 long tons, which makes a grand total of 23,282,812 long tons actually taken from the mines of the State since 1870. New Jersey still has large reserves of good ore, probably more than equal to all that has so far been taken from its mines, and it is to be hoped that conditions may naturally improve, or may be made to improve by those who can bring it about, so that the State shall once more take high rank as a producer of iron ore.

Stone.—The stone industry in New Jersey in 1921 and 1922 maintained the high level it had attained in 1920. The details regarding the production of stone are set forth in the following tables:

STONE PRODUCTION IN NEW JERSEY IN 1921 AND 1922

Variety	Producers	1921 Quantity	1921 Value	1922 Quantity	1922 Value
Trap (basalt, etc.) (a).....	37	1,342,040 s. t.	$2,194,729	1,581,740 s. t.	$2,412,109
Limestone (b).....	14	228,600 s. t.	280,761	264,340 s. t.	320,855
Other stone (c).....	6	110,300 s. t.	159,248	57,760 s. t.	117,593
Total (d).....	57	1,680,940 s. t.	$2,634,738	1,903,840 s. t.	$2,850,557

a. Chiefly crushed stone for road material, concrete and railroad ballast.

b. Chiefly white, high calcium limestone for flux and crushed blue limestone for concrete: also ground limestone for agricultural use, and minor quantities for other purposes.

c. In 1921 includes granite and sandstone only. The granite was in part rough building stone and in part crushed stone for road making. The sandstone was chiefly rough building stone. In 1922 includes granite, sandstone, argillite and serpentine. In 1916 included granite, sandstone, slate, talc and serpentine.

d. In 1921 is exclusive of argillite and serpentine which are put under Miscellaneous mineral products, in accordance with the action of the U. S. Geological Survey, to avoid revealing production of individual operators. The serpentine is partly verd antique marble and partly crushed material for use as stucco and terrazzo

The figures set forth in the above table indicate that, as for many years, the chief variety of stone quarried in New Jersey is *trap*. This is the general name given to dark-colored, medium and fine-grained igneous rocks such as form the Palisades, Rocky Hill, Sourland Mountain and the Watchung Mountains. The trap production was 239,700 tons *greater* in quantity and $217,380 *greater* in value in 1922 than in 1921 while the figures for 1921 showed an *increase* in value of $53,884 and an *increase* in quantity of 135,230 short tons over the great output of 1920. As usual the trap produced was nearly all in the form of crushed stone and was sold chiefly for use as road material; a fact that suggests that the main reason for the continued prosperity of this industry is that there has been no let up in the great program now on in the building of high class improved roads throughout the State.

The production of *limestone* which had shown a downward trend for several years, gave signs of improving conditions in 1922, when there was an increase of 35,740 tons in amount and $40,094 in value over the previous year. The recent completion of the large and well equipped limestone pulverizing plant of the Limestone Products Corporation of America near Newton, described in the issue of "Rock Products" for November 4, 1922, may lead to results that will give a more encouraging story in the future in regard to the limestone industry of the State.

Clay and clay products.—For years New Jersey has held a high rank among the States as a producer of clay and clay products. Clay is mined both by manufacturers who use it directly in making various products and by operators who sell the raw clay to makers of brick, tile and pottery either within or without the State. While the amount of clay used directly by producers who are also manufacturers is known to be large, there is no way of ascertaining the exact amount or value. Statistics are available however, regarding the clay mined and sold raw and are given in the following table:

CLAY MINED AND SOLD IN NEW JERSEY IN 1921 AND 1922

Variety	Pro-ducers	1921 Quantity	1921 Value	1922 Quantity	1922 Value
Fire clay	35	195,572 s. t.	$ 842,257	244,240 s. t.	$ 979,345
Stoneware clay	9	16,354 s. t.	71,919	10,008 s. t.	41,256
Ball clay	7	8,230 s. t.	62,638	9,314 s. t.	66,555
Miscellaneous clay (a)	13	43,022 s. t.	72,934	49,798 s. t.	119,791
Total raw clay (b)	42	263,178 s. t.	$1,049,748	313,360 s. t.	$1,206,947

a. Includes slip clay, foundry clay, crucible clay, clay for abrasive wheels, etc.
b. Includes only clay mined and sold as raw clay. Much of this is sold to New Jersey brick, tile and pottery manufacturers and its value is in part involved in their value. Considerable of it (perhaps 30 per cent) is shipped outside of the State. In addition to the clay here reported large quantities are mined by the manufacturers and used by them directly in making their clay products.

It will be noted that the above figures show that *fire clay*, or clay that will stand very high temperatures, constitutes by far the greater part of the New Jersey output. Compared to 1920, the output for 1922 shows a decrease of $449,920 in the total value of clay mined and sold as such. There were decreases in both value and quantity of fire clay and stoneware clay. While the total is not large, there was an increase in the quantity of ball clay from 4,980 short tons in 1920 to 9,314 tons in 1922.

The statistics in regard to *brick* and *tile* for 1921 and 1922 were collected by the U. S. Census Bureau. The details are summarized in the following table:

BRICK AND TILE PRODUCED IN NEW JERSEY IN 1921 AND 1922

Products	1921 Quantity	1921 Value	1922 Quantity	1922 Value
Common brick	191,208 M.	$ 2,546,793	289,406 M.	$ 4,340,175
Fire brick	18,101 M.	1,206,876	19,368 M.	1,366,064
Face brick (a)	21,506 M.	1,000,105	25,257 M.	947,392
Enameled brick (a)			(a)	(a)
Terra cotta	17,052 s. t.	2,284,219	30,390 s. t.	3,118,054
Hollow building tile (b)	176,231 s. t.	1,730,620	337,104 s. t.	3,016,383
Wall tile (c)	2,543,873 sq. ft.	973,812	4,770,468 sq. ft.	1,735,569
Ceramic mosaic	3,532,881 sq. ft.	811,408	5,426,085 sq. ft.	1,246,725
Floor tile (d)	1,916,424 sq. ft.	544,356	1,708,589 sq. ft.	478,316
Faience tile (e)	116,243 sq. ft.	106,111	240,171 sq. ft.	198,814
Miscellaneous (f)		217,309		795,953
Total brick and tile (65 producers)		$11,421,609		$17,243,445

a. The figures for 1922 are for face brick only; those for enameled brick being included under "Miscellaneous."
b. Includes partition, load-bearing, floor arch, blocks, silo tile and fireproofing.
c. Thin, white glazed, etc. partition tile not included—see hollow building tile.
d. Including plain, vitreous, encaustic, quarry, etc.
e. Including art tile, enameled tile and hand-decorated tile.
f. Includes drain tile, sewer pipe, stove lining, gas logs, wall coping, conduits, flue lining, glass house pots, etc.

A study of the above table taken with the figures for 1920 published previously shows that there were decreases in values in nearly all products as well as in the total between 1920 and 1921 but that there was a recovery along most lines in 1922. The 1922 figures showed notable increases in values for common brick, terra cotta, wall tile and ceramic mosaic.

The statistics in regard to pottery for 1921 and 1922 were collected by the U. S. Census Bureau. The details are summarized in the following table.

POTTERY PRODUCED IN NEW JERSEY IN 1921 and 1922

	1921	1922	1920
Sanitary ware	$ 8,230,836	$13,748,287	$12,763,442
Products	Value	Value	Value
Porcelain electrical supplies	2,542,836	2,978,144	5,058,518
White ware, including C. C., white granite, semi-porcelain, etc.	1,176,970	(a)	
Hotel china	1,713,933	1,628,296	4,916,387
China, Bone china, belleek, etc.	1,026,891	998,959	
Miscellaneous (b)	1,101,610	1,527,757	1,859,029
Total (51 producers)	15,793,076	20,881,443	24,597,376

a. Included under "Miscellaneous."
b. Includes red earthenware (flower pots, etc.), chemical stoneware, saggers, and minor articles such as tobacco pipes, hardware trimmings, art pottery, souvenirs, etc.

From the above table it appears that the large decrease in the pottery output between 1920 and 1921 amounting to $9,267,381 was nearly offset by the gain of $5,088,367 between 1921 and 1922. It will also be noticed that in 1922 sanitary ware was able to recover fully from the depression of the preceding year and even show an increase of $984,845 over the record-breaking output of 1920. A new feature of interest is the separate figure for "hotel china" now published for the first time, the value for 1921 being $1,713,933, and for 1922, $1,628,296.

The sand and gravel industry.—The production of sand and gravel constitutes an important mineral industry in New Jersey. It is one of the most widely distributed and involves a large number of producers, 70 of them in all. There was a decrease of $1,894,546 in the total value of the output between 1920 and 1921. The four chief varieties were as usual building, molding, paving and glass sands. Molding sand, first in 1920 fell to third place in 1921, and went to second place in 1922; while paving sand, fourth in 1920, forged to second place in 1921 and fell to third place in 1922. Further details will be found in the following table.

SAND AND GRAVEL PRODUCTION IN NEW JERSEY IN 1921 AND 1922

Variety	Pro-ducers	1921 Quantity	1921 Value	1922 Quantity	1922 Value
Building sand	30	1,426,327 s. t.	$ 627,232	1,977,013 s. t.	$ 934,434
Molding sand	28	241,587 s. t.	306,209	468,992 s. t.	554,867
Paving sand	17	632,368 s. t.	345,376	777,891 s. t.	379,252
Glass sand	6	103,694 s. t.	196,814	174,122 s. t.	277,467
Grinding and polishing sand	7	49,479 s. t.	132,351	87,812 s. t.	193,619
Fire and furnace sand	10	20,292 s. t.	30,252	43,374 s. t.	55,126
Engine sand	7	49,107 s. t.	27,612	68,178 s. t.	41,397
Other sands (a)	8	30,437 s. t.	68,645	66,004 s. t.	101,564
Total sand	70	2,553,291 s. t.	$1,734,491	3,663,386 s. t.	$2,537,726
Gravel (b)	20	1,015,489 s. t.	701,807	1,191,047 s. t.	887,287
Total sand and gravel	70	3,568,780 s. t.	$2,436,298	4,854,433 s. t.	$3,425,013

a. Includes filter sand, sand for potteries, soap manufacturers and for several other unspecified purposes.
b. Includes building gravel, paving and road making gravel and some sand used for "railroad ballast."

Portland cement industry.—The chief areas of *cement-rock* in New Jersey are in Warren County, in two narrow belts. One extends northeast from Carpentersville to New Village; and is being steadily utilized by two great Portland cement plants, one located at Vulcanite, (the Vulcanite Portland Cement Co.) and the other at New Village, (the Edison Portland Cement Co.). The other belt extends northeast from Belvidere to Johnsonburg. This has not been developed. It extends southwest into Pennsylvania and at Martin's Creek, across the Delaware, has been extensively utilized by the Alpha Portland Cement Company. A decade ago New Jersey stood sixth among the States in the production of Portland Cement; in 1921 it ranked eleventh. The change is partly due to the fact that the Alpha Portland Cement Co., whose plant at Alpha, New Jersey, was formerly very active has not been operated for several years, though it produces actively at its plant at Martins Creek, Pa. and sells much of its output in New Jersey. Although there were only two active plants in New Jersey, permission to publish the output for 1920 and 1921 was courteously given by the operators. In 1911 the quantity shipped (by three operators) was 4,411,890 barrels, with a value of $3,259,528; in 1920 (with two operators) the quantity was 2,563,453 barrels and value $5,096,558; while in 1921 the shipments were 2,840,699 barrels and value $4,820,538. It will be noticed therefore that the quantity in 1921 was less than it was a decade before. In 1921 the output increased over 1920 by 277,246 barrels. It is evident that the decrease in value of $276,020 between 1920 and 1921 was due to the lower price—$1.70 per barrel in 1921 and $1.99 in 1920.

Peat.—Within the past few years a considerable quantity of New Jersey peat has been dried and, with or without bacterial innoculation, sold for use as a fertilizer, or as an ingredient of fertilizers. The chief producing areas are the Pequest meadows northeast of Great Meadows P. O. in Warren County and a swamp near Newton, Sussex County. The output of peat in New Jersey in 1921 was 12,051 short tons, valued at $94,269 and in 1922 it was 39,095 tons valued at $193,940. In 1922 New Jersey led the country in this industry.

Mineral waters.—There was a decided decrease both in the quantity and value of the mineral water production in New Jersey in 1921 and 1922 as compared with 1920. In 1921 the total quantity was 250,295 gallons, having a value of $25,960, and in 1922 it was 290,808 gallons valued at $30,800; while in 1920 the production was 702,867 gallons, with a value of $68,036. Practically all of the mineral water produced in New Jersey is sold for table use. In 1922 there were eight active springs, as follows: the Belmar Spring, 1 mile south of Ridgewood, Bergen County; the Echo Spring, 5 miles north of Trenton, Mercer County; the Indian Spring, near Rockaway, Morris County; the Indian

Lady Hill Spring, near Asbury Park, Monmouth County; the Rock Spring, near West Orange, Essex County; the Watchung Spring and Washington Rock Spring, near North Plainfield, Somerset County; and the Rosemont Spring, near Somerville, Somerset County.

Lime.—Several operators burned New Jersey limestone and sold the burnt lime in 1921 and 1922, but the number of operators in this line is steadily decreasing in this State. One operator, the Twining-Large Co., located near Carpentersville, Warren County, also produced hydrated lime. The value of these products is included under "Miscellaneous."

Greensand marl.—There were three active producers of greensand marl in 1921 and 1922. Part of this material was dried, bagged and sold for use as a special dressing for extensive lawns, golf links, etc., and part of it was used in preparing a material for water-softening purposes. Interest in the use of greensand marl as a source of potash salts, which was so active during war times, has waned greatly in the past few years, due chiefly to the fact that the German potash salts are once more available and are sold in this country on a basis and with contract features that makes favorable competition by American potash producers out of the question. The value of the marl mined is included under "Miscellaneous." For further information on this subject see "The Potash Greensands of New Jersey," which sets forth the results of an investigation carried on cooperatively by the U. S. Geological Survey and this Department and recently published as Bulletin 727, U. S. Geological Survey.

Ground quartz or "silica."—The New Jersey Pulverizing Co. and the Pennsylvania Glass Sand Co. have been mining and pulverizing some of the high-grade white quartz sand of southern New Jersey for sale under the trade name "Silica." The material is usable for scouring soaps, polishing powder, paints and similar purposes. The sand is obtained at Cedarville and South Vineland in Cumberland County and at Williamstown Junction, Camden County. The value of this product is included under "Miscellaneous."

Ground Talcose rock.—One concern, the Rock Products Co., quarry and pulverize the talcose rock associated with serpentine that occurs near Phillipsburg, Warren County. This material is usable for many of the industrial purposes for which other ground talc is used. The value of the output is included under "Miscellaneous."

Coke and fuel briquets.—While New Jersey has no coal deposits it does produce considerable coke as a by-product in gas manufacture. The Camden Coke Company of Camden and the Seaboard By-Products Company of Kearny were the two producing companies. The total

amount of coke produced in the State in 1921 was 739,768 tons, and in 1922, 790,811 tons. The value of the amount sold cannot be separately published but is included in our "Miscellaneous" and in the total of all products.

The fuel briquet industry was less active in 1921 and 1922 than in 1920. The two producers were the Anthracite Manufacturing Co., (successors of the Fuel Briquet Co.) at Trenton and the Burnrite Coal Briquet Co. of Newark. As there were less than three producers, the figures in regard to fuel briquets cannot be separately published. The value of the output is included under "Miscellaneous" products.

Mineral Pigments.—A change in policy has taken place in regard to statistics relating to *lead and zinc pigments.* These are now collected by the U. S. Census Bureau and are no longer available for publication by this Department. As this item amounted in 1920 to 50,887 short tous, valued at $8,264,167 its omission from our mineral industries in 1921 is one reason for the decrease in the total value of all products. In 1921 a quantity of New Jersey *iron ore* was sold for use in making paint. The value of this is included under "Miscellaneous" products instead of under "Iron ore."

Slate, argillite and serpentine.—The Lafayette Slate Co. quarried slate near Lafayette, Sussex County; C. A. Williamson quarried argillite near Princeton, Mercer County and the Rock Products Co. successors to Lizzie Clay & Pulp Co. quarried some serpentine near Phillipsburg, Warren County. The values of these products, for various reasons, are included under "Miscellaneous."

Report of the Surface Water Supply Branch

H. T. Critchlow, Hydraulic Engineer

It is gratifying to record a considerable expansion in the activities of the Water Supply Branch made possible through the generous appropriation by the Legislatures of 1921 and 1922 from the Water Supply Fund. During the two years the force has been increased to four engineers, one on part time, two clerks and twenty-one local observers at stream gaging stations, in addition to the twelve observers paid by cooperating parties. The expansion has been mostly in connection with the reestablishing of the stream-gaging work which was allowed to lapse in 1914, the systematic inspection of existing dams, and in the special investigation of the water supply resources of the State.

It is confidently hoped that the work begun under such encouraging circumstances will be allowed to continue by receiving the necessary financial support of each succeeding legislature. The value of this work lies in its continuity. Any interruption not only destroys the organization of specially trained workers, but endangers the collection of vital information during critical years which occur at unknown intervals. The prudent and economical development of our splendid water resources demands that they be studied in the most intelligent manner possible.

PERMITS FOR THE DIVERSION OF WATER

Acting under the provisions of Chapter 252, Laws of 1907, and Chapter 304, Laws of 1910, which relate to the diversion of water for potable purposes, the Board considered twenty-six applications. Of these, twenty-two were approved, one denied, and three were withdrawn by the applicants. The Bayonne application involved the taking of much testimony bearing upon the water supply situation in the North Jersey metropolitan district, and emphasizing the need for a comprehensive plan of development for the future.

City of Bayonne.—The application of the City of Bayonne to take a new water supply from the Ramapo River near Oakland, filed February 21, 1921, was considered at public hearings on March 10, April 21, June 9, July 7, and September 8, 1921, and approved by the Board on March 23, 1922, in the following language:

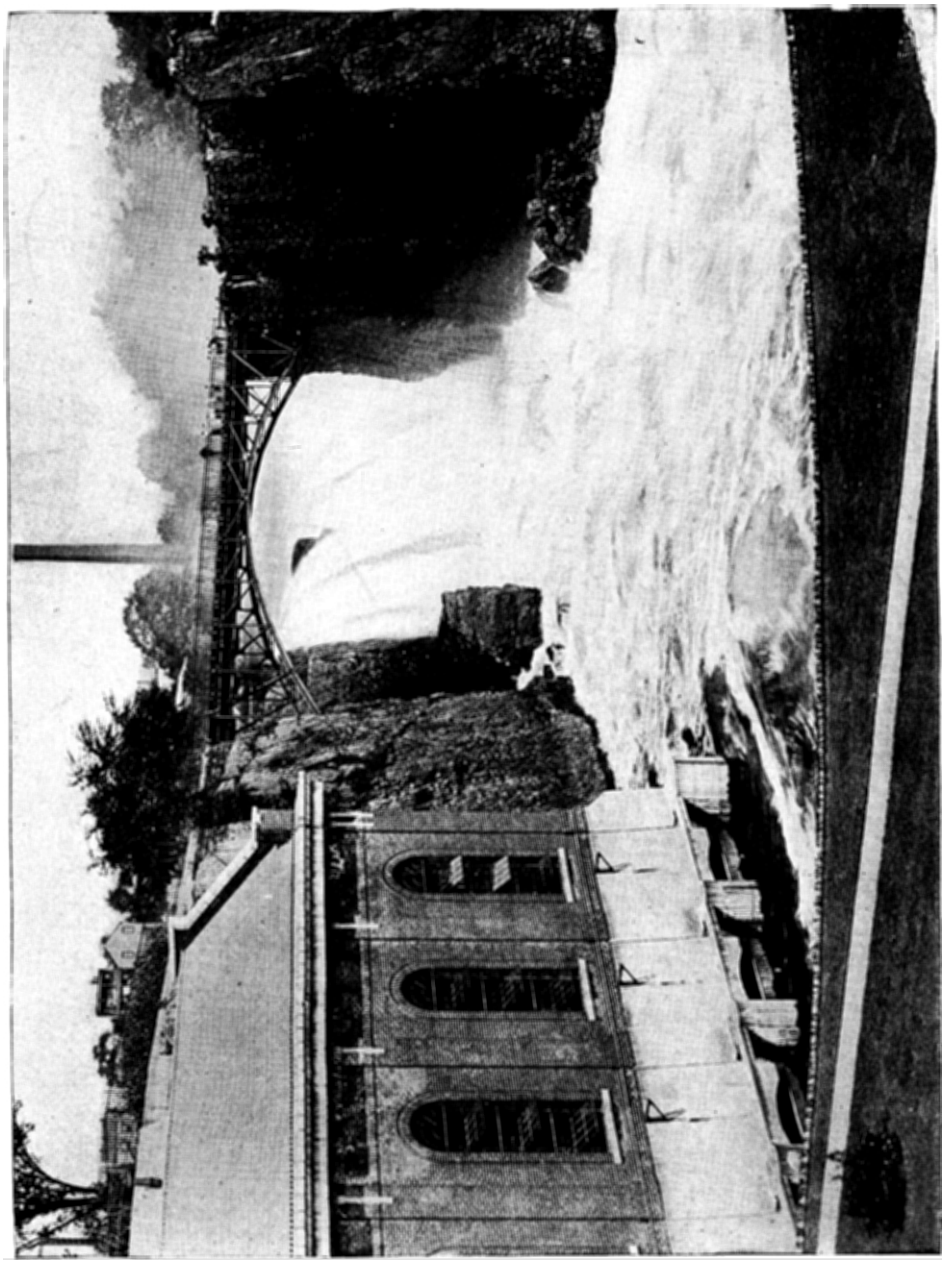

Fig. 7. Passaic River at Paterson. (p. 63)

APPROVAL OF APPLICATION OF THE CITY OF BAYONNE

To divert water from the Ramapo River at Oakland, Bergen County, New Jersey.

APPROVED MARCH 23RD, 1922.

The City of Bayonne, Hudson County, a municipal corporation in the State of New Jersey, having on the 21st day of February, 1921, filed a petition with the Board of Conservation and Development for the approval of its plans for obtaining a new source of water supply from the Ramapo River in the valley below Suffern, New York, but in the State of New Jersey, to an amount not exceeding one hundred million (100,000,000) gallons daily, which amount was reduced by the applicant at the first hearing to fifty million (50,000,000) gallons daily, and at the same time having filed maps, plans, statements, etc., as required by law;

And the Board of Conservation and Development having given due notice that it would grant a public hearing on said application to be held in its offices at Trenton, New Jersey, on Thursday, March 10th, 1921, at which time and place all persons or municipalities affected by the proposed plans might be heard for or against the approval of the application, which said notice bore date of February 24th, 1921, and was published in the Hudson Observer, the Jersey Journal, the Newark Evening News and the Paterson Press-Guardian, and copies of which notice were served by resistered mail upon the Mayors of Newark, Passaic, Paterson, Pompton Lakes Boro and Oakland Boro, also to the North Jersey District Water Supply Commission, the East Jersey Water Company, the Society for Establishing Useful Manufactures and the Morris Canal and Banking Company, all in accordance with orders of the Board;

And the Board of Conservation and Development at such public hearing and on the 21st of April, the 9th of June, the 7th of July and the 8th of September, 1921, days to which such hearing had been adjourned, having heard all who presented themselves and desired to be heard, and the statutory limitation for deciding the case having been waived by all parties appearing, and the Board having considered the matters and things set forth in the petition and the evidence, statements and representations given and made at such hearing, does on the 23d day of March, 1922, hereby decide that the plans proposed by the City of Bayonne to take water from the Ramapo River in the valley below Suffern, New York, as set forth in the maps and statements accompanying said application and filed therewith, are justified by public necessity and reasonably anticipated public use, and that they will not unduly interfere with the opportunity of other municipalities to obtain a water supply by the taking of waters necessary for their use, and that they will not cause a reduction of the dry season flow of any stream to an amount likely to produce unsanitary conditions, or otherwise unduly injure public or private interests, provided the conditions hereto attached and which are made a part of this approval are observed:

A. To supply any municipality or part thereof whose application for a public water supply, after public hearing, shall have been approved by this Board, at such price per million gallons as may be mutually agreed upon, or in default of such agreement as may be fixed by this Board, such price in general to cover such proportionate part of all costs, including operation, depreciation, interest and sinking fund payments as the amount contracted for shall bear to the developed capacity of the watershed.

B. To begin, without undue delay, the development of the Ramapo watershed, and to complete its development as outlined in the application to a yield for water supply purposes of not less than two-thirds of the maximum capacity before December 31st, 1929, and further to develop it to the maximum economic capacity, when this Board shall so determine. provided, however, that this requirement shall not be interpreted to apply to the New York portion of the watershed unless and until the necessary statutes have been enacted.

C. To surrender all its rights under this permit and to sell all the lands, reservoirs, pipeline and property of any description acquired in carrying out the provisions thereof to the State of New Jersey or to any board, body or commission thereof having authority to acquire or consolidate existing public water supplies, or to exercise any like power whenever said State board, body or commission may so elect, at cost less a fair allowance for depreciation. In determining such cost, interest in the investment shall be included for the period of construction, but not after the date upon which the plant has begun operation.

D. To maintain in the stream below the dam a flow of at least fifteen million (15,000,000) gallons daily at all times, provided, however, that in exceptionally dry years on application and presentation of evidence that this is largely in excess of the then normal flow and its discharge will seriously decrease the supply available to meet demands, this amount may be temporarily reduced by this Board in its discretion to not less than ten million (10,000,000) gallons daily, and provided further, that these figures may be increased or decreased as this Board may determine to be equitable in the light of future measurements of stream flow, and the need for water supply.

E. To pay the State Treasurer for itself and for such other municipalities as may be supplied such charges for excess diversion of water as are now, or may be hereafter required by statute.

2. This approval shall not become operative unless the applicant shall file with this Board, within ninety days from date hereof, its written acceptance of the terms and conditions hereby imposed, after taking such legal steps as may be necessary, subject to the approval of the Attorney General, to make such acceptance binding.

3. In the event that it shall be established to the satisfaction of this Board after due hearing that the conditions set forth in this permit have been or are being violated, it may by resolution declare the permission to divert water herein given to be withdrawn, and thereupon all rights and privileges hereunder shall cease and determine.

The Board of Conservation and Development does therefore approve the application of the City of Bayonne and assent to the diversion of water as set forth in said application and accompanying maps, subject nevertheless to the following terms and conditions:

1. By its acceptance of this approval and conditions thereof, as hereinafter provided, the City of Bayonne does covenant and agree

Fig. 8. Ramapo River near Oakland. Proposed water-supply reservoir site requested by Bayonne. (p. 47)

IN TESTIMONY WHEREOF, we, a majority of the members of the Board of Conservation and Development do hereunto set our hands and cause the official seal of the Board to be affixed hereto and attested by its Secretary.

Dated, Trenton, New Jersey,
March 23rd, 1922.

W. E. Florance,
President.

Simon P. Northrup,
Owen Winston,
Henry Crofut White,
John A. Waters,
Percival Chrystie,
J. L. Kuser,

Members of the Board of Conservation and Development.

ATTEST:

Henry B. Kümmel,
Secretary.

Writs of certiorari on the Bayonne decision were allowed the Borough of Pompton Lakes, Borough of Oakland, County of Bergen, County of Passaic, Township of Hohokus, Mr. Ludo Wilkins and others. Return of writ was made June 13, 1922. Argument before the Supreme Court was pending at the close of the fiscal year.*

Borough of Pompton Lakes.—The application of the Borough of Pompton Lakes, filed June 2, 1921, to divert a new supply of water from the Ramapo River at Pompton Lakes dam, was denied on September 8, with permission to renew the same without prejudice, as the application of the City of Bayonne to divert water from the same source was still pending. A new application was submitted November 16, and a public hearing held on December 8. On February 7, 1922 this application was withdrawn on account of a later plan of the Borough of Pompton Lakes to take water from the Butler Water Company.

Town of Bloomfield.—The application filed by the Town of Bloomfield on June 9, 1921 to take a new water supply not to exceed 10,000,000 gallons daily from the Ramapo River at Oakland, was denied on September 8 and a new application filed October 25, 1921. After a public hearing on March 9, 1922, this application was denied.

City of Rahway.—On October 26, 1921, the City of Rahway filed an application to take a new water supply from wells near Rahway,

*On November 3, 1922, the Supreme Court sustained the action of the Board and dismissed the writs. In September, 1923, the Court of Errors and Appeals reversed the decision of the Supreme Court and set aside the action of the Board.

the amount to be diverted not to exceed 8,000,000 gallons daily during any month. Hearings were held on November 22 and December 1, and on the latter date the application was withdrawn.

Borough of Milltown.—On October 31, 1921 the Borough of Milltown filed an application to take a new water supply from Lawrence Brook and a public hearing was held on November 18. At a hearing on April 13, 1922, this application was withdrawn, being replaced by one filed March 31, 1922 to obtain an additional supply from Bog Brook in the Borough of Milltown, to an amount not exceeding 190,000 gallons daily for any month. On April 13 this was approved, subject to standard conditions.

Livingston Water Company.—The plans of the Livingston Water Company to take a new supply of water, not to exceed 35,000 gallons daily during any month, from wells in the Township of Livingston, were filed on November 25,1921. After a public hearing on December 8, the plans were approved, subject to standard conditions.

Borough of Harvey Cedars.—The plans of the Borough of Harvey Cedars to take a new water supply, not to exceed 10,000 gallons daily during any month, from a well located in the Borough of Harvey Cedars, were filed on February 14, 1922. After a public hearing on March 9, the plans were approved, subject to standard conditions.

City of Camden.—The plans of the City of Camden to take an additional supply of water, not to exceed 6,000,000 gallons daily for any month, from artesian wells located within the city, were filed on February 25, 1922. After a public hearing on March 9, the plans were approved, subject to standard conditions.

Butler Water Company.—The plans of the Butler Water Company to furnish a water supply for the Borough of Pompton Lakes and Village of Riverdale from Kikeout and Apshawa watersheds, near Butler, to an amount not to exceed 400,000 gallons daily during any month, were filed March 15, 1922. After a public hearing on April 13, the plans were approved, subject to standard terms and the following condition:

> In the event of the construction of additional storage on Stone House Brook above the present reservoir of the Company, the entire supply from Apshawa watershed as at present developed, shall be first utilized before the Company may exercise the right it possesses to demand water from such additional storage on Stone House Brook in excess of 500,000 gallons per day.

Empire Steel and Iron Company.—On April 24, 1922 the Empire Steel and Iron Company filed an application to take an additional water supply from springs at Oxford, Warren County, the amount to be

diverted not to exceed 5,000 gallons daily. After a public hearing, the Board on May 11 approved the application, subject to standard terms and the following conditions:

In consideration of the permission herein contained, the Company, by the acceptance of this approval, hereby agrees to relinquish all grants, rights and privileges obtained and now held by virtue of the permit granted by the State Water Supply Commission under date of January 13, 1914, and it is mutually agreed that the terms and conditions herein set forth shall alone apply to all water diverted by the Empire Steel and Iron Company for the purpose of supplying the inhabitants of Oxford with potable water.

In the event that a municipal water supply shall, hereafter, be established to supply the inhabitants of Oxford, the diversion rights herein granted shall cease, provided, however, that the said Company shall first have been reimbursed by the municipality for the then value of so much of the water plant as was constructed for a public water supply.

The approval of the application herein and all rights conferred thereby, or arising by reason thereof, are granted and accepted upon the express condition that the applicant herein, its successors or assigns, shall surrender and sell any and all its rights under this permit and any and all lands, rights of way, reservoirs, pipe lines and other property, real or personal, corporeal or incorporeal, acquired in good faith, for or in connection with the exercise of the rights, or any of them, herein granted, to the State of New Jersey, or to any board, body or commission thereof having authority to acquire or consolidate existing public water supplies or to exercise any like power whenever said State board, body or commission shall so elect, at the fair cost of such property less a fair allowance for depreciation. In determining such cost, interest on the investment shall be included for the period of construction, but not after the date when the said applicant, its successors or assigns, shall begin the sale of water or the distribution thereof.

Mountain View Water Company.—The plans of the Mountain View Water Company to take a new supply of water not to exceed 10,000 gallons daily during any month from an artesian well in the Borough of Lincoln Park, Morris County, for the purpose of supplying a portion of said borough, were filed on May 26, 1922. A public hearing was held on June 8 and plans were approved on June 29, 1922, subject to standard terms and the following special condition:

The approval of the application herein and all rights conferred thereby or arising by reason thereof, are granted and accepted upon the express condition that the applicant herein, its successors or assigns, shall surrender and sell any and all of its rights under this permit and any and all lands, rights of way, reservoirs, pipe lines and other property, real or personal, corporeal or incorporeal, acquired in good faith, for or in connection with the exercise of the rights, or any of them herein granted, to the State of New Jersey, or to any board, body or commission thereof having authority to acquire or consolidate existing public water supplies or to exercise any like power whenever said State board, body or commission may so elect, at the fair cost of such property less a fair allowance for depreciation. In determining such cost, interest on the investment shall be included for the period of construction but not after the date when the said applicant, its successors or assigns, shall begin the sale of water or the distribution thereof.

Buckhorn Springs Water Company.—The plans of the Buckhorn Springs Water Company, Belvidere, to take an additional water supply, not to exceed 300,000 gallons daily during any month, from a tributary of Buckhorn Creek were filed on June 3, 1922. After a public hearing on June 29, the plans were approved subject to standard terms and the following special condition:

> The right of diversion hereby allowed to the Company as against the State shall terminate on April 28, 1938, with the right of renewal at that time for twenty (20) additional years, provided, however, that the approval of the application herein and all rights covered thereby or arising by reason thereof are granted and accepted upon the express condition that the applicant herein, its successors or assigns, shall surrender and sell any or all of its rights under this permit, and any and all lands, rights of way, reservoirs, pipe lines, and other property, real or personal, corporeal or incorporeal, acquired in good faith, for or in connection with the exercise of the rights, or any of them herein granted, to the State of New Jersey, or to any board, body or commission thereof having authority to acquire or consolidate existing public water supplies, or to exercise any like power whenever said State board, body or commission may so elect, at the fair cost of such property less a fair allowance for depreciation. In determining such cost, interest on the investment shall be included for the period of construction, but not after the date when the said applicant, its successors or assigns, shall begin the sale of water or the distribution thereof.*

Borough of Waldwick.—The plans of the Borough of Waldwick to divert a new supply of water, not to exceed 60,000 gallons daily during any month, from an artesian well located in the Borough of Waldwick, were filed on July 28, 1922. A public hearing was held August 10, 1922, and on September 7, 1922 the plans were approved subject to standard conditions.

Clinton Water and Water Supply Company.—The plans of the Clinton Water and Water Supply Company to divert an additional supply of water from its existing supply, not to exceed 25,000 gallons daily during any month, for the purpose of supplying the Village of Lebanon, were filed on August 7, 1922. After a public hearing on September 7, 1922, the plans were approved, subject to standard conditions. The Company declined to accept one of the conditions imposed and requested that the application be held in abeyance.

City of Jersey City.—The plans of the City of Jersey City to obtain an additional source of water supply, not to exceed 5,000,000 gallons daily during any month, from Beaver Brook at Split Rock Pond, were filed on August 31, 1922. After a public hearing on October 4, 1922, the plans were approved subject to standard conditions.

City of Ventnor.—The plans of the City of Ventnor to take an additional supply of water, not to exceed 1,000,000 gallons daily dur-

*The above condition is in the form finally adopted in September, 1922, and accepted by the Water Company.

ing any month, from artesian wells located within the city, were filed on September 2, 1922. After a public hearing on October 14, 1922, the plans were approved subject to standard conditions.

Borough of Rockaway.—The plans of the Borough of Rockaway to take an additional supply of water, not to exceed 432,000 gallons daily during any month, from a well located in the Borough of Rockaway, were filed September 8, 1922. After a public hearing on October 14, 1922, the plans were approved subject to standard conditions.

Township of Chester.—The plans of the Township of Chester, Camden County, to take a new supply of water, not to exceed 200,000 gallons daily during any month, from wells located in the Township of Chester, were filed on November 25, 1922. A public hearing was held on December 14, 1922, and on February 8, 1923, the plans were approved subject to standard conditions.

Mrs. Henry Thiem.—The plans of Mrs. Henry Thiem to take a new water supply not to exceed 5,000 gallons daily during any month, from a well located in the Village of Rochelle Park, were filed on January 26, 1923. After a public hearing on April 12, 1923, the plans were approved subject to standard conditions.

Fred E. Koch.—The plans of Fred E. Koch to take a new water supply, not to exceed 50,000 gallons daily during any month, from a well located in the Village of Rochelle Park, were filed on January 26, 1923. After a public hearing on April 12, 1923, the plans were approved subject to standard conditions.

Fangmann and Gaede Water System.—The plans of the Fangmann and Gaede Water System to take a new water supply, not to exceed 90,000 gallons daily during any month, from a well located in the Village of Rochelle Park, were filed on January 27, 1923. After a public hearing on April 12, 1923, the plans were approved subject to standard conditions.

Borough of Sayreville—City of Perth Amboy.—A contract between the Borough of Sayreville and the Board of Water Commissioners of the City of Perth Amboy, under date of March 7, 1923, under which the City of Perth Amboy will furnish water to the Borough of Sayreville in a quantity not to exceed 250,000 gallons daily, was approved on April 12, 1923.

Borough of Milltown.—The plans of the Borough of Milltown to take an additional supply of water, not to exceed 190,000 gallons daily during any month, from Lawrence Brook in the Borough of Milltown, were filed March 28, 1923. After a public hearing on April 12, 1923, the plans were approved subject to standard terms and the following special condition:

Whenever it shall become necessary for the City of New Brunswick to provide additional storage on the Lawrence Brook watershed, the Borough of Milltown shall be obligated to contribute to the cost thereof such proportionate share as this Board, after hearing the parties in interest, may then determine to be equitable, or in lieu thereof shall provide at its own expense such storage as the Board may then order.*

Laurence Harbor Heights Company.—The plans of the Laurence Harbor Heights Company to take a new water supply, not to exceed 60,000 gallons daily during any month, from wells located in Laurence Harbor, were filed on April 28, 1923. After a public hearing on May 10, 1923, the plans were approved subject to standard conditions.

Borough of Oaklyn.—The plans of the Borough of Oaklyn to take a new water supply, not to exceed 300,000 gallons daily during any month, from wells located in the Borough of Oaklyn, were filed on June 2, 1923. Pending negotiations with other municipalities for a joint supply, this application was withdrawn.

Borough of Stone Harbor.—The plans of the Borough of Stone Harbor to take an additional supply of water, not to exceed 720,000 gallons daily during any month, from wells located in the Borough of Stone Harbor, were filed on June 12, 1923. After a public hearing on July 12, the plans were approved subject to standard conditions.

EXTENSIONS OF TIME

Extensions of time were granted in the following cases: New Jersey Central Power Company, to complete proposed dam near Chester, to July 6, 1922; Palisades Interstate Park Commission, to complete Greenbrook dam in Bergen County, to April 3, 1923.

EXCESS DIVERSION CHARGES

Charges for 1921—1922.—Under the provisions of Chapter 252, Laws of 1907, and Chapter 304, Laws of 1910, all municipal corporations, corporations, or persons diverting water, either from surface, sub-surface, well or percolating sources, or from any combination of such sources for public water supply purposes, are required to keep accurate records by meter or other approved methods of the amount of water used and to report the same quarterly to the Board, as successor to

*The applicant failed to accept the terms and conditions of the grant as required and the Board finally abrogated the approval by resolution adopted February 14, 1924.

the State Water Supply Commission. The act of 1907 imposes certain charges for the excess diversion of water from surface sources.

For both years the Board fixed a rate of $1 per million gallons, the minimum rate provided by law. Certification to the State Comptroller of the amounts due the State, as per the tables below, was made, the amount due from each being equal in dollars to the figures shown in the last column. For 1921 the total was $23,261.79 and for 1922, $25,572.62. Both amounts have been paid in full.

EXCESS DIVERSION OF SURFACE WATERS, CALENDAR YEAR 1921

NAME OF COMPANY OR MUNICIPALITY	Total Free Allowance In Million Gallons	Total Diversion in Million Gallons	Excess Diversion in Million Gallons and Charge in Dollars
Acquackanonk Water Co.	1,589.940	2,728.800	1,138.86
Atlantic City, City of	1,649.070	2,154.353	505.28
Bound Brook Water Co.	157.972	194.020	36.05
Bridgeton, City of	497.276	703.098	205.82
Buckhorn Springs Water Co.	68.219	122.040	53.82
Burlington, City of	293.387	350.922	57.53
Butler Water Co.	102.200	158.891	56.69
East Jersey Water Co.	3,314.820	9,728.360	6,413.54
Hackensack Water Co.	7,924.941	10,343.392	2,418.45
Hackettstown, Town of	94.681	188.705	94.02
High Bridge, Borough of	50.443	68.601	18.15
Jersey City, City of	14,016.000	19,138.515	5,122.51
Lopatcong Water Co.	146.000	511.000	365.00
Middlesex Water Co.	639.006	1,582.245	943.24
Monmouth County Water Co.	160.308	259.948	99.64
Newark, City of	13,228.208	15,453.800	2,225.59
New Brunswick, City of	936.725	2,164.389	1,227.66
New Jersey Zinc Co.	58.400	66.890	8.49
Newton, Town of	161.403	244.185	82.78
Rahway, City of	555.397	980.241	424.84
J. A. Roebling's Sons Co.	42.340	110.764	68.42
Somerville Water Co.	472.067	645.402	173.33
Sussex Water Dept.	48.107	122.819	74.71
Tintern Manor Water Co.	1,147.782	1,573.050	425.27
Trenton, City of	4,923.850	5,927.370	1,003.52
Tuckerton Water Co.	48.618	49.541	.92
Washington Water Co.	125.232	142.880	17.65
Totals	52,452.392	75,714.221	23,261.79

EXCESS DIVERSION OF SURFACE WATERS, CALENDAR YEAR 1922.

NAME OF COMPANY OR MUNICIPALITY	Total Free Allowance in Million Gallons	Total Diversion in Million Gallons	Excess Diversion in Million Gallons and Charge in Dollars
Acquackanonk Water Co.	1,589,940	2,939,400	1,349.46
Atlantic City, City of	1,649,070	2,534,659	885.59
Boonton, Town of	143,628	172,527	28.90
Bound Brook Water Co.	157,972	247,154	89.18
Branchville, Boro of	21,571	43,398	21.83
Bridgeton, City of	497,276	866,003	368.73
Buckhorn Springs Water Co.	68,219	111,085	42.87
Burlington, City of	293,387	377,104	83.72
Butler Water Co.	102,200	280,150	177.95
East Jersey Water Co.	3,314,820	8,875,300	5,560.48
Hackensack Water Co.	7,924,941	10,769,403	2,844.46
Hackettstown, Town of	94,681	125,374	30.69
High Bridge, Boro of	50,443	72,775	22.33
Jersey City, City of	14,016,000	20,250,733	6,234.73
Lopatcong Water Co.	146,000	511,400	365.40
Middlesex Water Co.	639,006	1,305,739	666.73
Monmouth County Water Co.	160,308	186,442	26.13
Newark, City of	13,228,208	16,388,100	3,159.89
New Brunswick, City of	936,725	2,058,460	1,121.74
New Jersey Zinc Co.	58,400	67,421	9.02
Newton, Town of	161,403	244,550	83.15
Rahway, City of	555,397	1,139,359	583.96
J. A. Roebling's Sons Co.	42,340	108,334	65.99
Somerville Water Co.	472,067	647,622	175.56
Sussex, Town of	48,107	126,362	78.26
Tintern Manor Water Co.	1,147,782	1,607,728	459.95
Trenton, City of	4,923,850	5,923,060	999.21
Tuckerton Water Co.	48,618	49,406	.79
Washington Water Co.	125,232	161,153	35.92
Totals	52,617,591	78,190,201	25,572.62

Collection of Back Charges.—Of the amounts due the State on account of unpaid back charges, the sum of $74.92 was collected from the Borough of Sussex for the year 1920; the sum of $505.28 from the City of Atlantic City for the year 1921; the sum of $16,947.61 from the City of Trenton for thirteen and one-half years ending December 31, 1921; and the sum of $21,371.43 from the City of Newark for the years 1915, 1917, 1918, 1919, 1920 and 1921, including interest ($1,041.76). Claims against Atlantic City for $3,171.12 for the years 1912, 1913, 1914 and 1920, and the Millville Water Company for $1,313.19 for five and one-half years ending December 31, 1917 and the year 1919, are in the hands of the Attorney General.

The cases against Trenton and Newark were decided in favor of the Board by the Court of Errors and Appeals, but were appealed to the United States Supreme Court. This tribunal also affirmed the validity of the act.

CONSUMPTION FOR THE YEARS 1921, 1922.

The tables below show the gross and per capita consumption of water for 1921 and 1922.

PUBLIC WATER SUPPLIES IN 1921 (CALENDAR YEAR).

SOURCE OF SUPPLY	Number of Systems	Population Supplied	Consumption (Gallons Daily) Total	Per Person
Surface	44	1,911,848	214,974,000	112
Underground	141	699,004	70,852,000	101
Combination	15	339,169	36,054,000	109
Totals	200	2,950,021	321,880,000	109

PUBLIC WATER SUPPLIES IN 1922. (CALENDAR YEAR).

SOURCE OF SUPPLY	Number of Systems	Population Supplied	Consumption (Gallons Daily) Total	Per Person
Surface	47	1,972,365	221,763,000	112
Underground	144	701,424	71,931,000	103
Combination	15	343,306	35,525,000	103
Totals	206	3,017,095	329,219,000	109

MEASUREMENT OF WATER CONSUMPTION

The work of measuring the consumption of water by a portable meter was continued on a number of systems which have no means of measuring the water used. The results of these tests were used as a basis in determining the diversion of water from the sources of supply. Tests were made as follows:

May 26 to July 14, 1922—Bound Brook Water Company, to measure consumption and check calibration of Venturi meter.

July 14 to 26, 1922—Town of Boonton, gravity system.

July 27 to August 11, 1922—Buckhorn Springs Water Company, gravity system.

August 14 to 22, 1922—Washington Water Company, gravity system.

August 24 to September 5, 1922—Town of Hackettstown, gravity system.

September 6 to 14, 1922—Boro of Sussex, gravity system.
September 15 to 26, 1922—Town of Newton, gravity system.
September 29 to October 11, 1922—Boro of Branchville, gravity system.
October 11 to 20, 1922—Butler Water Company, gravity system.
October 20 to 24, 1922—Boro of Haledon, gravity system.
October 26 to 31, 1922—Town of Hackettstown, gravity system.
November 2 to 7, 1922—Washington Water Company, gravity system.
November 10 to 17, 1922—Butler Water Company, gravity system.

INSPECTION OF WATERWORKS

The following water works were visited during 1922-23. Commonwealth Water Company, Summit; Cragmere Water Company, Mahwah; Elizabethtown Water Company, Elizabeth; Merchantville Water Company, Merchantville; Middlesex Water Company, Woodbridge; New Jersey Water Service Company, Haddonfield; Plainfield-Union Water Company, Plainfield; State Hospital, Trenton; private plant at Mantua owned by Job Scott, and municipal plants at Asbury Park, Atlantic City, Camden, East Orange, Gloucester, Moorestown, Perth Amboy, Ridgewood, Salem, Wenonah and Woodbury.

INSPECTION OF DAMS

Plans for seven dams were approved during the years 1922-23 as follows:
Righter dam near Denville: Plans for this dam were approved September 8, 1921, 4 inspections made. Oradell dam of the Hackensack Water Company: Plans for this dam not having been submitted to the Board before the work was begun, an investigation by a special board of engineers composed of William H. Burr, Arthur H. Pratt and the Hydraulic Engineer was made on November 21, 1921. After conferences the board of engineers recommended some additions and modifications to the plans, which were approved January 12, 1922, subject to the carrying out of these recommendations. Five inspections were made. Dam on Hohokus River for Boro of Waldwick, approved August 10, 1922. Elkinton Pond dam, City of Salem, approved April 12, 1923, 3 inspections made. Three dams on Wanaque River and tributaries for Ringwood Company, namely,—Ryerson Furnace dam, approved May 10, 1923, West Brook dam, approved May 10, 1923, Cupsaw Brook dam, approved June 14, 1923.

Inspections of dams under construction, permits for which had been previously issued, were made as follows: Chester Lake dam of the New Jersey Central Power Company on Black River, 9 inspections;

Fig. 9. Raritan water power dam on Raritan River. (p. 58)

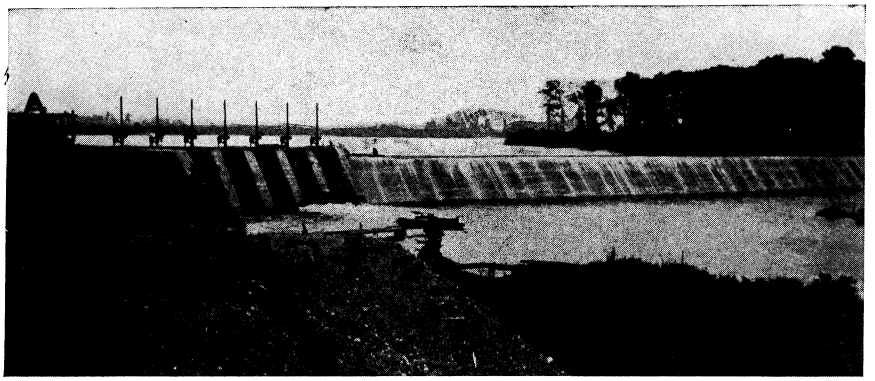

Fig. 10. Carnegie Lake dam on Millstone River near Kingston. (p. 58)

Fig. 11. Oradell dam on Hackensack River—water supply reservoir. (p. 58)

Wanaque dam at Midvale, 7 inspections. On November 14, 1922 the construction of the core wall up to the ground level was practically completed.

Echo Lake dam, Union County, was inspected June 30, 1922, at the request of the Union County Park Commission.

The dam of Milton F. Untermeyer, near Butler, was inspected twice at the request of the owner.

The Kennedy Electric Company dam above Long Valley, under repair by order of the Board, was inspected five times.

Wawayanda Lake dam in Sussex County was inspected at the request of the New York State Engineer, and special report submitted.

Examination to determine the stability and safety of existing dams was made by counties, as follows: Bergen 4; Burlington 3; Camden 3; Cumberland 2; Essex 12; Gloucester 4; Hunterdon 2; Mercer 11; Mercer-Burlington 1; Mercer-Middlesex 3; Mercer-Monmouth 1; Middlesex 1; Monmouth 8; Morris 13; Passaic 14; Passaic-Bergen 1; Salem 20; Salem-Gloucester 1; Somerset 15; Somerset-Morris 2; Somerset-Union 2; Sussex 13; Union 5; Warren 6. Total 147.

STREAM GAGING

United States Geological Survey:—In consequence of the appropriation made from the water supply fund by the Legislature of 1921 for water supply purposes, a cooperative agreement was made with the United States Geological Survey for reestablishing and maintaining the stream-gaging work which had been abandoned by both departments in 1914 due to lack of funds. Under this agreement, that bureau detailed Mr. O. W. Hartwell, District Engineer, to take charge of this work on July 1, 1921, under the general supervision of this Department. Mr. Otto Lauterhahn, Assistant Engineer, was also detailed from the Survey organization to work in New Jersey, and has met the requirements of the State Civil Service Commission. The Federal Bureau has provided funds for this work from which one-half the salary of the District Engineer and some other expenses are paid. They have also furnished special equipment for the work.

Work Reestablished.—At the close of the fiscal year 1920-21, the Department was maintaining only two stations, established for special studies. During the next two years 28 stations were established, and this Department cooperated in the operation of three other stations which had been established by outside parties, making a total of 33 stations being operated at the close of the fiscal year 1923. Of this total 17 stations are equipped with automatic recording gages. These instruments are installed to overcome trouble from daily fluctuation of

the stream, caused by artificial regulation of the water by mill operators, etc., and to overcome difficulty in getting competent gage readers at some of the remotely located stations.

The interest in this work throughout the State is reflected in the fact that 12 stations of the 33 have been constructed largely at the expense of cooperating parties, the Department maintaining and operating most of them. The following table gives a complete list of the stations being operated, type of gage and name of cooperating party:

LIST OF GAGING STATIONS

Stream	Location	Gage	Cooperating Party
Hackensack River	New Milford	Automatic	Hackensack Water Co.
Passaic River	Millington	Staff	
Passaic River	Paterson	*	*
Whippany River	Morristown	Staff	Dept. of Sts. & Sewers, City of Morristown
Rockaway River	Boonton	Automatic	Jersey City Water Department,
Pequannock River	Macopin	Automatic	Newark Water Department,
Wanaque River	Greenwood Lake	Staff	No. Jersey District Water Supply Comm.
Wanaque River	Wanaque	Automatic	No. Jersey District Water Supply Comm.
Ramapo River	Mahwah	Automatic	
Ramapo River	Pompton Lakes	Automatic	Boro of Pompton Lakes
Saddle River	Lodi	Automatic	
Elizabeth River	Elizabeth	Automatic	
Rahway River	Rahway	Staff	
Robinsons Branch, Rahway River	Goodmans	Staff	
Raritan River	Manville	Automatic	
South Branch, Raritan River	High Bridge	Automatic	Taylor-Wharton Iron and Steel Co.
South Branch, Raritan River	Stanton	Chain	
North Branch, Raritan	Far Hills	Hook	Somerset Lake and Game Club.
North Branch, Raritan	Milltown	Staff	
Black River	Pottersville	Automatic	
Millstone River	Blackwells Mill	Staff	
Green Brook	Bound Brook	Staff	
Lawrence River	Patricks Corner	Automatic	
Swimming River	Red Bank	Automatic	Tintern Manor Water Co.
Absecon Creek	Absecon	Automatic	Atlantic City Water Department.
Delaware River	Belvidere	Staff	
Delaware River	Riegelsville	Automatic	
Delaware River	Trenton	Chain	U. S. Weather Bureau.
Flat Brook	Flatbrookville	Staff	
Paulins Kill	Blairstown	Automatic	
Pequest River	Pequest	Staff	
Beaver Brook	Belvidere	Automatic	
Musconetcong River	Hackettstown	Automatic	
Musconetcong River	Bloomsbury	Automatic	Warren Manufacturing Co.
Assunpink Creek	Trenton	Automatic	
North Branch, Rancocas Creek	Pemberton	Staff	

*The flow of the Passaic River at Paterson has been determined by compilation of records furnished by the Society for Establishing Useful Manufactures, Newark Water Dept., Jersey City Water Dept., East Orange Water Department and Commonwealth Water Company.

Description of work.—Stream-gaging work consists primarily in keeping a continuous record of the flow of streams. Only a portion of the rainfall and snow finds its way into the surface stream. The relation beween the precipitation and surface runoff in the streams varies so widely with different conditions of topography, character of soil and underlying strata, forest cover, vegetation, temperature, wind movement, distribution of rainfall, etc., that direct measurement of the runoff is the only satisfactory way of determining its amount.

In selecting a gaging station on a stream the flow of which is to be recorded, the engineer looks for a place on the stream where the elevation or stage of the water for varying flows is regulated by a well-defined and permanent section of channel, called a "control." On some streams it is necessary to construct an artificial control, due to the shifting character of the stream bed. The stage of the water just above the control will then be an index of the amount flowing past the control. A gage is constructed so as to indicate the stage of the water just above the control and observations made which are called "gage heights." These gage heights are usually taken twice daily, morning and evening, throughout the year by a local observer. When the station has an automatic gage, it is only necessary for the observer to visit the station at intervals, usually one week, to attend the instrument and collect the record. The automatic gage makes a continuous graphic record of the gage height.

The flow of water past the control is measured, usually with a current meter, at a place where the flow is uniform and a suitable support for the current meter can be had. The engineer may work from a boat, bridge, cableway, by wading, or through holes chopped in the ice. Measurements of flow are obtained for different stages of water at the control and a diagram is then constructed which shows the relation between gage height at the control and the rate of flow or discharge. This stage-discharge diagram is then used to determine the daily discharge of the stream from the daily gage height read by the station observer or recorded by the automatic gage. In this way a continuous record of the flow can be obtained as long as the station is maintained.

Continuous records.—It is important that these records extend over a period of years. Records of 10 years are of considerable value, but in such a short period the maximum and minimum conditions of the flow may not occur. These extremes, as well as reliable averages, are needed before accurate studies of our water resources can be made.

Available data.—The stream gaging information collected by the United States Geological Survey is published in the Water Supply Papers by runoff years, ending September 30. These papers give the following information for each gaging station: description of station, list of discharge measurements, tables of daily and monthly discharge. There is necessarily some delay in getting this information into print. Therefore, the Survey and this Department are prepared to furnish data on file in their offices in blueprint form upon request from interested parties. In requesting this information, give name of stream, location, and character of information desired.

Records of stream flow in New Jersey may also be found in the following publications:

Geological Survey of New Jersey, Volume III, 1894.

Annual Reports of the State Water Supply Commission of New Jersey for 1908 and 1913.

Water Supply Papers of the United States Geological Survey, Nos. 97, 125, 166, 202, 241, 261, 281, 301, 321, 351, 381, 401, 431, 451, 471, 501, 521, 541, 561.

Description of stations.—In the following descriptions of the Stations in operation it is believed sufficient detail has been given to describe the information available and accuracy of the work done.

HACKENSACK RIVER AT NEW MILFORD.

Location.—At pumping plant of Hackensack Water Company, New Milford, Bergen County, about 3½ miles below mouth of Dwar's Kill.
Drainage Area.—115 square miles.
Records Available.—October 28, 1921 to date.
Determination of Discharge.—Water arriving at this station will pass on through one of the following channels, diversion to pumping station, flow over two spillways, flow thru or over sluice gates near intake. Discharge is determined for each of these channels.
Gages.—Venturi meter in pipe-line indicating amount of water diverted from stream. An automatic recorder on the intake pond indicates the head on the two spillways and the sluice gates.
Discharge Measurements.—Made from highway bridge at Oradell ½ mile upstream.
Regulation.—Flow of river is regulated at the storage dam of the Hackensack Water Company at Oradell, 1 mile upstream.
Cooperation.—Gages read by an employee of the Hackensack Water Company.

PASSAIC RIVER NEAR MILLINGTON.

Location.—At highway bridge known as Davis Bridge 1 mile above Millington, Somerset County, about 1½ miles below mouth of Black Brook. About ¾ mile above gaging station formerly maintained at Millington.
Drainage Area.—55 square miles.
Records Available.—November 10, 1921 to date. At Millington ¾ mile downstream, November 25, 1903 to July 15, 1906.
Gage.—Inclined staff gage on right bank about 400 feet below Davis Bridge, moved 100 feet upstream in October 1923.
Discharge Measurements.—Made from bridge or by wading near gage.
Channel and Control.—Channel coarse gravel and rock; control is narrow section in channel and rocky riffle just below, about 100 feet below gage.
In October, 1923 a concrete control was built about 300 feet below the bridge.
Ice.—Stage discharge relation probably affected by ice.

PASSAIC RIVER AT PATERSON.

Location.—At Hydro-electric Power Plant of the Society for Establishing Useful Manufactures in Paterson, Passaic County.
Drainage Area.—785 square miles.
Records Available.—1898 to date.
Determination of Discharge.—Actual flow at Paterson determined by engineers of the Society for Establishing Useful Manufactures. This consists of discharge over spillway computed from a theoretic formula, discharge through the turbines determined from the manufacturers' ratings, discharge through the Dyers' pipe-line, metered, and the discharge through the old race measured twice daily by current meter.
Diversions.—Water is diverted from the Passaic River above Paterson by the Newark Water Works, Jersey City Water Works, Commonwealth Water Company, East Orange Water Works, and the Morris Canal. Diversion by Newark and Jersey City measured by Venturi meter; diversion by Commonwealth Water Company and East Orange Water Works measured by piston displacement; diversion by Morris Canal estimated.
Regulation.—Correction has been made for storage in the Newark and Jersey City storage reservoirs and in Greenwood Lake, which is a storage reservoir for the Morris Canal. No correction has been made for evaporation of the surface of the various reservoirs, which comprises about 1 per cent of the total drainage area.
Cooperation.—Records furnished for compilation by the Society for Establishing Useful Manufactures, Newark Water Department, Jersey City Water Department, Commonwealth Water Company and East Orange Water Department.

WHIPPANY RIVER AT MORRISTOWN.

Location.—At Morristown Sewage Disposal Plant about ¾ mile below center of Morristown, Morris County, and 8 miles above the mouth.
Drainage Area.—29 square miles.
Records Available.—August 26, 1921 to date.
Gage.—Vertical staff on left bank about 150 feet above Chlorination House of Sewage Disposal Plant.
Discharge Measurements.—Made by wading near gage.
Channel and Control.—Channel, sand and fine gravel; control, head of riffle about 50 feet below gage. Right bank overflows at very high stages.
Cooperation.—Gage read by an employee of the Commissioner of Sewers, City of Morristown.

ROCKAWAY AT BOONTON.

Location.—At dam of the Jersey City Water Works at Boonton, Morris County.
Drainage Area.—119 square miles.
Records Available.—January 1, 1906, to date.
Gages.—Elevation of water surface in reservoir determined by measuring from a reference point on the dam to the water surface with a graduated rod. Read once daily by an employee of the Jersey City Water Works.
Automatic water-stage recorder on left bank about ¼ of a mile below dam. Operated by an employee of the Jersey City Water Works.
Determination of Discharge.—Discharge over dam. January 1, 1906 to March 18, 1918 determined from elevation of water surface in the reservoir and rating curve for spillway. Discharge March 3, 1918 to date determined at gaging station.
Discharge Measurements.—For gaging station made by wading near water-stage recorder.
Channel and Control.—For gaging station coarse gravel, probably permanent.
Regulation.—Records are corrected for storage above the dam.
Diversion.—Water diverted to Jersey City through pipe line measured by Venturi meter. Records corrected for this diversion.
Cooperation.—Gage height records and records of diversion furnished by the Bureau of Water, Department of Streets and Public Improvements, Jersey City, N. J.

PEQUANNOCK RIVER AT MACOPIN INTAKE DAM.

Location.—At Macopin Intake dam of the Newark Water Works about 3 miles above Butler, Morris County.
Drainage Area.—63.7 square miles. In September 1911, a small brook was permanently diverted into the Pequannock basin increasing the drainage area from 62.7 square miles to 63.7 square miles.
Records Available.—January 1, 1892, to date.
Gage.—Head on spillway at dam indicated by water-stage recorder in gate house. Water diverted measured by Venturi meter. Elevation of water surface in various storage reservoirs indicated by staff gages.
Determination of Discharge.—Rating for spillway of intake dam determined by constructing weir at head of pond and making a series of simultaneous observations of head on weir and dam. Discharge determined in millions of gallons per week. In converting discharge to monthly units, the diversion of overlapping weeks was made after a graphic comparison with the temperature and precipitation records.
Diversions.—Water diverted from the stream at intake dam only. Diversion included in the records. No correction made for evaporation from reservoirs.
Regulation.—Flow above the dam regulated by several reservoirs. These records corrected for such regulation.
Cooperation.—Monthly discharge computed from records furnished by the Department of Streets and Public Improvements, City of Newark.

WANAQUE RIVER AT GREENWOOD LAKE.

Location.—Just below the dam at the outlet of Greenwood Lake, at The Glens, Passaic County.
Drainage Area.—27 square miles.
Records Available.—May 13, 1919 to date.
Gage.—Vertical staff on left bank about 600 feet below the dam.
Discharge Measurements.—Made by wading at or near the gage.
Channel and Control.—Coarse gravel and boulders. Control is riffle of small boulders about 200 feet below gage, probably permanent.

Ice.—Stage discharge relation probably not affected by ice.
Regulation.—Flow regulated by operation of sluice gates at the outlet of the Lake, which is a storage reservoir of the Morris Canal.
Cooperation.—Gage heights observed under direction of the North Jersey District Water Supply Commission, and furnished by that Commission for publication.

WANAQUE RIVER AT WANAQUE.

Location.—Near the Erie Railroad bridge in Wanaque, Passaic County.
Drainage Area.—91 square miles.
Records Available.—December 16, 1903 to December 31, 1905; May 1, 1912 to May 1, 1915 and from May 13, 1919 to date.
Gages.—Chain gage on upstream side of highway bridge 300 feet above the railroad bridge, used 1903 to 1905. Vertical staff gage on left bank 100 feet above railroad bridge used May 1, 1912 to March 9, 1922. Automatic water stage recorder on left bank 100 feet below railroad bridge, March 10, 1922 to date. All three gages at different datums.
Discharge Measurements.—Made from highway bridge or by wading 150 feet below gage.
Channel and Control.—Sand and fine gravel. Control is gravel riffle about 50 feet below gage.
Regulation.—Flow regulated by operation of sluice gates at Greenwood Lake about 11 miles upstream. See gaging station on Wanaque River at Greenwood Lake.
Cooperation.—Gage installed and read by North Jersey District Water Supply Commission; record furnished for publication by that Commission.

RAMAPO RIVER NEAR MAHWAH.

Location.—At concrete highway bridge 1 mile west of Mahwah, Bergen County, about ¾ mile below mouth of Mahwah River.
Drainage Area.—118 square miles.
Records Available.—February 10, 1903 to July 31, 1914 and from September 1, 1922 to date.
Gage.—Chain gage on down stream side of bridge used 1903 to 1914. Automatic water stage recorder on right bank just below bridge, September 1, 1922 to date.
Discharge Measurements.—Made from bridge or by wading 150 feet downstream.
Channel and Control.—Coarse gravel; control is gravel riffle 150 feet below bridge, probably permanent.
Regulation.—Daily distribution of flow affected by water powers at points upstream.

RAMAPO RIVER AT POMPTON LAKES.

Location.—At Municipal Hydro-electric plant in the boro of Pompton Lakes, Passaic County, 1½ miles above the mouth of Ramapo River.
Drainage Area.—160 square miles.
Records Available.—September 1921, to date.
Determination of Discharge.—Flow at this station determined by computing the discharge over the spillway and through each of two turbines.
Gages.—Head on the spillway is indicated by an automatic water stage recorder at right end of dam. An automatic gage is located in the tail race about 30 feet below the draft tubes of the turbines. This gage together with the automatic recorder above the dam indicates the head on the turbines.

Wicket-gate opening for each turbine is recorded hourly from indicators on the turbine governors.

Discharge Measurements.—Made from temporary foot bridge over tail race and from cable about 300 feet below dam.
Regulation.—Record indicates flow as released by power plant.
Cooperation.—The Boro of Pompton Lakes has provided the shelter for the water stage recorder, furnishes the power plant records for computation of discharge, and has the gages read by the power house operators.

SADDLE RIVER NEAR LODI.

Location.—At highway bridge about 1 mile above center of Lodi, Bergen County, and 2 miles above mouth.
Drainage Area.—55 square miles.
Records Available.—September 20, 1923 to date.
Gage.—Automatic recorder on left bank just above bridge.
Discharge Measurements.—Made from downstream side of bridge or by wading.
Channel and Control.—Banks low, overflow at extreme stages. Bed of coarse gravel. Control is riffle of coarse gravel and small boulders about 100 feet below bridge.
Regulation.—Daily distribution of flow affected by small water powers upstream.

ELIZABETH RIVER AT ELIZABETH.

Location.—Just above the Westfield Avenue bridge in Elizabeth, Union County, and about 2½ miles above the mouth.
Drainage Area.—20 square miles.
Records Available.—October 5, 1921 to date.
Gages.—Automatic recorder on left bank 20 feet above dam, 75 feet above Westfield Avenue bridge.
Discharge Measurements.—Made by wading just below bridge.
Control.—Concrete dam with crest 48.5 feet long at gage height elevation 5.00 feet. A sluice gate through the dam is occasionally used.
Diversions.—The Elizabethtown Water Company diverts water from the Elizabeth River above this point, at the Ursina Lake Pumping Station and through wells at its Hummock Station.

RAHWAY RIVER AT RAHWAY.

Location.—At Church Street bridge in Rahway, Union County, ½ mile above the mouth of Robinsons Branch of Rahway River.
Drainage Area.—41 square miles.
Records Available.—July 10, 1908 to April 29, 1915; and October 1, 1921 to date.
Gage.—Vertical staff gage attached to tree on right bank about 30 feet below bridge.
Discharge Measurements.—Made by wading.
Channel and Control.—Channel is fine gravel; control, head of riffle about 300 feet below gage.
Diversions.—The following water companies divert water from Rahway River above Rahway: Orange Water Co.; South Orange Water Works (wells); Short Hills Water Co. (wells); Springfield Station of Elizabethtown Water Co. (wells); and Rahway Water Works. The total flow diverted is about 15 second-feet.

ROBINSONS BRANCH RAHWAY RIVER AT GOODMANS.

Location.—At Goodmans railroad station on Lehigh Valley Railroad, 2¾ miles above the dam and pumping station of the Middlesex Water Company near Rahway, Union County, and 4½ miles above the mouth of the stream.
Drainage Area.—12.7 square miles.

Fig. 12.

Fig. 13.

Fig. 12. Stream gaging station on So. Branch Raritan River near High Bridge. (p. 67)

Fig. 13. Stream gaging station on Beaver Brook near Belvidere, showing staff gages and shelter house for automatic gage. (p. 72)

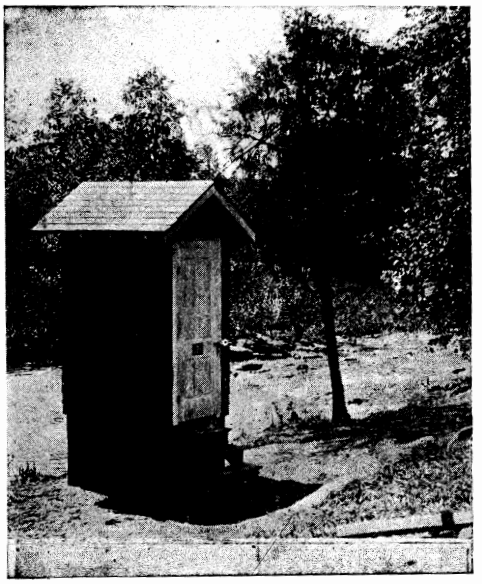

Fig. 14.

Fig. 14. Stream gaging station on Beaver Brook near Belvidere. showing shelter house and "control." (p. 72)

Records Available.—October 27, 1921 to date.
Gage.—Vertical staff attached to tree on right bank about 100 feet below highway bridge at Goodmans station.
Discharge Measurements.—Made by wading.
Channel and Control.—Channel, fine gravel, banks high. Control, riffle of rocks, probably artificial, about 50 feet below gage, submerged during high water and occasionally blocked by leaves and small debris.

RARITAN RIVER AT MANVILLE.

Location.—At highway bridge between Manville and Finderne, Somerset County, and about 1¼ miles above mouth of Millstone River and 4½ miles below confluence of north and south branches of Raritan River. Station formerly named Finderne.
Drainage Area.—490 square miles.
Records Available.—June 27, 1903, to March 31, 1907; August 10, 1908 to April 30, 1915; and from August 19, 1921 to date.
Gage.—Chain gage at downstream side of left span 30 feet from center pier. Automatic recorder installed on left bank August, 1923. Gages at same datum as gage used for former Finderne record.
Discharge Measurements.—Made from downstream side of bridge or by wading at same section.
Channel and Control.—Red sandstone on left side; sand and gravel on right side, fairly permanent, affected by vegetable growth during summer months. Banks overflow at very high stages.
Diversions.—The Johns-Manville Company diverts about 2 second-feet from the Raritan at a point about ¼ mile above the gage.
Regulation.—Distribution of flow affected by water powers at Somerville and other points upstream.

SOUTH BRANCH RARITAN RIVER NEAR HIGH BRIDGE.

Location.—1 mile above High Bridge, Hunterdon County, and 4 miles above mouth of Spruce Run.
Drainage Area.—64 square miles.
Records Available.—February 24, 1919, to date.
Gage.—Reference stake 2 inches square driven into bed of stream on left bank near large pine tree 1 mile above High Bridge. Automatic water stage recorder installed just above pine tree, September 30, 1921.
Discharge Measurements.—Made by wading near gage for low stages and at highway bridge one-third mile upstream for high stages.
Channel and Control.—Channel very rough with many boulders. Control is well defined riffle of rock and boulders about 100 feet below gage. Permanent.
Ice.—Stage discharge relation affected by ice during extremely cold periods.
Regulation.—Daily distribution of flow affected by small water powers at points upstream.
Cooperation.—Gage read and water stage recorder inspected by an engineer of the Taylor-Wharton Iron and Steel Company.

SOUTH BRANCH RARITAN RIVER AT STANTON.

Location.—At highway bridge near Lehigh Valley Railroad station in Stanton, Hunterdon County, ½ mile above mouth of Prescott Brook and 5 miles below mouth of Cakepoulin Creek.
Drainage Area.—158 square miles.
Records Available.—July 2, 1903 to December 31, 1906; and from July 1, 1919 to date.
Gage.—Chain gage on downstream side of bridge near left end.

Discharge Measurements.—Made from downstream side of bridge or by wading.
Channel and Control.—Gravel bed and banks. Banks overflow at high stages. Control is slight riffle about 100 feet below bridge.
Ice.—Stage discharge relation affected by ice.
Regulation.—Distribution of flow slightly affected by small water powers at points upstream.

NORTH BRANCH RARITAN RIVER AT FAR HILLS.

Location.—At the dam of the Somerset Lake and Game Club 2 miles north of Far Hills, Somerset County, and 2 miles above the mouth of Peapack Brook.
Drainage Area.—26 square miles.
Records Available.—February 15, 1922 to date.
Gage.—Hook gage in stilling box at left end of dam.
Discharge Measurements.—Made by wading about 200 feet below dam.
Control.—Masonry dam with flat crest having low water notch 26 feet long with crest at elevation of gage height 1.696 feet. Remainder of spillway 137 feet long with crest at elevation of gage height 2.204 feet.
Cooperation.—Gage read by game warden of Somerset Lake and Game Club.

NORTH BRANCH OF RARITAN RIVER AT MILLTOWN.

Location.—At Milltown, Somerset County, 1½ miles above junction of North and South Branches of Raritan River.
Drainage Area.—190 square miles.
Records Available.—June 14, 1923 to date.
Gage.—Inclined staff gage on right bank 300 feet above highway bridge at Milltown.
Discharge Measurements.—Made from downstream side of highway bridge or by wading.
Channel and Control.—Channel, clay and fine gravel. Control is remains of foundation of an old dam.
Regulation.—Probably some slight diurnal fluctuation due to small water powers upstream.

BLACK RIVER NEAR POTTERSVILLE.

Location.—One mile above highway bridge and former gaging station at Pottersville, Somerset County.
Drainage Area.—33 square miles.
Records Available.—June 27, 1922 to date.
Gage.—Automatic water stage recorder on right bank 1 mile above bridge at Pottersville.
Discharge Measurements.—Made by wading 100 feet above gage.
Channel and Control.—Gravel and boulders, very rough. Control is riffle of boulders just below gage. Probably permanent.
Regulation.—Daily fluctuations caused by operation of small mills upstream.

BLACK RIVER AT POTTERSVILLE.

Location.—At highway bridge in Pottersville, Somerset County, 7 miles above mouth of Rockaway Creek.
Drainage Area.—33 square miles.
Records Available.—November 8, 1921 to June 30, 1922, when the station was relocated 1 mile upstream. See records for Black River near Pottersville.
Gage.—Chain gage on downstream side of highway bridge.

Discharge Measurements.—Made from bridge or by wading.
Channel and Control.—Channel, sand and gravel; control is at head of slight riffle about 150 feet below gage. Not permanent. Right bank overflows at very high stages.
Ice.—Stage-discharge relation affected by ice.
Regulation and Storage.—Distribution of flow may be slightly affected by a small water power about ¼ mile above the bridge and by a dam now under construction about 5 miles upstream.

MILLSTONE RIVER AT BLACKWELLS MILLS.

Location.—At highway bridge in village of Blackwells Mills, Somerset County, ¼ mile below mouth of Middlebush Brook, 1¾ miles above the village of Millstone, and 5 miles above mouth of Millstone River.
Drainage Area.—258 square miles.
Records Available.—August 4, 1921, to date. A station was maintained at Millstone 1¾ miles downstream from June 28, 1903 to December 31, 1904; and from June 7, 1912 to April 30, 1915.
Gage.—Vertical staff in two sections on downstream side of left bridge abutment.
Discharge Measurements.—Made by wading about 200 feet downstream from gage or from highway bridge at Millstone.
Channel and Control.—Channel, clay banks overflowing at high stages; control is foundation of old stone and timber dam 100 feet downstream from gage.
Diversions.—The Delaware and Raritan Canal takes water from the Delaware River and flows in a northeasterly direction to the Raritan River. It passes along the right bank of the Millstone river for 15 miles above the gaging station and for 5 miles below. The canal is above the river at all points and loses water to the river by leakage, seepage and by discharge from spillways.
Regulation.—Several small mills above the gage and Carnegie Lake slightly affect distribution of flow.

GREEN BROOK AT BOUND BROOK.

Location.—Near state highway bridge at Bound Brook, Middlesex County, one-half mile above mouth.
Drainage Area.—49 square miles.
Records Available.—June 12, 1923 to date.
Gage.—Vertical staff fastened to willow tree on left bank 300 feet below bridge.
Discharge Measurements.—Made by wading near gage or from the bridge.
Channel and Control.—Channel,—sand and fine gravel. Control is riffle of gravel 200 feet below gage. Possibly not permanent. Control affected by growth of grass during summer months.
Diversions and Regulation.—Green Brook receives the sewage of Plainfield about 3 miles upstream. A well field of the Elizabethtown Water Company, Consolidated, is located along the stream just above the station; also well fields of Middlesex Water Company supply water without the drainage area.

LAWRENCE BROOK AT PATRICKS CORNER.

Location.—Near highway bridge at Patricks Corner, Middlesex County, 3 miles southwest of Milltown, ⅞ of a mile above Beaver Brook Dam and 6¼ miles above the mouth of Lawrence Brook.
Drainage Area.—29 square miles.
Records Available.—June 21, 1922 to date.

Gage.—Gurley 7-day automatic water stage recorder installed in wooden shelter on right bank about 150 feet above highway bridge. Inclined gage at shelter and highwater staff gage attached to shelter.
Discharge Measurements.—Made by wading near gage for low and medium stages and from highway bridge for high stages.
Channel and Control.—Sill of old wooden dam. Both banks low and overflow about 25 feet on both sides.
Regulation and Storage.—Distribution of flow affected by water power above the station.

SWIMMING RIVER NEAR RED BANK.

Location.—At dam of Tintern Manor Water Company, 3 miles above the mouth of Swimming River at Red Bank, Monmouth County.
Drainage Area.—47.7 square miles.
Records Available.—July 27, 1922 to date.
Gage.—Automatic water-stage register on right bank 100 feet above end of dam.
Discharge Measurements.—Made by wading on crest of dam.
Control.—Dam of stone and concrete, with spillway 147.2 feet long. In cross section the dam has a flat top 7 feet wide with downstream edge 1 foot higher then upstream edge.
Diversions.—Water diverted from dam to Newman Springs Pumping Station of the Tintern Manor Water Company. Diversion measured by piston displacement method.
Cooperation.—Station maintained in cooperation with the Tintern Manor Water Company.

DELAWARE RIVER AT BELVIDERE.

Location.—At Belvidere, Warren County, just below mouth of Pequest River.
Drainage Area.—4540 square miles.
Records Available.—October 27, 1922 to date.
Gage.—Inclined staff gage on left bank bolted to downstream side of storm sewer outlet at foot of Second Street, Belvidere.
Discharge Measurements.—Made by boat 1000 feet below gage for low water and from highway bridge ½ mile upstream during high water. Pequest River measured separately when highway bridge is used.
Channel and Control.—Control is heavy gravel and boulders. Control, ledge and boulders about ¾ mile below gage known as Little Foul Rift.

ABSECON CREEK NEAR ABSECON.

Location.—At reservoir dam of Atlantic City Water Department about 1 mile northwest of Absecon, Atlantic County, and 2 miles above mouth.
Drainage Area.—17 square miles.
Records Available.—December 1, 1923 to date.
Determination of Discharge.—Discharge is determined by adding the amount of water diverted to the pumping station, the amount wasted over the spillway or through two 30-inch circular sluice gates, and a correction for gain or loss in storage in the reservoir. Amount diverted measured by observing loss of head in 42-inch wood stave pipe line from dam to pumping station. Amount wasted measured by weir about 50 feet below dam. Weir is of 2-inch lumber about 2½ feet high and 49 feet long.
Gages.—Loss of head in pipe line determined by two automatic water stage registers 9383 feet apart on the 42-inch pipe line. The upper gage is set over a 12-inch float well in the dam tender's shanty 100 feet below

the dam. The lower gage is set over a 12-inch float well in a small pump house about 500 feet north of the pumping station. There are no valves, gates or changes in size of pipe between the recorders.

Head on weir measured by an automatic water stage recorder just above the right end of the weir.

Discharge Measurements.—Flow through pipe line for various losses of head was determined by diverting this flow into a waste channel and measuring the discharge by current meter. Rating of weir is to be tested by current meter discharge measurements from highway bridge just below the weir.

Cooperation.—Station established and maintained in cooperation with the Atlantic City Water Department.

DELAWARE RIVER AT RIEGELSVILLE.

Location.—At suspension bridge between Riegelsville, Warren County, New Jersey, and Riegelsville, Bucks County, Pennsylvania, 600 feet above Musconetcong River and 9 miles below Lehigh River.

Drainage Area.—6,430 square miles.

Records Available.—July 3, 1906 to date.

Gages.—Inclined staff installed November 14, 1914, on left bank (New Jersey side) at upstream side of bridge; prior to November 14, 1914, chain gage attached to upstream side of bridge. Automatic recorder installed on left bank just above bridge in February 1924.

Discharge Measurements.—Made from bridge.

Channel and Control.—Large boulders; practically permanent.

Ice.—Stage discharge relation affected by ice during severe winters only.

Diversions.—The Delaware division of the Pennsylvania Canal diverts about 230 second-feet from Lehigh River near its mouth from about the last of March to the middle of December each year.

DELAWARE RIVER AT TRENTON.

Location.—At Calhoun Street bridge, Trenton, Mercer County, and ½ mile above mouth of Assunpink Creek.

Drainage Area.—7,040 square miles.

Records Available.—February 24, 1913 to date.

Gage.—Chain gage on downstream side of bridge about 100 feet from left abutment.

Discharge Measurements.—Made from upstream side of bridge.

Channel and Control.—Channel coarse gravel and boulders. Control is at ledge which outcrops about 400 feet below bridge.

Ice.—Stage discharge relation affected by ice during winter.

Diversions.—The Delaware division of the Pennsylvania Canal diverts about 20 second-feet from Lehigh River from about the last of March to the middle of December each year. All but about 50 second-feet of this water has been wasted back into the Delaware River above Trenton.

The Delaware and Raritan feeder canal diverts about 160 second-feet from the first of March to the last of December each year.

The Trenton Power canal diverts about 210 second-feet around the gage daily.

Cooperation.—Gage readings furnished by United States Weather Bureau.

FLAT BROOK NEAR FLATBROOKVILLE.

Location.—At farm of E. S. Aker 1 mile above Flatbrookville, Sussex County, and 1½ miles above mouth.

Drainage Area.—65 square miles.

Records Available.—July 8, 1923 to date.

Gage.—Inclined staff gage on right bank opposite farm house of E. S. Aker.
Discharge Measurements.—Made by wading.
Channel and Control.—Channel fine to coarse gravel. Control is bar of heavy gravel about 50 feet below gage.
Ice.—Stage discharge relation affected by ice.

PAULINS KILL AT BLAIRSTOWN

Location.—At highway bridge in Blairstown, Warren County, 200 feet above mouth of Blairs Creek and about 9 miles above mouth of Paulins Kill.
Drainage Area.—128 square miles.
Records Available.—October 19, 1921 to date.
Gage.—Automatic water stage recorder in wooden shelter on left bank just above highway bridge. Auxiliary chain gage on upstream side of highway bridge.
Discharge Measurements.—Made from bridge or by wading above bridge.
Channel and Control.—Sand and gravel.
Regulation and Storage.—Distribution of flow affected by water power above the station.

PEQUEST RIVER AT PEQUEST

Location.—At Pequest Station, Warren County, on Lehigh and Hudson River Railroad, 100 feet above railroad bridge, 300 feet below mouth of Furnace Brook and 6¾ miles above mouth of Pequest River.
Drainage Area.—108 square miles.
Records Available.—November 7th, 1921 to date.
Gage.—Vertical staff gage attached to face of former bridge abutment on right bank 100 feet above railroad bridge.
Discharge Measurements.—Made by wading or from foot-bridge 15 feet above gage.
Channel and Control.—Channel, fine gravel; control, riffle of large stones probably remains of old diversion dam about 50 feet below the gage.
Ice.—Stage discharge relation affected by ice during severe winters only.

BEAVER BROOK NEAR BELVIDERE.

Location.—About 500 feet above mouth of stream in Pequest River 2 miles east of Belvidere, Warren County.
Drainage Area.—36 square miles.
Records Available.—May 22, 1922 to date.
Gage.—Automatic water stage recorder on right bank 500 feet above mouth of brook.
Discharge Measurements.—Made by wading at various points or from highway bridge ¼ mile above gage.
Channel and Control.—Gravel and ledge. Control is solid rock outcrop 25 feet below gage, improved by having rough cavities filled with concrete. Permanent.
Regulation.—Daily distribution of flow often irregular because of operation of small grist mills some distance upstream.

MUSCONETCONG NEAR HACKETTSTOWN.

Location.—About 500 feet above Delaware, Lackawanna and Western Railroad bridge, ½ mile below Saxton Falls dam of Morris Canal and about 3 miles above Hackettston, Warren County.
Drainage Area.—70 square miles.
Records Available.—September 24, 1921 to date.
Gage.—Automatic recorder on left bank about 500 feet above Delaware, Lackawanna and Western Railroad bridge.

Discharge Measurements.—Made from railroad bridge or by wading.
Channel and Control.—Coarse gravel, probably permanent.
Ice.—Stage discharge relation affected by ice.
Diversions.—Lake Hopatcong, about 9 miles above this station, is the source of supply for the Morris Canal. There is a complex interchange of water between the canal and the river from the lake down to the Saxton Falls dam, where the canal finally leaves the river and flows westerly to Delaware River at Phillipsburg. The canal also flows easterly to Wharton and thence down the Passaic Valley to Newark. The record at this station represents the amount of water left in the Musconetcong River by the Morris Canal.
Regulation.—Distribution of flow is affected by operation of Morris Canal. (See Diversions)

MUSCONETCONG RIVER NEAR BLOOMSBURY

Location.—At highway bridge 1½ miles above Bloomsbury, Hunterdon County, and 9 miles above the mouth.
Drainage Area.—143 square miles.
Records Available.—July 4, 1903, to March 31, 1907; and from July 26, 1921 to date.
Gage.—Automatic recorder in concrete shelter on right bank just below the bridge. Auxiliary vertical staff gage in downstream side of right bridge abutment. Not at same datum as gage used 1903 to 1907.
Discharge Measurements.—Made from downstream side of bridge or by wading.
Channel and Control.—Channel, gravel. Control, gravel riffle about 150 feet below gage. Banks overflow at high stages.
Ice.—Stage discharge relation probably affected by ice during extreme periods.
Diversions.—Lake Hopatcong at the head of the Musconetcong River is the source of supply for the Morris Canal. Through this canal water passes westward to Delaware River at Phillipsburg and eastward down the Passaic Valley to Newark. Water left in the Musconetcong by the canal is measured by the gaging station near Hackettstown.
Regulation.—Distribution of flow affected by several small water powers above the station.

ASSUNPINK CREEK AT TRENTON.

Location.—At Chambers Street bridge in Trenton, Mercer County 1½ miles above mouth.
Drainage Area.—89 square miles.
Records Available.—July 5, 1923 to date.
Gage.—Automatic recorder on left bank about 50 feet above Chambers Street bridge.
Discharge Measurements.—Made by wading or from downstrean side of Monmouth Street bridge 400 feet below gage.
Channel and Control.—Channel sand and gravel. Control is bar of gravel and large stone placed 40 feet below gage.
Regulation.—Large fluctuations in flow at low stages due to water powers upstream.
Ice.—Stage discharge relation not affected by ice because of use of water for condensing at steam power plant just above gage.

NORTH BRANCH RANCOCAS CREEK AT PEMBERTON.

Location.—Near highway bridge at Pemberton, Burlington County, about 11 miles above confluence with South Branch.
Drainage Area.—Not measured.
Records Available.—September 15, 1921 to date.

Gage.—Automatic recorder on left bank about 800 feet downstream from highway bridge.
Discharge Measurements.—Made by wading near gage.
Channel and Control.—Sand, shifting. Banks overflow at high stages.
Regulation.—Distribution of flow affected by small power plants at Pemberton and Browns Mills.

SPECIAL WATER SUPPLY INVESTIGATION

In the previous annual report reference was made to the engagement of the firm of Hazen, Whipple and Fuller, Civil Engineers, New York City, to investigate the future water supply needs of the North Jersey Metropolitan District, and how those needs could best be met.

This investigation was made during the fall and winter of 1921 under the direction of Mr. Allen Hazen, who spent considerable time personally on the work. Mr. Malcolm Pirnie of the firm of Hazen, Whipple and Fuller devoted his time largely to collecting the field data and to studies, and several assistants from the firm's force aided in the work.

This Department cooperated in the work by assisting in field inspection and supplying data on file in the office. The officials of many of the water works systems operating in the Metropolitan District gave cordial cooperation in connection with the work.

The report was written by Mr. Hazen and dated January 28, 1922. Three thousand copies of the report were printed and circulated widely throughout the State and among other interested parties. Some copies are still available for distribution.

The report states that scarcely a state in the Union is so favorably situated for providing the water supply of a great Metropolitan District both in regard to quality and accessibility of the water that can be provided. Also that if there were a market for ten times the quantity of water now sold, it could be provided at reasonable rates. The value of these splendid water resources of the State can be realized only by use. On the other hand, if they are not developed and used, unsurmountable obstacles to their development may be found at some future time, due to the use of necessary sites for other purposes. The repc suggests that it may be possible for New Jersey, through some approved instrumentality, to acquire and develop and find some temporary use for water from these magnificent supplies so as to hold them more certainly for use when finally needed. To realize the possibility in these great resources there must be strong, courageous, far-seeing and competent management.

Four possible projects for developing these water resources have been studied, their yields calculated and the cost of their development estimated. Three of these are in North Jersey. With their complete

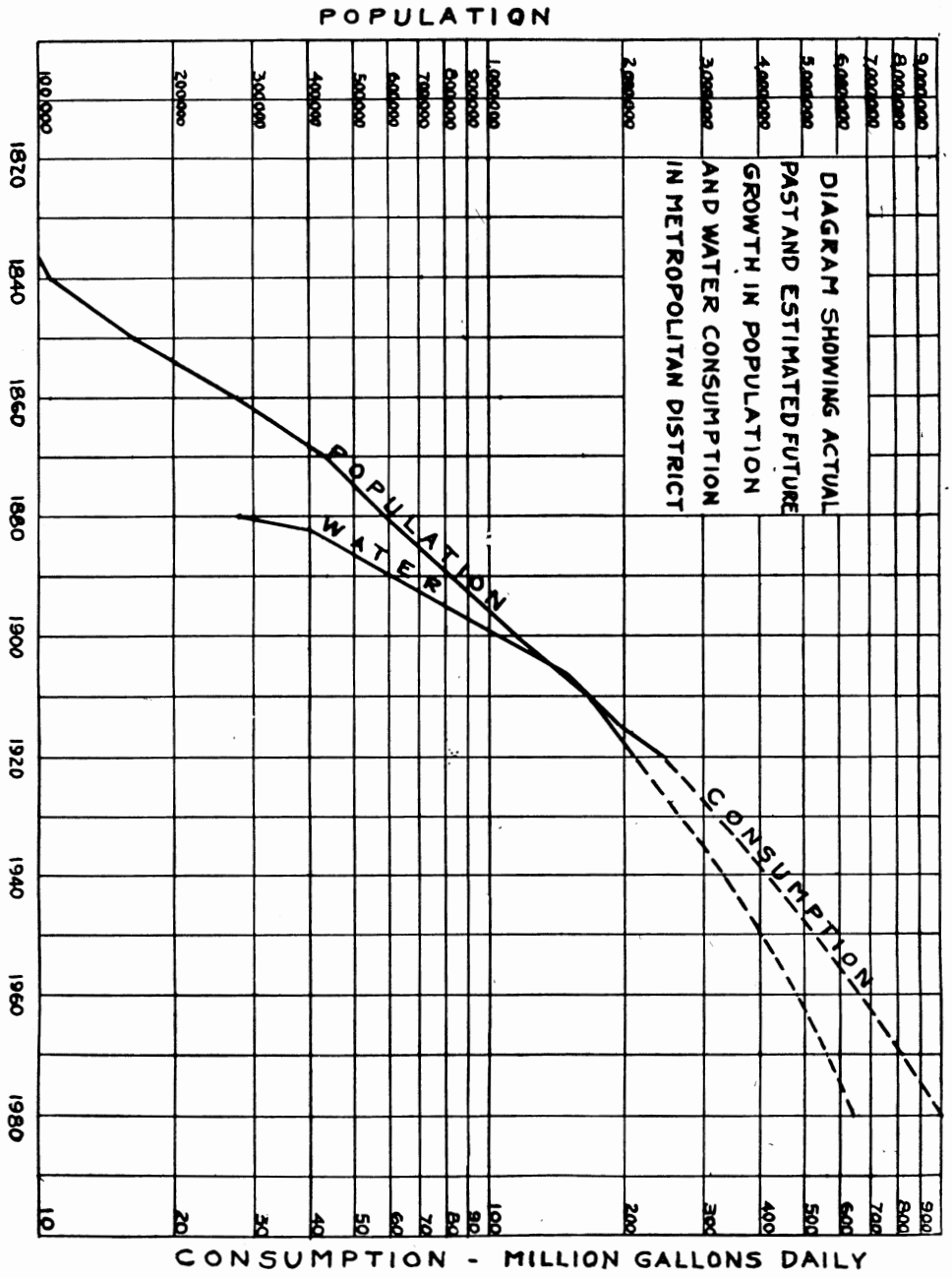

Fig. 15. Diagram showing actual past and estimated future growth in population and water consumption in metropolitan district. (p. 57)

development nearly twice the estimated consumption in 1970 can be provided, and by including the use of the flood flows from the Delaware River, over three times the estimated consumption in 1970 will be available.

The present supplies of the Metropolitan District are derived from 33 separate systems serving over two million people with 244 million gallons daily in 1920. The safe capacity of the 33 systems combined and pooled is only 268 million gallons daily, a margin of only 10 per cent. It is estimated that the population of this district in 1930 will be 2,650,000 requiring 315 million gallons daily; in 1950 the population will be 4,000,000, requiring 520 million gallons daily, and in 1970 the population will be 5,600,000, requiring 820 million gallons daily.

Of the four projects studied, the Long Hill system has a great advantage over the others in that it can be built by successive steps as the need for more water arises.

The Long Hill System consists essentially of a large storage reservoir created by a dam in the gorge at Millington, the outlet of the Great Swamp of the Upper Passaic River. The water stored in this reservoir could be delivered by gravity to practically the entire Metropolitan District by a pressure tunnel 19 miles long under Newark and Jersey City and distributed by lateral pipe lines. To fill this reservoir it is planned to drive short gravity tunnels, which will take successively the North Branch of the Raritan River, Black River, the South Branch of the Raritan, the Musconetcong, Pequest, Paulins Kill and Flat Brook, and if desirable, the Upper Delaware. The estimated cost of this plan for ultimate development is also the lowest of the four projects, and will require considerably less capital expenditure to start. It will provide an ultimate capacity of 750 million gallons daily at a cost of $173,000 per million gallons. This is only 58 per cent of the cost of the Catskill System for New York City, similar features being compared.

Any of these projects is too great to be solved by any single municipality. The solution is to get cooperation or something to take its place. Voluntary cooperation is difficult to obtain, particularly with respect to a need that is not imminent. And yet to delay initiating a comprehensive plan for the entire district until portions of it are in the grasp of a water famine, is to invite precipitate and probably unwise action.

The Department has endeavored to assist in encouraging this spirit of cooperation whenever possible. In the case of the application of the Borough of Verona for a water supply, decided February 10, 1921, (the decision being printed in full in the annual report for 1921), the Board went on record as believing that it was to the best interests

of all that Verona should continue to take water from the common source of supply developed for Essex Fells, Caldwell, and Verona, and not to allow the development of new and separate sources. It is encouraging to report that an effective and equitable plan of cooperation has been worked out by these communities.

Again in the Bayonne decision, which is set forth in full above (see page 47), the Board ruled that the City of Bayonne, in accepting the grant to develop a new water supply from the Ramapo River, should agree to supply other communities upon application as this Board may direct, and at reasonable rates, also to surrender its rights under the permit, after just compensation, if in the future it seems best to include its system in a plan of consolidation of public water supplies.

The Wanaque Project under development by the North Jersey District Water Supply Commission is another example of the development of a joint public water supply.

There should be the fullest discussion of the comprehensive development of future water supplies by public organizations, municipal officials and public-spirited individuals. More detailed investigations of certain reservoir sites, acqueduct and tunnel locations, yield of watersheds, etc., should be made. Many of the stream gaging stations established during the past year have been located on streams which are going to be needed for sources of future water supply, so that when they are actually developed there will be accurate information as to the amount of water available.

Fig. 16. Distribution of New Jersey's 2,000,000 Acres of Woodland.

Report of the State Forester

C. P. Wilber

FORESTRY PROGRESS

There has been real progress during the year just closed in definite, tangible forest work done. There is also apparent a material increase in general appreciation of the need for forestry and in public understanding and support of the endeavor to meet the situation in the State. People are coming to recognize the necessity of local timber production. The public consciousness is becoming aroused to the criminal waste and economic unsoundness of inadequate fire protection. More and more owners of timber land and so-called "wasteland" are proving that timber cropping is both practical and profitable. Both the owners and the public are seeing the folly of allowing land to lie idle or produce little when it might be growing timber. The urgency of maintaining and developing these out-of-door playgrounds for our metropolitan multitudes is being emphasized by the tremendous exodus from the cities for recreation, both transient and seasonal. To the average citizen, therefore, forestry has outgrown its earlier status of an idealism of questionable practicality and of something remote from his own interest. It now stands as a practical part of the community life in wood and timber supply, in watershed protection, in recreational advantage, with all that these mean to the individual and the commonwealth.

POLICY AND SITUATION.

Almost one-half (46 %) of the State's upland area is forest land. On a large part of these two million acres the present woodland is in poor condition because of past abuse and neglect. About one-third of the forest area now contains merchantable timber. The other two-thirds has been recently cut over or so severely burned that the present tree growth, though potentially valuable, is now too small to be merchantable. Of this total forest area probably not more than one-quarter possesses soils that can be used profitably for agriculture if it is ever needed for such use.

The State now imports annually nine-tenths of the sawed lumber and four-fifths of all the forest products which it uses. At the same time it annually cuts or burns more than it grows. With fire protection and wiser cutting and after a reasonable period for recuperation, the State each year will produce from the woodlands timber sufficient for

all its needs, with the exception of a limited amount of special species, grades or sizes which can never be grown here. And it will do this without using land needed for agriculture or more valuable for any other purpose.

The forest policy of the State seeks to bring our present idle or low productive land to full production and thereby provide for local timber needs at home and at the same time eliminate the handicap of unproductive or waste areas. In doing this it also assures to the public a permanent out-of-doors playground, accessible locally and sufficient for the growing need. It purposes to do this first by reducing forest fire damage to a minimum, then by owning and operating a considerable area of forest land itself, and by encouraging and assisting forest owners to manage and develop their woodlands at a profit.

LINES OF WORK.

The forestry work of the State is included under five main heads: (1) statewide forest fire protection, through the Forest Fire Service; (2) the administration and development of the State Forests; (3) the promotion of forestry practice on privately owned land, by advice and assistance; (4) the conduct of studies, experiments and demonstrations of means and methods for the best forest and market practice; and (5) general educational effort to arouse an informed public consciousness of the need for and practicability of forestry practice. In addition, so far as limited funds and personnel permit, advice and cooperation are extended to public and private inquirers relative to shade tree problems; to timber operators or woodland owners in locating or disposing of timber supplies; and in other problems related to forestry and arboriculture.

FOREST FIRE.

Preserving what we have, maintaining the improvement made, developing our possibilities further, all demand adequate forest fire protection. Forestry is impractical, if not impossible, until forest fire is stopped. It is not expected that fires will be entirely stamped out in the woodlands any more than they are in our cities or in other classes of property. But the number of fires can be reduced and their damage curtailed to a point where the fire risk to woodland is not a hazard but is insurable at reasonable rates. And the cost of such a degree of security is not extravagant but altogether reasonable. New Jersey now needs, and in the future will need even more than now, the homegrown forest products which she can produce. The State cannot meet this need until the woodlands are reasonably safe from

fire. The provision made by the 1923 Legislature for an adequate fire protection force and equipment is an outstanding forward step in the progress of forestry in the state. Just what it means and how it will be applied are dealt with in the report of the State Firewarden on page 90.

STATE FORESTS

The State Forests with an aggregate area of 16,504 acres are located and described in detail on p. 81. Their value, which has increased from year to year under careful management, is now far in excess of the original purchase cost. Experimental plantations and cuttings, and timber growth and market studies on them are an increasing source of invaluable information to the foresters while also providing practical demonstration to the public of forestry practice. There are now on them 80 acres of plantations, varying in age from 1 to 15 years, which are already of immense value to forestry in the state. Of this area, 12 acres on the Stokes Forest, 2 acres on the Bass River Forest, and 3 acres on the Lebanon Forest were planted during the spring of 1923. A total of 90 acres on the forests have been thinned or otherwise improved in working out the silvicultural problems met in the State. Of this area, 5 acres on the Stokes, 2 acres on the Jackson, and 5 acres on the Bass River Forest were thinned during 1923.

Public Use.—The State Forests are made fully available for recreational purposes. The number of vacationists and pleasure seekers, using them for camping, fishing and hunting is increasing yearly. During the past two seasons on the Stokes Forest, the most popular area in this way, several hundred persons occupied the camp sites which have been prepared in the most attractive spots. In addition, an even larger number of transient tourists, hikers, and sportsmen have made use of the area.

Expansion.—Widespread, favorable interest has been aroused by the Department's recently announced policy of materially increasing the State's ownership of forest land. The program calls for the acquisition of not less than 200,000 acres of State Forest, at the rate of not less than 20,000 acres per year. The proposal is the only practicable means of beginning at once the redemption of the vast area of present idle, abandoned forest land in the State, of promptly making a start on a large scale in building up home grown timber facilities for recreation of all sorts out-of-doors, the demand for which is rapidly growing. It will provide a stimulation badly needed to private imitation of the State's activity in this respect and is an investment program in that it will begin to pay money returns to the State within a reasonable time. It cannot be too strongly urged or too rapidly accomplished.

Fire.—During the severe fire season of April and May 1922, the State Forests paid heavy toll to the weakness of the whole Fire Service

under such conditions. The most serious loss was on the Lebanon Forest where two fires burning simultaneously swept over 2000 acres, severely injuring or destroying a large part of the best pine on the forest. On the Bass River Forest 200 acres, mostly oak and pine reproduction not yet of merchantable size, were burned by an extremely dangerous fire. The same acreage was burned on the Penn Forest, but the fire was confined to an area burned over two years before and did little damage. The Stokes Forest was threatened by several severe fires nearby, but lost only two acres within its boundaries. Great credit is due to the firewardens concerned and especially to the rangers in charge of the areas, for preventing a far more serious loss, especially in plantations and experimental areas where damage done could not have been repaired for years. The only fire damage to the properties during 1923 occurred on the Lebanon Forest, where 500 acres were burned by a light fire.

Sales and leases.—A very desirable change in the policy of handling the State Forests made by action of the 1923 Legislature has been operative for the first time during the last year. Heretofore, maintenance and improvement costs for the State Forests have come from direct appropriations for these purposes. Under the new policy, the income from the administration of the properties up to a stated figure is made the appropriation for these purposes, placing the State Forests upon a strict basis of self-support, so that they are concrete demonstrations of the possibilities of forestry practice in the handling of wild land profitably. Since their acquisition, the State Forest lands of the State have increased in value to far above their purchase cost. Because of the degraded condition of the woodlands when acquired, sale revenue has never been large, the effort being to direct such work to removing inferior and deteriorating material only, for salvage and improvement rather than for revenue production.

Improvements.—Funds for this purpose have been too limited to permit much work of this nature to be done. The house on the Bass River Forest, previously leased, was repaired during 1922 to make it usable for the resident ranger installed. During the same year a small forest nursery for raising loblolly pine for experimental plantings in this forest was started in the spring. Considerable work was done on the Penn Forest to improve the public roads on the area so that there might be readier access to the property. The telephone line to this forest which was seriously damaged by the spring fires was partly rebuilt and made more serviceable, and damage by lightning to the fire lookout tower was repaired. The new county road from New Lisbon to Four Mile has materially helped to open up the Lebanon Forest both for use and for protection. Material cooperation was extended toward the construction of this new improved road by contribu-

tion of gravel from adjoining areas on the Lebanon Forest. Many minor repairs have been made on roads and buildings on the Stokes and Penn Forests and several new camp sites prepared on the Stokes. A private one-mile extension to furnish telephone service to the headquarters on the Bass River Forest has been built. A nursery was established on this forest in 1921 and has furnished a considerable quantity of planting stock for experimental and restocking work on this and other Forests. On all the Forests, road signs have been posted and maintained on the public roads to help make them more available to the public.

Location and description.—Below is given a brief description of the location and character of each State Forest.

Bass River Forest.—Supervisor, Lawrence E. Terhune, New Gretna,.. 1,633 acres
Is in Burlington County ½ mile north of New Gretna and is typical of the so-called "pine barrens," now recovering from severe burnings. Considerable cedar swamp is also found on this tract. A number of experimental forest plantations are developing rapidly.

Jackson Forest.—Warden, Frank B. Matthews, Cassville,..... 43 acres
Is in Ocean County, on the Lakewood-New Egypt road ¼ mile east of Cassville, and contains a forest of nearly pure pine about 50 years old. It is intended only to demonstrate the methods of practical forestry. An improvement cutting made during 1923 in 50-year-old pine, which left 60% of the timber standing, netted $40 per acre.

Lebanon Forest.—Warden, Victor Bush, Pemberton..... 4,812 acres
Is in Burlington County, 9 miles southeast of Pemberton, and contains pine, oak and cedar. There are on it several experimental plantations and improvement cuttings and thinnings. It is also valuable as an area of sufficient size for working out market problems under the difficult conditions typical of the South Jersey area. Considerable fire damage has been suffered since the acquisition of the property.

Mount Laurel Forest.—Warden, Harvey Darnell, Moorestown..... 21 acres
Is a small woodlot of hardwood and pine in Burlington County, 3 miles southeast of Moorestown. It is peculiarly accessible and susceptible to forest management, and because of very complete and successful thinning and plantings 11 years ago, has unusual value as an example of applied forestry.

Penn Forest.—Supervisor, L. E. Terhune, New Gretna..... 2,764 acres
Is in Burlington County, 6 miles southeast of Chatsworth. It is a tract of almost pure pine in the heart of the wilderness. The forest on most of it has been completely destroyed by two serious fires, one of which burned last spring.

Stokes Forest.—Supervisor, Paul B. Haines, Branchville..... 7,231 acres
Is in Sussex County, extending 10 miles north and south of Culver's Gap on the Kittatinny Mountains. The greater part of it is typical of absolute forest land in North Jersey. It also contains valuable demonstration plantations and woodlands, improved by proper cutting. Under fire protection it is rapidly developing in value and it has great recreational, as well as timber producing possi-

bilities. Roads, trails, and camping sites are being provided as fast as facilities permit. The Forest is easily accessible from the highway in Culver's Gap and is available for use by camping parties.

Total ..... 16,504 acres

STATE PARKS.

In addition to the State Forests with their recreational facilities, in its capacity as custodian and administrator of State Parks, the Department has the custody of two such areas, located and described below.

Swartswood Lake Park.—Supervisor, Paul B. Haines, Branchville.... 560 acres

Is in Sussex County, 7 miles northwest of Newton. It consists of Swartswood Lake, with an area of 544 acres, and eight adjacent pieces of upland embracing 16 acres. It is maintained for the use of the public as a park and recreation spot. A number of extremely attractive camp sites on several of the approaches are available for transient campers, or to public and semi-public organizations for more permanent occupancy under lease.

The lack of funds has made it impossible for the Department to make adequate provision for the maintenance of this tract. Permanent survey marks have been set along the boundaries of the State approaches, but nothing in the way of improvements has been possible. A small outlay for the improvement of these areas will make an altogether disproportionate increase in their value and attractiveness to the public and provision for this is urged.

Washington Crossing Park.—Warden, Edward B. Anderson, Titusville 107 acres

Is in Mercer County, 6 miles above Trenton on the site of the historic crossing of the Delaware River by the Continental Army just prior to the battle of Trenton. The State property includes the historic Ferry House. It is the beginning of a proposed Memorial Park for the further expansion and development of which the 1923 Legislature appropriated $50,000. It is hoped and urged that provision for its completion by 1926 may be made so that it may be ready at the time of the sesquicentennial celebration in that year.

FORESTRY ON PRIVATE LANDS.

The State Forester's office offers advice and assistance to private owners in undertaking and maintaining forestry practice on private holdings. The advice and assistance so given to timberland owners and those desiring to develop forest property, continue to grow in volume. The Department finds it increasingly difficult to do justice to those asking help because of the limited personnel available. The foresters inspected the properties of over 40 woodland owners during 1922 and made specific recommendation regarding the treatment of the stand, the disposal of the product or the establishment of new forest, one or all. During 1923 such help was given in the field to

Fig. 17. A dense natural stand of young pine not fully productive because badly crowded.

Fig. 18. The same thrifty stand of native pine ready to speed up its growth after a profitable thinning.

WOODS ARE WOODS

even though left to themselves provided they are protected from fire. But "better than nothing" can be made far more profitable by lucrative improvement in most stands.

42 different owners whose holdings have varied from a few acres to many thousand acres each. In addition a large number of other owners have been helped in doing forest planting, and hundreds of inquiries were answered by letter and publication. But far too many inquiries have, of necessity, been answered by correspondence only. The practice of forestry by private owners in New Jersey is increasing. It should go forward much more rapidly, and it could do so if the Department had the facilities for pushing its educational work and for meeting increased demands for assistance. More trained foresters are needed.

In addition to the progress made in starting work on smaller holdings, the results which are appearing on two large holdings are striking. The New Jersey Zinc Company on an extensive area of stumpage in North Jersey is finding forestry a paying proposition under the direction of their own forester. The East Orange Water Department has adopted a definite plan for improvement and enlargement of the forest on its water reservation by cutting and planting under the direction of the Department's foresters. The cutting is showing an attractive profit and at the same time transforming the present stand into better forest, and the planting, begun on a considerable scale last spring, has started to build up future forest on their idle open land.

The owners of approximately 8% of the total wooded area of the State are now practicing forestry under the supervision of their own or the Department's foresters. The appearance of these areas and the results which the owners are securing from their work are the best selling agents for forestry and are tremendously stimulating interest and activity among other owners.

Neither the need nor the demand for tree seedlings in the State are sufficient to permit the State to raise this stock in quantities large enough to keep the cost of sale as low as those quoted by reliable forest nurseries. Because a State Forest tree nursery is not justifiable, the securing of this material for planters in New Jersey at the lowest possible rates has been worked out otherwise. An arrangement was successfully initiated during 1923 for the first time, whereby the State Forester has reserved tree seedling stock, of the best species for use in the State, in quantity in commercial nurseries. Orders for this material have been collected by the State Forester, and the seedlings shipped direct by the nursey to the planter at the lowest rates in lots of 1000 or more trees per purchase. Under this plan orders were placed at $4 per thousand for over 200,000 trees, the maximum reserved for this first year of the arrangement, and many later orders could not be accepted.

EXPERIMENTS AND STUDIES.

In most instances where field investigation is a part of the cooperation with a private owner in putting his woodlands under forestry practice, there is new data of value collected. However, many phases of forest research cannot be satisfied in this way. For this reason the Department is building up its laboratory facilities in the field as rapidly as possible by establishing experimental work of a more permanent nature. This activity in forest planting, in thinnings, in natural regeneration, in general improvement, in logging, in protection, is undertaken either on the State Forests where permanency of treatment and care is assured or on especially selected private holdings, under formal agreement with the owner which assures sufficient permanency to the project, when some feature of location, species, condition of stand, etc., is found which cannot be satisfactorily duplicated on the public forest.

Silviculture.—In cooperation with the U. S. Forest Service there was begun during 1922 a special study of the white cedar to secure complete and needed information as to its growth, reproduction, silvical needs, methods of logging, markets and utilization. The work is being done on the Wharton properties and the Bass River State Forest principally.

Two more experimental thinnings were completed on the Stokes State Forest in hardwood stands and a special experimental thinning has been made in a typical cedar stand on the Penn State Forest, in 1922.

In cooperation with the forester in charge, combination experimental thinnings and public demonstration areas in both white cedar and pine stands were established during 1922 on the property of the Wharton Estate. These have already yielded information of real value and as they develop will be a source of badly needed knowledge on the problem of similar stands elsewhere.

In connection with the forestry work on the East Orange Water Board's properties, several extremely valuable thinning experiments, with peculiar value as demonstration areas have been begun. The stands are typical of a large area of the North Jersey hardwood type and are so situated that they are easily accessible along adjoining improved roads. In the same way eleven special projects were begun during 1923; nine on the various State Forests and two on private holdings. These projects cover thinnings and improvement cuttings in South Jersey pine and white cedar, and in oak and mixed hardwood stands in both North and South Jersey, and include plantations, a study of the natural pine reproduction and of pine and hardwood volume growth.

Markets.—Forestry seeks to grow the largest and most valuable crop which the timberland can produce. When the crop matures it must be thoroughly utilized and profitably marketed if the operation is to be successful. Because this is so, the wisest management of woodland or the best advice for forest work is only possible when the needs and outlets for the products are known. To make such information available the Department has continued to study and assemble information of the market possibilities for wood products. A survey of wood-using industries and timber markets for the State has made considerable progress. However, the field is so large that, although hundreds of operators and markets have been visited or corresponded with during the past two years, the ground has not been adequately covered. Complete information cannot be collected and kept up to date by the present limited force of foresters.

Needs.—Only an increase in personnel will make it possible for the Department's foresters to bridge the gap that now exists between timber growers and timber users, and bring about better market conditions, closer ulitization of timber and less waste. This will result in surer and larger profits for timber growers and operators but cheaper lumber and wood products for the public. Just as soon as conditions make it possible, the State should provide two additional foresters to meet the demands now made upon the Department.

PUBLIC EDUCATION.

In spite of the steady progress being made in interesting and informing the people of the State of their forestry program, far more public interest and action must be had if our forest resources are to be conserved and developed. To secure this interest and support there must be a constant program of education to reach those who still are uninformed.

During the two years, forestry lectures have been given before many organizations: civic, fraternal, scientific, and commercial, within the State and several outside New Jersey. A course of lectures on forestry has been given to the regular agricultural students at Rutgers College, and radio broadcasts made on forestry. Forestry exhibits have been maintained at several fairs and association meetings.

A number of special articles have been prepared and published in technical and popular periodicals, in addition to a large volume of news material made available to the press, and data furnished for the use of special writers.

Several publications which have been prepared and widely distributed have aroused real interest and called out much favorable comment. Funds for increased activity are badly needed and urgently requested.

SHADE TREES.

The growing demand for more and better cared-for shade trees deserves the active support of every citizen. Beautiful shade means much in value, in comfort, in pride to any town or city, but it is possible only where the work is carefully and intelligently planned and developed. Communities which have not already done so will do well to consider the wisdom of appointing a local Shade Tree Commission, under the terms of Chap. 325, P. L. 1915. A revised list of the municipalities which already have such commissions, together with a brief summary of their activities appeared in the State Forester's report for 1921. Since then the towns of Flemington, Salem, Stockton, and Toms River have reported the establishment of local commissions, and others are considering it.

The Department's foresters have made local examinations at several municipalities at the request of the shade tree authorities and have continued to give advice through the mails to others seeking such information. They have not been able to meet numerous requests for personal investigation and cannot undertake to meet this need with the limited force now available. The employment of an arborist to enable shade tree work to be developed is again recommended.

New Jersey is so advanced in making provision for the maintenance of street shade within its municipalities that the contrast between the borders of municipal roads and those under control of the various highway authorities is marked. In many, perhaps most, parts of the State, there appears to be an actual decrease, rather than an increase, in the number and quantity of the trees bordering our public roads. That the destruction of trees is sometimes necessary when an old road is improved in no way satisfies the requirement that our highways shall be made attractive and pleasant as well as convenient. Trees are so easily maintained in all parts of the State that there is no reason, apart from inclination and cost, why all of our roads should not be made ways of pleasantness. The effort that the State is making to create a model system of highways will fall short of the ideal unless this feature has full consideration. The common understanding that roadside shade can come only by tree planting is altogether wrong. Our State has so many native trees of so many kinds, close to established lines of travel, that it is necessary to resort to planting only when standing trees—native or other—are not available. Uniform rows of trees are advisable in built-up communities where curbing and building lines are straight, but in the open country it is decidedly better to have the maximum of diversity in species and in placing. Tree rows should be broken frequently for scenic effect, if not to meet the local requirements, such as the presence of culti-

vated fields. Where it is practicable, the ideal roadside border is a strip of park, though it be not more than 20 feet wide, broken at intervals by field views or vistas. This plan is easily accommodated to existing growth, and to such modifications as are necessary to satisfy property interests. If standing trees are marked out on dangerous curves, and plantings made on fills, such border trees, sometimes with their trunks whited, may even take the place of guard rails and save considerable cost. There need be no fear that tree shade will work injury to the roadbed, or to adjacent properties. Where sunlight, rather than shade is wanted, as on north exposures, trees should be omitted. Along field lines the unplowed headland usually gives ample room for all desirable trees. The cost of adequate maintenance is almost insignificant in comparison with the cost of building and keeping the road itself. Trees of acceptable species and ordinary nursery size (10-12 feet high) can be planted at 50-foot intervals, both sides, for not over $800 per mile, but it is estimated that not more than 40 per cent of the total mileage in the State will need to be, or should be, planted; 60 per cent can be satisfactorily shaded by utilizing existing growth at an outside cost of $200 per mile. On this basis, the average cost of shading and maintaining borders on all the roads in the State that should be so provided would be no more than $440 per mile—less than 1 per cent of the cost of most road construction. As all trees outside of forests need some care now and then, and since those exposed, as roadside trees are bound to be, are subject to dangers and ills, it is held to be absolutely necessary that provision be made for upkeep. An average of $50 per mile per year is ample to maintain planted or selected rows of trees. $100 per mile per year will easily keep in good condition 20-foot borders worked out from natural forest.

It frequently has been suggested that our highways be bordered with fruit trees, that the public might enjoy their fruit as well as their shade. This proposal appears to be unwise, impracticable, and undesirable from every standpoint. A fruit tree, to be productive, must be headed low, sprayed, trimmed and carefully worked over. The fruit when set, and often before it is ripe, invites injury to the tree, and sometimes its broad, low crown causes interference with traffic. Naturally, the removal of fruit trees from roadsides where they are already established, or when the owner desires to establish them, is not advised.

The central idea in this proposal is that all those portions of our highways which now are sunburned and windswept shall be planted with appropriate border trees; that other portions having voluntary growths along their borders shall be improved, partly by cleaning and trimming, partly by planting; that those portions which pass

through forests shall be relieved of unbroken and ill kept tree growth and a narrow strip opened up. The immediate road border in every case should be kept free from brush and wild growth. To make this rule effective, the highway authorities in each political unit should assume control over the full width of the highway dedication and provide for tree location and tree maintenance in the same way that the upkeep of the roadbed is provided for. In a word, the thought is that a proper highway naturally consists of a well-kept roadbed, and of an attractive border on each side, where physical objects do not interfere. This Department is ready so far as its facilities permit to cooperate in establishing and maintaining roadside shade. If the plan is undertaken in any large way, however, there must be an arborist whose time can be wholly given to it.

TREE ENEMIES.

Control of the serious situation created by the Gypsy Moth infestation is apparently making encouraging headway, under the supervision of the State Department of Agriculture with Federal assistance. In the light of the experience of the New England States and from the standpoint of the forest interest of this State it cannot be too strongly urged that the Legislature continue its full support to make the work continuously effective. The season has been an unusually favorable one for many forms of insect life attacking forest growth. In general the most of these have been of local interest or not permanently serious. Various species of plant lice have been more active and plentiful than ordinarily but have done little if any permanent harm. The Striped Oak Caterpillar in parts of south Jersey and the Birch Leaf Skeletonizer elsewhere have defoliated a considerable number of trees or even small areas here and there but have not assumed serious importance. Infestations of the Fall Canker Worm have done serious harm at one or two points but give no promise of making a dangerous situation in any general way.

Considerable local distress was caused during 1923 by infestation of the tent caterpillar and fall web worm which have been more than usually plentiful. No serious damage has been done by the attacks, however, and natural control can be trusted to take care of it. Its eradication locally is also a simple matter, and owners are urged to cut off and burn the webs or tents with the insects. Plant lice, especially on the maples in some sections, have again had a very favorable season, but also can be easily controlled locally and in general will account for little serious harm except to shade and ornamental trees. In most cases they will yield to natural control.

PERSONNEL.

The retirement of Alfred Gaskill, State Forester, in 1922, necessitated a considerable reorganization in the personnel of the Division of Forestry and Parks and the employment of one new Division Firewarden. The organization now includes the State Forester and Firewarden, an Associate State Forester and two Deputy State Firewardens, one assistant Forester and three Division Firewardens, with six rangers and wardens in charge of the State Forests, twelve watchmen for the fire lookout towers and approximately 400 locally appointed firewardens. This personnel includes four professional foresters.

THE FUTURE.

The forestry program in New Jersey has grown from a minor movement to a part of the permanent public policy of the State. Real progress has been made in its present use of, and future provision for our forest resources. But the State is yet only on the threshold of the full realization of this necessary natural wealth. The development of adequate fire protection is paramount. The strengthening of the Forest Fire Service recently made possible must not be decreased and the heartiest public support of its work must be had to make it effective. Two additional foresters are also badly needed to meet the demands now made for direction and advice, for the immediate development of privately owned woodlands, for a closer and better relationship between producer and user and for a more general and rapid development of the shade tree interests in the State. Generous and prompt appropriation for the acquisition of additional State Forest land is urgently needed. In addition, larger funds for publication should be provided so that not only more material may be put into form for educational distribution but that such material may be made available in larger quantities to cover adequately special fields which limited editions cannot reach.

Report of the State Firewarden.

C. P. Wilber.

In the following report, the general statement of conditions and progress is for the two fiscal years, July 1, 1921 to June 30, 1923. But to conform with the natural division of the fire season and with similar data for the entire country, the tabular and statistical matter are for the calendar years 1921 and 1922.

THE FOREST FIRE SERVICE.

The Organization.—The State force consists of the State Firewarden and an assistant located at Trenton who have general oversight of the entire Forest Fire Service. Under them are three division firewardens located at Newfoundland, Toms River and Bridgeton, each of whom has direct charge of all fire service work in his division. They are paid by the State and give their entire time to the work. A lookout watcher is stationed at each of the twelve lookout stations in operation at the close of 1923. Each is on duty during the entire fire season, usually from April 1 to December 1, and gives his full time to the work. The local force, covering practically all the forested townships, at the close of the fiscal year 1923, includes one township firewarden in each of these 168 townships and 198 district firewardens. These wardens are paid, one-half by their township and one-half by the State, at $20 per year to township firewardens and $10 per year to district firewardens plus 50 cents per hour to either for the time spent fighting fire.

Changes and extensions. Except for a few changes in lookout watchers, township and district firewardens, the personnel is the same as previously. During 1922 the Fire Service was newly established in Lakehurst Borough, Ocean County, formerly a part of Manchester County, and Far Hills Borough, Somerset County, formerly a part of Bernards Township; and during 1923 in Chatham, Morris County and Corbin City, Atlantic County.

The number of lookout stations in operation was increased to eleven by the erection of two new towers in 1922. Sixty foot steel towers were erected, one about 1 mile north of Belle Plain, Cape May County, and another about 2 miles west of Millville, Cumberland County, along the Millville-Bridgeton Pike. Both of these stations were established from State funds and opened for service on April 1. Two more towers were erected during 1923. On Kittatinny Mountain at a point about

Fig. 19. THOUSANDS OF ACRES LIKE THIS

in South Jersey make mute protest against past neglect and mute appeal for a chance to "come back". Thrifty young pine restocking a bad burn. One more fire here means no forest without artificial planting.

7 miles west of Blairstown, Warren County, a 60 foot steel tower and a connecting telephone line have been completed. The 8-mile telephone connection is all new line, opening up telephone service not only to the tower but to a considerable area which otherwise would remain without telephone service. Because of the mutual advantage to the Forest Fire Service and the local residents, in thus establishing communication in a hitherto unserved area, this telephone work is being done in cooperation with the local people, the Department paying about one-half of the total cost. The expenditure by the Department for this and for the tower were paid from Federal funds. (See below). This telephone construction, with its possibility of extension over the mountain where there is still a decided need for such service, is one of the most important pieces of cooperation for forest fire protection yet achieved in the State. Through the cooperation of the U. S. Navy Department a suitable observation house was erected by State funds on the roof of the hangar at the U. S. Naval Air Station near Lakehurst, Ocean County, and put into operation as a lookout station in the fall of 1922. This cooperation has made it possible to establish not only a unique but an unusually effective station at low cost to the State.

The Pennsylvania Department of Forestry has established a fire lookout at Delaware Water Gap. By agreement this lookout guards a considerable area on the New Jersey side of the river which could not have been covered by the New Jersey equipment, except by a special tower for a limited area. By mutual agreement this Pennsylvania tower and the New Jersey stations at Catfish Pond and Culvers Lake jointly control the entire area in both states along the Delaware River valley from the Water Gap to the New York state line.

By a similar cooperative understanding with the New York Conservation Commission, a new station opened by the New York authorities on Sterling Mountain, just east of Greenwood Lake provides mutual help with the Windbeam and Bearfort Stations in New Jersey.

By special arrangement with the Bell Telephone Company, a new and very effective plan for the handling of forest fire calls has been established. Under it any person desiring to report a forest fire or a violation of the forest-fire law will be connected at once with the lookout station covering the area involved, wherever lookouts are available. When the lookout system is completed the arrangement will make it possible for every interested person to give easy and effective help in getting prompt action for any fire seen.

Federal Cooperation.—The Department was fortunate in securing an increased allotment of funds from the Federal Forest Service for exepnditure under the Weeks law for 1922. The $2500 allotment of the previous year was raised to $5050 for the current year, to which

there was added later a $1400 extra emergency fund, a total of $6450. These funds are used for the payment of the salaries of lookout watchers and the installation of new equipment. In addition, a special fund of $1500 for the prevention and control of special types of fire menaces has been made available from the same source.

For 1923 the allotment of $5050 was renewed and in addition a special emergency allotment of $725 was made available for New Jersey because of the severe spring fire season of 1923.

THE FIRE SERVICE TO BE.

The practical doubling of the appropriation for forest fire protection by the 1923 Legislature will make possible during the coming year the reorganization, enlargement and equipment of the Forest Fire Service to make it a fully effective organization. This forward step is one of the most significant advances in forestry since the movement was first inaugurated in New Jersey. It gives practical assurance that the State may anticipate active and fully effective progress toward the production of a home grown supply of timber to meet the rapidly approaching necessity for such a supply.

The reorganization referred to is a carefully worked out plan, the result of 15 years of work and study, under which the Department can assure the State adequate forest-fire protection. It involves the expenditure of 3½ cents per year per acre of woodland to provide and keep in operation an organization which will reduce forest fire damage to a point where woodlands will be a property insurable at reasonable rates. It will secure the result promised. It cannot do so completely at once of course, and it will require an interested, intelligent and sympathetic public support. But it takes the security of the two million acres of forest land in the State out of the haphazard, "good luck" sphere, and makes a steady and rapid improvement in fire conditions possible and assured.

PUBLICATIONS AND EDUCATION.

The "Lookout Guide," described by its title and issued first in 1922, created a demand that exhausted the edition almost at once. A second edition for 1923 was similarly popular. The second edition of a booklet "Fires for Fun" has been completely exhausted and the supply of another "Fighting Forest Fires" is rapidly dwindling. There has been an increased demand for all publications dealing with forest-fire protection, and there is real need for funds to meet this demand. Requests for talks on forest-fire protection before Boy Scout, Y. M. C. A. and other organizations and groups are multiplying faster than the limited

personnel can handle them, despite their great value in stimulating public care and interest in forest fire protection.

FOREST FIRES BY MONTHS

Calendar years 1921 and 1922

1921 Month	Number of Fires	Per Cent of Total	1921 Month	Number of Fires	Per Cent of Total
January	67	8	July	39	4
February	47	6	August	28	3
March	160	18	September	22	2
April	164	18	October	71	8
May	96	11	November	38	4
June	148	17	December	10	1

1922 Month	Number of Fires	Per Cent of Total	1922 Month	Number of Fires	PerCent of Total
January	15	2	July	4	1
February	9	1	August	1	..
March	121	15	September	4	1
April	291	37	October	12	2
May	177	1	November	126	16
June	11	1	December	17	2

The 1922 fire season began about mid March. A lack of rain with abundant sunshine and high winds developed a very serious condition during late April and early May. Some of the most serious losses to standing timber on record in the State occurred during this period. The situation became so acute that the public press and the citizenship of the State became both alarmed and incensed at the magnitude of the damage done. Nearly 800 fires had been reported up to June 20, more than the total number for a 12 months period in most previous years. During April and May alone 94,000 acres were burned over. The regular appropriation of $10,000 for fire fighting was completely exhausted and an emergency allotment of $7,000 made from the Governor's emergency funds was not sufficient to entirely cover the expense of this one brief season.

Practically one-third of all the 1922 fires burned during April and more than two-thirds during March, April and May, the usually recognized danger period of spring. The balance of the 1922 burning occurred during November when fall conditions made the woodlands especially susceptible to fire.

NUMBER AND SIZES OF FIRES

Calendar Years 1921 and 1922.

There were 890 fires reported for the calendar year 1921. Of these, 10 fires, or barely 1% of the total number, burned more than 1,000 acres each; but they burned a total of 58,000 acres or more than one-half of the total area burned. There were 60 fires which burned between 100 and 1,000 acres: 231 which burned between 10 and 100 acres: 291 which were put out before they reached 10 acres in size and 298 fires, or 33% of the total were extinguished before they burned two acres. The total area burned was 90,104 acres. The average area burned per fire was approximately 100 acres. The total damage done by forest fires in 1921 was $693,432. Of this the damage to standing timber and young forest growth was $657,120. The damage to improved property such as buildings, fences, cranberry bogs, cut lumber in woods, etc. was $36,312. The average damage done per fire was $779.

Of the total number of 1922 fires, 28% were put out before they burned two acres, and 59% before they became 100-acre fires. Less than 1% burned more than 1000 acres. The total area burned in 1922 was 106,086 acres and the total damage done, $603,756.

CAUSES OF FIRE

Calendar Year 1921.

Of the 890 fires reported in 1921, 549 or 62% were started from known causes and 341 or 38% from causes which could not be determined definitely. Railroad operation in the State was responsible in 1921 for 38% of the fires that burned. This is an increase of 3% over the proportion of fires charged to the same cause in 1920, and 9% over that charged to the railroads in 1919. This rising percentage of railroad fires, after continuing improvement from 1910 to 1919, demanded that the reason for an increased number of fires along the rights-of-way be found and the cause cured if possible. In March 1922 a conference with officials delegated from each of the railroads in the State to consider the matter was held in Trenton. It was frankly admitted by most of the railroad officials present that the labor shortage and fiscal conditions of most of the companies had resulted in the cutting down of the work on the railroad rights-of-way. It appeared however, that the crisis in this respect had been passed and that conditions from this time on would be improved so that it could be confidently expected that the number of railroad fires soon would be a very

small proportion of the total. In this connection advice and suggestion has already been asked for by and supplied to several of the major railroad companies in dealing with conditions, either along the entire system or at specific points of danger.

Carelessness in using fire for such purposes as brush burning, burning waste materials, meadow burning and campfires during 1921 was responsible for 10% of the total number reported; another 10% of the year's total were traced to careless smoking; and 4% were charged to various miscellaneous causes such as children at play, burning automobiles and buildings and stationary steam engines.

VIOLATION OF THE LAW

Calendar Years 1921 and 1922.

The responsibility for 406 fires or 45% of all the 890 fires reported was definitely placed on those who started them. In 16 additional cases, technical violations of the forest fire law were dealt with. In two different instances two men were reported for refusing to help fight fire, a total of 4 such offenders. Two of these were fined. The other two were released with a reprimand because of mitigating circumstances. A wide-spread story of a general strike at Woodbine, Cape May County, in connection with the serious fires of the spring of 1922, was found to be pure fabrication by a local space writer for the general press. Of the total 1921 violation cases, 307 were railroad fires and 99 were due to various other causes, mostly personal carelessness or ignorance. Of the 406 violation cases for the year 1921, 287 or 70% have been settled. Of the 143 cases from previous years that were unsettled on January 1, 1921, 116 have been disposed of. The penalties collected during the year 1921 amounted to $3,049.49. Of this, $2,146.19 was paid by the railroad companies and $903.30 by other agencies. During 1922, in 469 cases, or 42% of the total number of 1922 fires, responsibility has been definitely fixed upon the person or agency causing the fire. Penalties amounting to $1681.15 have been collected on account of these violations, of which the railroads paid $1002.25 and other agencies or individuals $678.90, with 159 cases still pending settlement.

TABLE 1—FOREST FIRES IN CALENDAR YEAR 1921 AND IN PREVIOUS YEARS

YEARS	No. of Fires	Total Acres Burned	Acres per Fire	Total Loss	Loss Per Fire
No organized service, incomplete reports					
1872	.....	100,000	.....	$1,000,000	.....
1880	54	71,074	1,316	252,240	$4,671
1885	.....	128,000	.....	1,128,000	.....
1895	49	66,120	1,349	600,000	12,245
1902	65	98,850	1,520	169,323	2,605
1903	79	85,046	1,076	305,744	3,870
1904	81	41,530	512	193,413	2,388
Organized fire service					
1907	167	11,525	69	11,647	70
1908	533	52,978	100	64,536	121
1909	563	93,525	166	133,944	238
1910	611	81,452	133	127,850	209
1911, Forest Fires	289				
Embryo Fires†	239	64,404	122	86,940	165
1912, Forest Fires	214				
Embryo Fires†	331	26,291	48	21,501	39
1913, Forest Fires	311				
Embryo Fires†	367	53,823	77	67,205	99
1914, Forest Fires	396				
Embryo Fires†	451	78,655	92	83,880	99
1915, Forest Fires	549				
Embryo Fires†	467	150,258	147	209,090	207
1916, Forest Fires	269				
Embryo Fires†	314	51,654	88	69,001	118
1917, Forest Fires	486				
Embryo Fires†	385	92,479	106	79,335	90
1918, Forest Fires	567				
Embryo Fires*	229	67,272	85	69,835	88
1919, Forest Fires	443				
Embryo Fires*	164	46,927	77	63,638	105
1920, Forest Fires	393				
Embryo Fires*	161	35,497	64	244,942	442
1921, Forest Fires	592				
Embryo Fires*	298	90,104	99	718,298	793

† Burned less than 5 acres.
* Burned less than 2 acres.

Fig. 20. The mountain tree line end of the new 8-mile phone line to Catfish Lookout Station. (See p. 78)

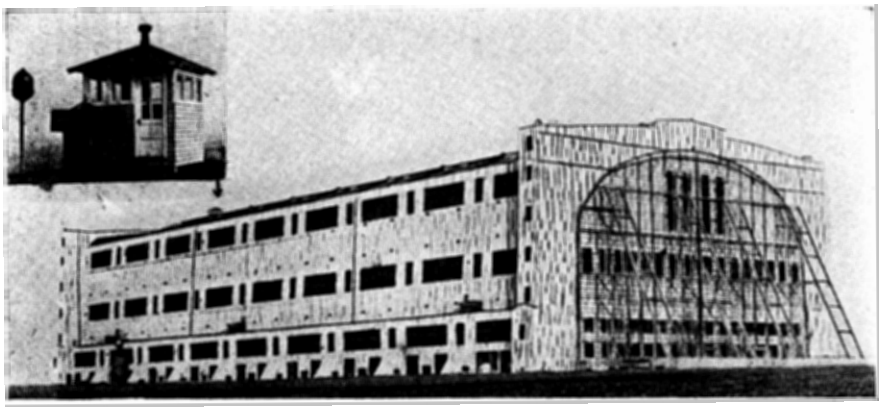

Fig. 21. The biggest lookout tower in New Jersey. Station on the huge naval hangar at Lakehurst. (See p. 78)

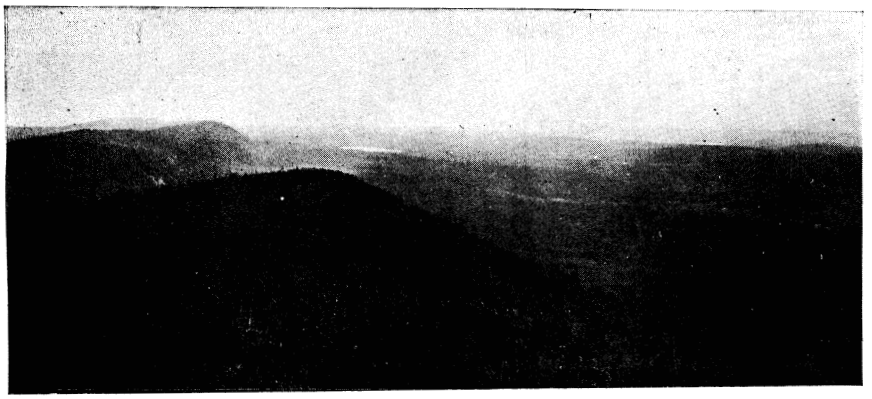

Fig. 22. The northward sweep of unbroken woodland on the Kittatinny ridge from Catfish Lookout Station.

FIRE LOOKOUTS MEAN PROMPT ACTION. TARDINESS MEANS BIG FOREST FIRES.

TABLE 2—FOREST FIRES BY RELATIVE AREA BURNED, AND BY COUNTIES, CALENDAR YEAR 1921.

COUNTY.	NUMBER OF FOREST FIRES.					Total Embryo Fires (less than 2 acres).
	2–10 Acres.	11–100 Acres.	101–1,000 Acres.	Over 1,000 Acres.	Total.	
North Jersey—						
Bergen, ...	16	7	1	...	24	19
Hunterdon, ...	...	...	1	...	1	1
Morris, ...	27	26	2	1	56	20
Passaic, ...	29	15	2	1	47	21
Somerset, ...	12	5	...	...	17	12
Sussex, ...	7	6	1	...	14	12
Union, ...	1	1	...	...	2	1
Warren, ...	10	6	1	...	17	12
Totals, ...	102	66	8	2	178	98
South Jersey—						
Atlantic, ...	43	28	15	2	88	47
Burlington, ...	13	19	5	2	39	14
Camden, ...	15	16	3	...	33	15
Cape May, ...	17	17	3	2	39	28
Cumberland, ...	25	24	14	...	63	22
Gloucester, ...	5	16	2	...	22	4
Mercer, ...	...	...	...	...	...	...
Middlesex, ...	9	13	...	...	22	6
Monmouth, ...	37	12	2	...	51	23
Ocean, ...	24	18	4	3	51	40
Salem, ...	1	1	1	...	3	1
Fires that burned in more than 1 county,	...	...	1	2	3	...
Totals, ...	189	164	49	11	414	200
State Totals,..	291	230	57	13	592	298
Per cent. of State totals, ...	33	26	7	1	67	33

TABLE 3—FOREST FIRES BY CAUSES AND COUNTIES, CALENDAR YEAR 1921

COUNTY	NUMBER										Totals	
	Locomotive		Brush Burning		Smokers		Miscellaneous		Unknown			
	FF	eF	FF	eF	FF	eF	FF	eF	FF	eF	FF	eF
North Jersey—												
Bergen	7	9	1	1	2	..	..	1	14	8	24	19
Hunterdon	..	..	..	..	1	1	..	..	..	..	1	1
Morris	14	10	6	2	9	3	4	1	23	4	56	20
Passaic	24	10	4	5	5	3	..	..	14	3	47	21
Somerset	..	..	4	1	3	0	2	5	8	6	17	12
Sussex	9	3	1	3	1	3	..	1	3	2	14	12
Union	..	..	2	..	..	..	..	..	..	1	2	1
Warren	5	8	5	..	..	1	..	..	7	3	17	12
Totals	59	40	23	12	21	11	6	8	69	27	178	98
South Jersey—												
Atlantic	35	20	5	4	10	9	7	..	31	14	88	47
Burlington	9	3	4	2	1	2	4	1	21	6	39	14
Camden	15	11	1	1	..	..	1	..	16	3	33	15
Cape May	15	19	5	1	1	..	1	..	17	8	39	28
Cumberland	8	2	2	2	8	2	1	1	44	15	63	22
Gloucester	2	2	9	..	3	..	1	..	7	2	22	4
Mercer	..	..	..	..	..	..	..	..	..	..	..	..
Middlesex	2	1	1	..	4	2	2	..	13	3	22	6
Monmouth	29	15	3	3	2	1	1	..	16	4	51	23
Ocean	14	34	6	1	11	..	2	..	18	5	51	40
Salem	..	..	1	..	2	..	..	..	..	1	3	1
Fires that burned in more than 1 county	1	..	..	..	1	..	..	..	1	..	3	..
Totals	130	107	37	14	43	16	20	2	184	61	414	200
State totals	189	147	60	26	64	27	26	10	253	88	592	298
Per cent of State totals	38		10		10		4		38		67	33

FF—Forest Fires.

eF—Embryo Fires (less than 2 acres).

TABLE 4—VIOLATIONS OF THE FIRE LAW, CALENDAR YEAR 1921.

Cause	Pending Jan. 1, 1922.	Settled Jan. 1, 1922.	Total.
Brush burning and camp fires,	21	61	82
Careless smoking,	...	4	4
Miscellaneous,	...	13	13
Total,	21	78	99
Erie R. R.,	9	24	33
D. L. and W. R. R.,	...	11	11
L. and H. R. R.,	...	1	1
L. and N. E. R. R.,	...	5	5
Morristown and Erie R. R.,	6	...	6
N. J. Central R. R.,	37	79	116
N. Y., S. and W. R. R.,	5	18	23
Penn. R. R.,	25	39	64
Rar. Riv. R. R.,	...	1	1
Reading R. R.,	16	31	47
Tuckerton R. R.,	...	...	...
Wharton and Northern R. R.,	...	...	...
Total R. R.,	98	209	307
Total all causes,	119	287	406
Per cent. of total,	29	71	...

TABLE 5—SUMMARY OF PENALTY WORK DONE, CALENDAR YEAR 1921.

YEAR OF ORIGIN.	Railroad Cases.			Cases From Other Causes.			Totals		
	Pending Jan. 1, 1920.	Settled Jan. 1, 1920.	Total.	Pending Jan. 1, 1920.	Settled Jan. 1, 1920.	Total.	Pending Jan. 1, 1920.	Settled Jan. 1, 1920.	Total.
1921 cases,	98	209	307	21	78	99	119	287	406
1920 cases,	21	73	94	4	14	18	25	87	112
1919 cases,	2	15	17	...	5	5	2	20	22
1918 cases,	...	8	8	...	1	1	...	9	9
Total,	121	305	426	25	98	123	146	403	549
Per cent, of total,	29	71	...	*20	80	...	27	73	...

*Does not include 3 technical violations—refusing to fight fire in Woodland Township.

TABLE 6—FOREST FIRES BY COUNTIES AND TOWNSHIPS. CALENDAR YEAR 1921.

COUNTY AND TOWNSHIP	Number		Acres Burned	Loss to Forests and Other Property	Cost to Extinguish	Paid by†		
	Forest Fires	Embryo Fires				Township	State	Offenders
Atlantic County—								
Absecon (City)	1	..	40	$100	$10.20	.....	.....	$10.20
Buena Vista	8	1	627	4,374	140.65	$54.97	$54.98	38.70
Egg Harbor	13	6	1,387	5,400	494.70	209.08	209.07	77.55
Egg Harbor (City)	5	5	43	99	77.50	34.75	34.75	8.00
Folsom	7	..	185	875	90.90	45.45	45.45	.....
Galloway	29	23	1,725	15,693	636.50	235.72	235.73	165.05
Hamilton	5	2	2,085	4,750	503.20	251.60	251.60	.....
Hammonton	5	4	888	4,665	320.35	156.68	156.67	7.00
Linwood	1	..	9	20	12.00	.....	.....	12.00
Mullica	13	1	478	1,475	282.00	129.50	129.61	22.80
Northfield (City)	..	..	.....	.....	.....	.....	.....	.....
Pleasantville	..	..	.....	.....	.....	.....	.....	.....
Port Republic	1	..	50	200	22.00	11.00	11.00	.....
Somers Point	..	..	.....	.....	.....	.....	.....	.....
Weymouth	3	5	961	5,121	184.81	92.40	92.41	.....
Total	91	47	8,478	42,772	2,874.81	1,321.15	1,222.27	341.30
Bergen County—								
Franklin	3	..	24	19	23.00	8.00	8.00	7.00
Hillsdale	3	8	97	345	55.00	22.50	22.50	10.00
Hohokus	6	..	67	893	94.75	47.37	47.38	.....
Montvale (Boro.)	1	..	6	20	9.00	4.50	4.50	.....
Oakland (Boro.)	4	6	45	177	47.50	7.50	7.50	32.50
Park Ridge (Boro.)	1	2	10	40	48.60	24.30	24.30	.....
Ridgefield (Boro.)	3	1	11	50	9.00	3.50	3.50	2.00
Washington	1	1	25	104	19.00	9.50	9.50	.....
Woodcliffe Lake	2	1	10	21	25.00	3.00	3.00	19.00
Total	24	19	295	1,669	330.85	130.17	130.18	70.50
Burlington County—								
Bass River	3	3	15,847	357.695	888.65	444.33	444.32	.....
Evesham	3	..	1,006	2,025	1,079.12	536.87	536.85	5.40
Medford	1	..	600	2,250	56.00	.....	.....	56.00
New Hanover	3	..	130	450	128.80	64.40	64.40	.....
Pemberton	6	6	414	2,200	168.10	72.55	82.55	13.00
Shamong	6	1	923	8,250	366.12	81.71	81.71	202.70
Southampton	3	..	23	195	36.70	18.10	18.10	.....
Tabernacle	7	2	398	7,750	417.14	154.82	154.82	107.50
Washington	4	..	1,269	1,230	191.30	95.65	95.65	.....
Woodland	7	2	3,257	7,415	158.30	65.40	92.90	.....
Total	43	14	23,868	389,460	3,489.73	1,533.82	1,571.31	384.60

TABLE 6—FOREST FIRES BY COUNTIES AND TOWNSHIPS, CALENDAR YEAR 1921—*Continued*

COUNTY AND TOWNSHIP	Number		Acres Burned	Loss to Forests and Other Property	Cost to Extinguish	Paid by†		
	Forest Fires	Embryo Fires				Township	State	Offenders
Camden County—								
Berlin	1	..	20	$25	$10.50	$5.25	$5.25	.....
Chesilhurst (Boro.)	..	2	.....	.....	9.25	2.12	2.13	5.00
Clementon	..	..	.....	.....	.....	.....	.....	.....
Delaware	..	..	.....	.....	.....	.....	.....	.....
Gloucester	8	2	182	1,060	190.50	92.75	92.75	5.00
Voorhees	3	..	135	1,000	56.00	28.00	28.00	.....
Waterford	6	3	205	595	222.90	60.25	60.25	102.40
Winslow	15	8	628	3,178	354.25	148.89	148.88	66.50
Total	33	15	1,170	5,858	843.40	337.26	337.26	178.90
Cape May County—								
Dennis	11	2	935	4,540	318.00	103.40	103.40	111.20
Lower	2	7	7	49	53.00	22.00	22.00	9.00
Middle	13	12	326	4,079	343.05	111.48	111.47	120.10
Upper	12	7	2,278	7,307	250.70	59.20	59.20	132.30
Woodbine (Boro.)	1	..	15	30	7.70	3.85	3.85	.....
Total	39	28	3,561	16,005	972.45	299.93	299.92	372.60
Cumberland County—								
Commercial	3	1	116	465	48.70	24.35	24.35	.....
Deerfield	9	1	588	3,640	194.20	73.65	73.65	50.40
Downe	2	2	500	2,157	86.10	43.05	43.05	.....
Fairfield	..	1	.....	.....	6.00	3.00	3.00	.....
Landis	20	2	1,804	7,555	470.55	228.78	228.77	17.00
Lawrence	2	1	12	100	35.00	3.00	3.00	29.00
Maurice River	4	1	1,878	8,135	414.30	207.15	207.15	.....
Millville (City)	24	13	1,206	3,048	711.90	319.24	319.26	78.40
Total	64	22	6,104	25,100	1,966.75	902.22	902.23	174.80
Gloucester County—								
Clayton (Boro.)	..	..	.....	.....	.....	.....	.....	.....
Elk	2	1	82	1,250	41.30	2.00	2.00	37.30
Franklin	13	2	666	3,030	252.75	105.62	105.63	41.50
Monroe	8	0	508	3,140	113.70	53.95	53.95	10.00
Washington	..	1	.....	.....	10.00	5.00	5.00	.....
Total	23	4	1,256	7,420	417.75	166.57	166.58	88.80

TABLE 6—FOREST FIRES BY COUNTIES AND TOWNSHIPS, CALENDAR YEAR 1921—*Continued*

COUNTY AND TOWNSHIP	Number		Acres Burned	Loss to Forests and Other Property	Cost to Extinguish	Paid by†		
	Forest Fires	Embryo Fires				Township	State	Offenders
Hunterdon County—								
Alexandria	..	..	.....	.....	.....	.....	.....	.....
Bethlehem	..	..	.....	.....	.....	.....	.....	.....
Clinton	..	..	.....	.....	.....	.....	.....	.....
Delaware	..	..	.....	.....	.....	.....	.....	.....
East Amwell	..	..	.....	.....	.....	.....	.....	..
Franklin	..	..	.....	.....	$6.00	$3.00	$3.00	.....
Holland	1	..	200	$1,000	50.10	25.05	25.05	.....
Kingwood	..	..	.....	.....	.....	.....	.....	.....
Lebanon	..	..	.....	.....	.....	.....	.....	.....
Tewksbury	..	..	.....	.....	.....	.....	.....	.....
West Amwell	..	1	.....	.....	1.00	.50	.50	.....
Total	1	1	200	1,000	57.10	28.55	28.55	.....
Mercer County—								
Hopewell	..	..	.....	.....	.....	.....	.....	.....
Princeton	..	..	.....	.....	.....	.....	.....	.....
Total	..	..	.....	.....	.....	.....	.....	.....
Middlesex County—								
East Brunswick	5	1	275	880	54.70	27.35	27.35	.....
Madison	5	..	52	132	86.00	14.55	14.55	56.90
Monroe	1	..	20	200	43.30	21.65	21.65	.....
Sayreville	10	5	117	357	95.70	44.86	44.84	6.00
South Brunswick	1	..	35	175	55.50	27.75	27.75	.....
Spotswood (Boro.)	..	..	.....	.....	.....	.....	.....	.....
Total	22	6	499	1,744	335.20	136.16	136.14	62.90
Monmouth County—								
Atlantic	4	..	345	1,575	96.90	24.95	24.95	47.00
Freehold	10	1	366	674	221.40	110.70	110.70	.....
Howell	30	17	274	3,240	434.50	66.55	66.55	301.40
Marlboro	1	3	4	30	39.70	10.35	10.35	19.00
Middletown	..	..	.....	.....	.....	.....	.....	.....
Ocean	1	..	2	50	14.80	7.40	7.40	.....
Shrewsbury	4	2	68	165	63.40	7.50	7.50	48.40
Wall	1	..	68	100	15.12	7.56	7.56	.....
Total	57	23	1,227	5,834	885.82	235.01	235.01	415.80

TABLE 6—FOREST FIRES BY COUNTIES AND TOWNSHIPS, CALENDAR YEAR 1921—*Continued*

COUNTY AND TOWNSHIP	Number		Acres Burned	Loss to Forests and Other Property	Cost to Extinguish	Paid by†		
	Forest Fires	Embryo Fires				Township	State	Offenders
Morris County—								
Boonton	2	1	25	$110	$33.90	$16.95	$16.95	.....
Chester	2	1	13	190	38.00	12.50	12.50	$13.00
Denville	4	1	58	835	80.00	27.00	27.00	26.00
Hanover	5	8	2,258	9,125	602.95	253.67	253.68	98.60
Jefferson	16	2	581	3,715	330.45	135.42	135.43	109.60
Mendham	1	1	150	50	60.40	30.20	30.20	.....
Montville	3	..	70	140	28.00	2.50	2.50	23.00
Morris	..	..	.....	.....	.....	.....	.....	.....
Mt. Arlington	..	1	.....	2	13.65	6.82	6.83	.....
Mt. Olive	2	1	28	275	38.60	8.35	16.80	13.45
Passaic	2	1	28	40	23.00	11.50	11.50	.....
Pequannock	1	1	2	15	25.00	2.80	2.80	19.40
Randolph	4	..	110	1,990	102.80	51.40	51.40	.....
Rockaway	6	..	119	995	97.65	37.42	37.43	22.80
Roxbury	6	2	207	1,055	134.55	24.59	24.61	85.35
Washington	2	..	15	2,925	68.00	34.00	34.00	.....
Total	56	20	3,664	21,462	1,676.95	655.12	663.63	411.20
Ocean County—								
Beachwood (Boro.)	1	..	1,500	700	231.60	.....	.....	231.60
Berkeley	10	..	614	11,410	510.53	145.04	145.04	222.15
Brick	1	..	3	30	10.00	5.00	5.00	.....
Dover	5	2	209	1,970	114.80	46.60	46.60	31.60
Eagleswood	1	..	2,040	6,000	168.40	84.20	84.20	.....
Jackson	7	2	2,938	7,215	319.10	140.75	162.55	15.80
Lacey	3	21	58	215	123.30	17.40	17.40	87.50
Lakehurst	..	..	.....	.....	.....	.....	.....	.....
Lakewood	5	..	2,165	11,715	149.40	56.35	56.35	36.70
Little Egg Harbor	1	1	13,200	9,020	716.71	358.36	358.35	.....
Manchester	14	2	4,223	71,865	502.50	206.75	280.75	15.00
Ocean	3	10	16	72	28.00	.....	.....	28.00
Ocean Gate	..	1	.....	.....	.....	.....	.....	.....
Plumstead	4	..	3,460	7,600	206.40	44.65	161.75	.....
Pt. Pleasant	2	1	9	25	26.00	13.00	13.00	.....
Stafford	2	..	2,085	5,005	333.85	166.93	166.92	.....
Union	1	..	3,500	22,500	79.00	39.50	39.50	.....
Total	60	40	36,020	155,342	3,519.59	1,324.53	1,537.41	668.35
Passaic County—								
Bloom'gdale (Boro.)	1	..	25	125	7.50	.....	.....	7.50
Ringwood (Boro.)	27	11	2,300	18,765	618.35	194.85	194.85	228.65
Wanaque (Boro.)	..	1	.....	.....	7.50	3.75	3.75	.....
West Milford	20	9	1,046	12,900	467.85	71.54	71.51	324.80
Total	48	21	3,371	31,790	1,101.20	270.14	270.11	560.95

TABLE 6—FOREST FIRES BY COUNTIES AND TOWNSHIPS, CALENDAR YEAR 1921—*Continued*

COUNTY AND TOWNSHIP	Number		Acres Burned	Loss to Forests and Other Property	Cost to Extinguish	Paid by†		
	Forest Fires	Embryo Fires				Township	State	Offenders
Salem County—								
Alloway	..	1	.....	$5	$5.50	$2.75	$2.75	.....
L. Alloways Cr.	..	..	.....	.....	.....	.....	.....	.....
Pittsgrove	2	..	207	1,070	74.00	37.00	37.00	.....
Quinton	..	..	.....	.....	.....	.....	.....	.....
Upper Pittsgrove	1	..	75	575	31.30	15.65	15.65	.....
Total	3	1	282	1,650	110.80	55.40	55.40	.....
Somerset County—								
Bernard	1	1	8	150	67.60	33.80	33.80	.....
Bridgewater	5	4	36	305	74.05	29.07	29.08	20.00
Far Hills	..	..	.....	.....	.....	.....	.....	.....
Hillsborough	..	..	.....	.....	.....	.....	.....	.....
Montgomery	..	..	.....	.....	.....	.....	.....	.....
North Plainfield	7	5	83	520	183.00	54.67	54.68	97.65
Warren	5	2	83	275	105.40	52.70	52.70	10.00
Total	18	12	210	1,250	430.05	170.24	170.26	127.65
Sussex County—								
Andover	1	..	35	575	8.00	.....	.....	8.00
Byram	..	1	.....	.....	7.50	.....	.....	7.50
Frankford	..	1	.....	5	16.00	8.00	8.00	.....
Franklin (Boro.)	..	..	.....	.....	.....	.....	.....	.....
Green	..	1	.....	.....	6.00	3.00	3.00	.....
Hampton	1	..	6	50	3.00	.....	.....	5.00
Hardyston	1	..	5	10	18.50	.....	.....	18.50
Hopatcong	..	..	.....	.....	.....	.....	.....	.....
Montague	..	2	.....	.....	47.60	11.55	23.05	13.00
Ogdensburg (Boro.)	1	..	2	10	2.00	.....	.....	2.00
Sandyston	..	2	.....	10	6.50	2.25	4.25	.....
Sparta	10	5	266	2,558	209.25	59.25	59.25	90.75
Stillwater	..	..	.....	.....	.....	.....	.....	.....
Vernon	..	..	.....	.....	3.50	1.75	1.75	.....
Walpack	..	..	.....	.....	.....	.....	.....	.....
Wantage	..	..	.....	.....	.....	.....	.....	.....
Total	14	12	314	3,218	327.85	85.80	99.30	144.75

TABLE 6—FOREST FIRES BY COUNTIES AND TOWNSHIPS, CALENDAR YEAR 1921—*Continued*

COUNTY AND TOWNSHIP	Number		Acres Burned	Loss to Forests and Other Property	Cost to Extinguish	Paid by†		
	Forest Fires	Embryo Fires				Township	State	Offenders
Union County—								
Mountainside	2	1	32	500	35.00	17.50	17.50	.....
New Providence	..	..	.....	.....	.....	.....	.....	.....
Scotch Plains	..	..	.....	.....	.....	.....	.....	.....
Springfield	..	..	.....	.....	.....	.....	.....	.....
Total	2	1	32	500	35.00	17.50	17.50	.....
Warren County—								
Allamuchy	..	..	.....	.....	.....	.....	.....	.....
Blairstown	1	4	3	275	43.00	.....	.....	43.00
Franklin	..	..	.....	.....	.....	.....	.....	.....
Frelinghuysen	..	..	.....	.....	.....	.....	.....	.....
Hardwick	2	..	303	4,755	153.00	6.00	6.00	141.00
Harmony	..	..	.....	.....	.....	.....	.....	.....
Hope	2	..	60	80	81.40	40.70	40.70	.....
Independence	..	1	.....	.....	4.00	.....	.....	4.00
Knowlton	4	4	50	260	42.20	.50	.50	42.20
Mansfield	1	..	60	300	49.60	24.80	24.80	.....
Pahaquarry	..	1	.....	.....	4.00	2.00	2.00	.....
Washington	7	2	77	554	92.30	41.41	41.39	9.50
White	..	..	.....	.....	.....	.....	.....	.....
Total	17	12	553	6,224	469.50	115.41	115.39	239.70
State Total	*607	*298	90,104	718,298	19,844.80	7,784.98	7,961.45	3,242.80

*The total of these two columns is greater than the actual number of separate fires (890) because in 15 cases one fire burned in two or more townships.

†The sum of these columns often differs from the "Cost to Extinguish" item because a fine was larger than the bill, or a bill was withdrawn, etc.

CALENDAR YEAR 1922.

TABLE 1—FOREST FIRES IN CALENDAR YEAR 1922 AND IN PREVIOUS YEARS.

YEARS	No. of Fires	Total Acres Burned	Acres per Fire	Total Loss	Loss per Fire
No organized service, incomplete reports					
1872	.....	100,000	.....	$1,000,000	.....
1880	54	71,074	1,316	252,240	$4,671
1885	.....	128,000	.....	1,128,000	.....
1895	49	66,120	1,349	600,000	12,245
1902	65	98,850	1,520	169,323	2,605
1903	79	85,046	1,076	305,744	3,870
1904	81	41,530	512	193,413	2,388
Organized fire service					
1907	167	11,525	69	11,647	70
1908	533	52,978	100	64,536	121
1909	563	93,525	166	133,944	238
1910	611	81,452	133	127,850	209
1911, Forest Fires	289				
Embryo Fires†	239	64,404	122	86,940	165
1912, Forest Fires	214				
Embryo Fires†	331	26,291	48	21,501	39
1913, Forest Fires	311				
Embryo Fires†	367	53,823	77	67,205	99
1914, Forest Fires	396				
Embryo Fires†	451	78,655	92	83,880	99
1915, Forest Fires	549				
Embryo Fires†	467	150,258	147	209,090	207
1916, Forest Fires	269				
Embryo Fires†	314	51,654	88	69,001	118
1917, Forest Fires	486				
Embryo Fires†	385	92,479	106	79,335	90
1918, Forest Fires	567				
Embryo Fires*	229	67,272	85	69,835	88
1919, Forest Fires	443				
Embryo Fires*	164	46,927	77	63,638	105
1920, Forest Fires	393				
Embryo Fires*	161	35,497	64	244,942	442
1921, Forest Fires	607				
Embryo Fires*	298	91,104	101	718,298	794
1922, Forest Fires	788				
Embryo Fires*	309	106,086	97	603,756	550

†Burned less than 5 acres.
*Burned less than 2 acres.

TABLE 2—FOREST FIRES BY RELATIVE AREA BURNED, AND BY COUNTIES, CALENDAR YEAR 1922.

COUNTY.	NUMBER OF FOREST FIRES.					Total Embryo Fires (less than 2 acres).
	2-10 Acres.	11-100 Acres.	101-1,000 Acres.	Over 1,000 Acres.	Total.	
North Jersey—						
Bergen	23	10	5	1	39	21
Hunterdon	4	7	4	...	15	2
Morris, ...	52	57	12	...	121	35
Passaic	20	30	10	...	60	19
Somerset	12	12	1	...	25	14
Sussex	12	20	3	1	36	20
Union	3	...	...	...	3	6
Warren	9	1	...	...	10	17
Totals	135	137	35	2	309	134
South Jersey—						
Atlantic	40	39	23	3	105	46
Burlington	9	11	9	5	34	3
Camden	17	27	9	...	53	19
Cape May.....	5	19	2	2	28	18
Cumberland ...	36	34	12	...	82	28
Gloucester	4	16	6	...	26	3
Mercer	2	1	...	...	3	2
Middlesex	16	16	4	...	36	1
Monmouth	30	11	9	...	50	17
Ocean	21	11	14	2	48	35
Salem	7	5	2	...	14	3
Fires that burned in more than 1 county,	...	...	...	...	...	...
Totals	187	190	90	12	479	175
State totals .	322	327	125	14	788	309
Per cent of State totals	29	30	12	1	72	28

TABLE 3—FOREST FIRES BY CAUSES AND COUNTIES, CALENDAR YEAR 1922.

COUNTY	NUMBER											
	Locomotive		Brush Burning		Smokers		Miscellaneous		Unknown		Totals	
	FF	eF	FF	eF	FF	eF	FF	eF	FF	eF	FF	eF
North Jersey—												
Bergen	8	6	4	4	2	..	2	..	23	11	39	21
Hunterdon	1	1	2	1	1	..	..	..	10	..	115	2
Morris	25	5	9	4	9	3	3	5	75	18	121	35
Passaic	10	5	6	2	6	1	..	2	38	9	60	19
Somerset	5	5	4	2	3	1	2	3	11	3	25	14
Sussex	10	5	6	2	4	2	2	2	13	9	36	20
Union	..	..	1	1	..	..	1	..	1	5	3	6
Warren	4	9	..	1	1	..	2	..	3	7	10	17
Totals	73	36	32	17	27	7	13	12	167	62	309	134
South Jersey—												
Atlantic	38	32	10	1	10	2	2	1	45	10	105	46
Burlington	1	..	11	..	1	1	3	..	18	2	34	3
Camden	18	9	6	..	2	..	2	..	25	10	53	19
Cape May	6	12	3	..	2	..	2	1	15	5	28	18
Cumberland	10	5	6	1	1	..	4	1	61	21	82	28
Gloucester	3	1	4	1	..	1	..	..	19	..	26	3
Mercer	..	..	1	1	1	..	..	1	1	..	3	2
Middlesex	8	..	3	..	2	..	1	1	22	..	36	1
Monmouth	26	10	1	..	9	1	1	1	13	5	50	17
Ocean	16	24	3	..	1	2	4	1	24	8	48	35
Salem	2	..	3	..	3	1	..	..	6	2	14	3
Fires that burned in more than 1 county	..	..	..	..	..	..	..	..	..	..	..	..
Totals	128	93	51	4	32	8	19	7	250	63	479	175
State totals	201	129	83	21	59	15	32	19	414	125	788	309
Per cent of State totals	30		9		7		5		49		1097	

FF—Forest Fires.

eF—Embryo Fires (less than 2 acres).

TABLE 4—VIOLATIONS OF THE FIRE LAW, CALENDAR YEAR 1922.

Cause	Pending Jan. 1, 1923.	Settled Jan. 1, 1923.	Total.
Brush burning and camp fires	30	93	123
Careless smoking	..	7	7
Miscellaneous	6	12	18
Total	36	112	148
Erie R. R.	1	6	7
D. L. & W. R. R.	7	28	35
Morristown and Erie R. R.	6	..	6
N. J. Central R. R.	44	40	84
N. Y. S. & W. R. R.	14	21	35
Penn. R. R.	45	65	110
L. & N. E. R. R.	4	1	5
Lehigh & Hudson R. R.	1	..	1
Raritan River R. R.	1	6	7
Reading R. R.	..	31	31
Total	123	198	321
Total all causes	159	310	469
Per cent of total	34	67	...

TABLE 5—SUMMARY OF PENALTY WORK DONE, CALENDAR YEAR 1922.

YEAR OF ORIGIN.	Railroad Cases.			Cases From Other Causes.			Totals.		
	Pending Jan. 1, 1922.	Settled Jan. 1, 1922.	Total.	Pending Jan. 1, 1922.	Settled Jan. 1, 1922.	Total.	Pending Jan. 1, 1922.	Settled Jan. 1, 1922.	Total.
1922 Cases	123	198	321	36	112	148	159	310	469
1921 Cases	9	95	104	2	30	32	11	125	136
1920 Cases	1	13	14	1	12	13	2	25	27
1919 Cases	1	...	1	...	1	...	1	1	2
Total	134	306	440	39	155	193	173	461	634
Per cent of total.		70			30				

TABLE 6—FOREST FIRES BY COUNTIES AND TOWNSHIPS, CALENDAR YEAR 1922.

COUNTY AND TOWNSHIP	Number		Acres Burned	Loss to Forests and Other Property	Cost to Extinguish	Paid by†		
	Forest Fires	Embryo Fires				Township	State	Offenders
Atlantic County—								
Absecon (City) ..	1	..	250	500	19.60	9.80	9.80	....
Buena Vista	7	1	810	3,865	199.70	87.10	87.10	28.00
Corbin City	1	..	70	350	41.00	20.50	20.50	....
Egg Harbor	12	6	2,210	10,660	560.89	280.45	280.45	....
Egg Harbor City..	3	2	28	65	74.50	7.75	7.75	59.00
Folsom	..	..	....	.....	.....	.....	.....	.....
Galloway	33	18	2,327	5,619	834.52	202.31	202.34	429.87
Hamilton	16	3	4,302	22,970	965.85	396.77	396.78	177.30
Hammonton	11	12	100	599	218.32	35.85	35.85	146.62
Linwood	..	1	....	.....	3.00	1.50	1.50	.....
Mullica	14	2	3,149	15,210	663.70	314.45	314.45	34.80
Northfield (City).	..	..	....	.....	.....	.....	.....	.....
Pleasantville	..	..	....	.....	.....	.....	.....	.....
Port Republic	1	..	1,500	3,580	143.90	71.95	71.95	.....
Somers Point	1	1	35	70	21.10	10.55	10.55	.....
Weymouth	3	..	595	2,700	122.40	61.20	61.20	.....
Total	103	46	15,376	81,564	3,868.48	1,500.18	1,500.21	875.59
Bergen County—								
Franklin	8	1	282	4,626	301.65	117.32	117.33	67.00
Franklin Lakes ...	2	..	163	3,630	24.50	.....	.....	24.50
Hillsdale	2	7	20	195	61.00	30.50	30.50	....
Hohokus	7	2	270	2,114	146.40	73.20	73.20	....
Montvale (Boro)..	..	..	....	.....	.....	.....	.....	....
Oakland (Boro)..	10	5	756	44,580	293.15	114.50	122.25	60.90
Park Ridge (Boro)	1	3	3	....	20.00	10.00	10.00	....
Ridgefield (Boro).	4	3	20	20	61.25	22.63	22.62	16.00
Washington	3	..	239	775	173.40	86.70	86.70	....
Woodcliffe Lake...	2	..	23	80	34.00	15.00	15.00	4.00
Total	39	21	1,776	56,020	1,115.35	469.85	477.60	172.40
Burlington County—								
Bass River	2	..	2,758	5,700	764.41	34.20	317.35	412.80
Evesham	3	..	311	3,010	50.60	20.80	20.80	9.00
Medford	5	..	234	430	161.32	72.91	72.91	15.50
New Haven	1	..	6	100	14.60	7.30	7.30	....
Pemberton	10	..	4,148	24,347	297.01	131.05	131.06	34.90
Shamong	1	1	15	150	15.20	7.60	7.60	....
Southampton	..	..	100	500	33.90	16.95	16.95	....
Tabernacle	4	..	320	3,300	206.50	54.40	54.40	97.70
Washington	2	2	1,550	4,610	201.59	100.80	100.79	50.00
Woodland	4	..	14,530	73,260	646.21	242.50	359.81	73.90
Total	32	3	23,972	115,907	2,391.34	688.51	1,088.97	693.86

TABLE 6—FOREST FIRES BY COUNTIES AND TOWNSHIPS, CALENDAR YEAR 1922—*Cont.*

COUNTY AND TOWNSHIP	Number		Acres Burned	Loss to Forests and Other Property	Cost to Extinguish	Paid by†		
	Forest Fires	Embryo Fires				Township	State	Offenders
Camden County—								
Berlin	6	1	109	1,025	137.20	68.60	68.60	....
Chesilhurst (Boro)	2	7	125	254	178.80	81.65	81.65	15.50
Clementon	1	..	45	140	16.00	8.00	8.00	10.00
Delaware	1	..	2	....	5.10	....	....	5.10
Gloucester	5	3	191	880	150.40	75.20	75.20	....
Voorhees	2	..	29	225	26.00	13.00	13.00	....
Waterford	8	1	491	2,880	297.05	101.80	101.80	93.15
Winslow	27	7	3,651	19,961	1,114.70	438.52	414.23	261.95
Total	53	19	4,643	25,365	1,925.25	786.77	762.48	385.70
Cape May County—								
Dennis	7	3	662	5,275	313.40	145.75	145.75	21.90
Lower	2	4	102	790	160.10	74.35	74.35	11.40
Middle	8	10	360	1,485	289.25	89.75	89.75	109.75
Upper	2	1	2,205	19,040	379.40	183.20	183.20	13.00
Woodbine (Boro)	6	..	830	4,385	261.50	117.00	117.00	27.50
Total	25	18	4,159	30,976	1,403.65	610.05	610.05	183.55
Cumberland County—								
Commercial	3	..	2,057	18,366	89.27	44.63	44.64	....
Deerfield	16	4	391	4,330	253.60	115.30	115.30	23.00
Downe	9	..	1,351	3,594	303.75	151.87	151.88	....
Fairfield	1	2	102	1,050	41.30	18.15	18.15	5.00
Landis	17	2	2,188	3,860	727.00	339.57	339.58	47.85
Lawrence	1	..	502	1,000	204.06	94.33	94.33	15.40
Maurice River	3	2	637	1,087	199.00	79.09	79.11	40.80
Millville (City)	30	18	2,585	6,554	1,461.85	673.41	673.44	115.00
Total	80	28	9,831	39,841	3,279.83	1,516.35	1,516.43	247.05
Gloucester County—								
Clayton (Boro)	1	..	75	250	10.50	5.25	5.25	....
Elk	1	..	14	231	9.00	.....	.....	9.00
Franklin	16	2	1,004	6,401	256.68	125.83	125.85	5.00
Monroe	8	1	1,108	6,365	167.20	62.25	62.25	44.30
Washington	..	..	....	.....	.....	.....	.....	....
Total	26	3	2,201	13,247	443.38	193.33	193.35	58.30

TABLE 6—FOREST FIRES BY COUNTIES AND TOWNSHIPS, CALENDAR YEAR 1922—*Cont.*

COUNTY AND TOWNSHIP	Number		Acres Burned	Loss to Forests and Other Property	Cost to Extinguish	Paid by†		
	Forest Fires	Embryo Fires				Township	State	Offenders
Hunterdon County—								
Alexandria	1	..	200	2,000	256.90	128.45	128.45	....
Bethlehem	1	..	125	250	22.60	11.30	11.30	....
Clinton	..	..	...	....	.....	.....	.....	....
Delaware	..	..	...	....	.....	.....	.....	....
East Amwell	..	..	150	1,500	90.80	45.40	45.40	....
Franklin	2	..	31	550	22.26	11.63	11.63	....
Holland	3	..	124	1,050	37.00	18.50	18.50	....
Kingwood	..	1	..,	....	5.00	.....	.....	5.00
Lebanon	4	..	335	2,290	212.50	125.25	125.25	....
Tewksbury	1	..	5	50	30.80	.....	.....	30.80
West Amwell	2	1	162	210	14.40	5.20	5.20	4.00
Total	14	2	1,132	7,900	692.26	345.73	350.83	39.80
Mercer County—								
Hopewell	1	..	50	400	16.80	8.40	8.40	....
Princeton	2	2	7	40	20.20	10.10	10.10	....
Total	3	2	57	440	37.00	18.50	18.50	....
Middlesex County—								
East Brunswick	11	..	197	720	73.40	36.70	36.70	....
Madison	6	..	328	615	230.05	107.12	107.13	15.80
Monroe	4	..	1,191	2,165	45.30	22.65	22.65	....
Sayreville	15	..	651	5,626	190.40	61.20	61.20	68.00
South Brunswick	..	1	...	....	.....	.....	.....	....
Spotswood (Boro)	..	..	...	....	.....	.....	.....	....
Total	36	1	2,367	9,126	539.15	227.67	227.68	83.80
Monmouth County—								
Atlantic	1	..	600	3,000	24.35	.....	.....	24.35
Freehold	5	3	826	1,630	380.50	190.25	190.25	....
Howell	28	11	656	6,071	1,103.60	414.75	414.75	274.10
Marlboro	2	..	10	100	40.00	20.00	20.00	....
Middletown	..	..	...	....	.....	.....	.....	....
Ocean	..	..	...	....	.....	.....	.....	....
Shrewsbury	7	2	102	290	93.70	29.45	29.45	34.80
Wall	5	1	845	6,100	107.90	51.45	51.45	5.00
Total	48	17	3,039	17,191	1,750.05	705.90	705.90	338.25

TABLE 6—FOREST FIRES BY COUNTIES AND TOWNSHIPS, CALENDAR YEAR 1922—*Cont.*

COUNTY AND TOWNSHIP	Number		Acres Burned	Loss to Forests and Other Property	Cost to Extinguish	Paid by†		
	Forest Fires	Embryo Fires				Township	State	Offenders
Morris County—								
Boonton	1	2	20	200	28.50	14.02	14.03	10.00
Chester	3	..	77	170	167.65	83.83	83.82	....
Denville	7	3	148	845	147.20	36.75	36.75	73.70
Hanover	28	4	2,093	11,960	1,295.65	583.13	583.12	129.40
Jefferson	9	1	427	3,065	279.30	101.85	101.85	75.60
Kinnelon	..	..	....	.....	.....	.....	.....	.....
Mendham	3	1	223	735	92.50	36.25	36.25	20.00
Montville	5	1	120	1,220	90.00	45.00	45.00	....
Morris	9	6	206	1,411	335.35	159.68	159.67	16.00
Mt. Arlington	1	..	5	25	13.60	6.80	6.80	....
Mt. Olive	5	5	68	768	196.15	92.58	92.57	11.00
Passaic	3	3	7	110	66.00	16.00	16.00	34.00
Pequannock	..	..	....	.....	.....	.....	.....	.....
Randolph	3	2	40	140	95.55	47.77	47.78	.....
Rockaway	22	2	1,133	8,259	871.11	434.05	434.05	3.00
Roxbury	18	3	1,650	5,410	654.66	241.23	241.23	172.20
Washington	3	2	61	1,290	123.10	58.55	58.55	6.00
Total	120	35	6,278	35,608	4,455.86	1,957.49	1,957.47	550.90
Ocean County—								
Beachwood (Boro)	..	..	10	20	29.00	14.50	14.50	.....
Berkeley	7	3	1,791	6,015	454.00	175.55	175.55	102.90
Brick	1	..	10,005	10,025	404.60	202.30	202.30	.....
Dover	5	1	584	2,285	265.20	75.05	75.05	132.50
Eagleswood	..	..	....	.....	.....	.....	.....	.....
Jackson	6	1	1,634	6,550	450.20	221.30	221.30	7.60
Lacey	1	17	5	9,350	93.50	6.50	6.50	80.50
Lakehurst	..	..	300	15,000	137.75	68.87	68.88	.....
Lakewood	1	..	3	10	6.00	.....	.....	6.00
Little Egg Harbor	..	..	...	.....	6.90	3.45	3.45	.....
Manchester	11	6	534	2,630	296.10	39.10	39.10	217.90
Ocean	3	5	203	712	45.00	3.50	3.50	38.00
Ocean Gate	1	..	4	40	19.40	.....	.....	19.40
Plumstead	3	2	530	12,750	51.70	25.85	25.85	.....
Pt. Pleasant (Boro)	..	..	300	300	187.90	93.95	93.95	.....
Stafford	2	..	7	25	18.00	9.00	9.00	.....
Union	1	..	25	250	38.70	19.35	19.35	.....
Total	42	35	15,935	65,962	2,503.95	958.27	958.28	604.80
Passaic County—								
Bloom'gd'le (Boro)	6	1	385	6,005	128.70	64.35	64.35	.....
Ringwood (Boro)	22	5	1,977	22,510	803.15	376.43	376.42	100.30
Wanaque (Boro)	13	1	491	5,194	602.10	301.05	301.05	.....
West Milford	19	12	2,927	.....	1,286.75	544.89	544.91	216.95
Total	60	19	5,780	33,709	2,820.70	1,286.72	1,286.73	317.25

TABLE 6—FOREST FIRES BY COUNTIES AND TOWNSHIPS, CALENDAR YEAR 1922—*Cont.*

COUNTY AND TOWNSHIP	Number		Acres Burned	Loss to Forests and Other Property	Cost to Extinguish	Paid by†		
	Forest Fires	Embryo Fires				Township	State	Offenders
Salem County—								
Alloway	3	1	784	2,175	89.65	44.83	44.82	.....
L. Alloways Cr.	1	..	...	20	3.00	1.50	1.50	.....
Pittsgrove	5	2	118	790	77.25	25.00	25.00	27.25
Quinton	3	..	159	590	61.90	30.95	30.95	.....
Upper Pittsgrove	2	..	105	270	50.65	18.97	18.98	12.70
Total	14	3	1,166	3,845	282.45	121.25	121.25	39.95
Somerset County—								
Bernard	7	9	104	450	360.70	65.25	65.25	230.20
Bridgewater	3	2	77	660	89.10	44.55	44.55	.....
Far Hills	1	..	5	15	5.00	.....	.....	5.00
Hillsborough	..	..	520	21,200	214.80	107.40	107.40	.....
Montgomery	..	..	...	.....	.....	.....	.....	.....
North Plainfield	9	3	445	2,200	372.45	148.98	148.97	74.50
Warren	5	..	47	495	72.20	19.55	19.55	33.10
Total	25	14	1,198	25,020	1,114.25	385.73	385.72	342.80
Sussex County—								
Andover	..	1	...	.....	3.00	1.50	1.50	.....
Byram	3	3	530	4,561	349.42	164.21	164.21	21.00
Frankford	3	1	21	129	61.80	20.70	20.70	20.40
Franklin (Boro)	2	..	52	500	58.90	29.45	29.45	.....
Green	..	..	...	.....	.....	.....	.....	.....
Hampton	2	2	11	74	32.00	16.00	16.00	.....
Hardyston	7	7	497	6,118	391.76	83.20	83.20	225.36
Hopatcong	1	..	42	200	241.60	86.30	86.30	69.00
Montague	3	1	3,615	18,125	2,912.09	1,397.24	1,514.85	.....
Ogdensb'rg (Boro)	2	..	45	450	37.70	13.23	13.22	11.25
Sandyston	3	1	71	165	97.70	48.85	48.85	.....
Sparta	2	2	77	565	34.10	9.00	9.00	16.10
Stillwater	1	2	175	1,275	78.25	39.12	39.13	.....
Vernon	5	..	289	1,240	128.25	35.62	35.63	57.00
Walpack	1	..	2	25	15.00	7.50	7.50	.....
Wantage	..	..	1,500	7,500	769.82	384.91	384.91	.....
Total	35	20	6,927	40,927	5,211.39	2,336.83	2,454.45	420.11

TABLE 6—FOREST FIRES BY COUNTIES AND TOWNSHIPS, CALENDAR YEAR 1922—*Cont.*

COUNTY AND TOWNSHIP	Number		Acres Burned	Loss to Forests and Other Property	Cost to Extinguish	Paid by†		
	Forest Fires	Embryo Fires				Township	State	Offenders
Union County—								
Mountainside	2	1	12	210	44.40	22.20	22.20	10.00
New Providence ..	..	..	...	.....	.....	.....	.....	.....
Scotch Plains	1	3	7	20	40.00	20.00	20.00	.....
Springfield	..	2	...	.....	21.00	10.50	10.50	.....
Total	3	6	19	230	105.40	52.70	52.70	10.00
Warren County—								
Allamuchy	..	1	...	.....	11.00	5.50	5.50	.....
Blairstown	..	1	...	.....	9.00	4.50	4.50	.....
Franklin	..	..	...	.....	.....	.....	.....	.....
Frelinghuysen	..	..	...	.....	.....	.....	.....	.....
Hardwick	1	1	25	210	121.30	60.65	60.65	.....
Harmony	1	1	40	200	43.20	21.60	21.60	.....
Hope	1	..	100	230	94.20	47.10	47.10	.....
Independence	1	..	40	160	24.00	12.00	12.00	.....
Knowlton	5	11	20	68	98.40	15.20	15.20	68.00
Mansfield	..	..	...	.....	.....	.....	.....	.....
Pahaquarry	..	..	...	.....	.....	.....	.....	.....
Washington	1	2	5	10	27.25	13.62	13.63	.....
White	..	..	...	.....	.....	.....	.....	.....
Total	10	17	230	878	428.35	180.17	180.18	68.00
State Total	788	309	106,086	603,756	•34,368.09	14,342.02	14,848.78	5,432.11

†The sum of these columns often differs from the "Cost to Extinguish" item because a fine was larger than the bill, or a bill was withdrawn, etc.

Land Registry and Publicity

T. O. COOK

The close of the fiscal year 1923 completes the fourth year of the Land Registry, created to advertise the State's farming, residential and recreational advantages and to obtain the data necessary to give inquirers definite and trustworthy information and assistance in locating within its borders.

The first undertaking was to attract farmers to our soil; that project, now well under way, has been continued. Much time and attention has been directed to promoting the State's industrial advantages and residential and recreational attractions. The effort is beginning to make itself felt though it is still too soon to measure positive and complete results.

GENERAL PUBLICITY

Methods.—The same methods of publicity have been employed as heretofore, as the funds available do not permit of the extensive advertising which will be necessary to acquaint the people in other sections with the State's real attractions. The booklets, "New Jersey for Progressive Farmers," and "Industrial Opportunities in New Jersey," which have been published and distributed during the last two years have set a standard for this kind of publicity and have been of great value. While continuing the distribution of such literature, other circulars have been published and special articles written. A small amount of newspaper and magazine advertising has been carried on, circular letters distributed and frequent press bulletins issued. In addition photographs and other material have been distributed, some to foreign countries and parts of the Middle West, and material for future publications has been collected from time to time.

Photographic file.—A file has been prepared containing 250 carefully selected photographs, the negatives of which are in our possession, and 150 prints from other sources. This collection includes views relating to agriculture, industries, resorts, homes, communications, and mosquito extermination work and will be of great value for supplying photographic material for publicity purposes.

Fig. 23. There is still good timber cut from our forests, but we pay more than 5 million dollars annually for freight alone on imported timber which we could grow at home.

Fig. 24. The sawmill industry of the state is largely temporary, transient, intermittent, therefore poorly equipped, inefficient and wasteful. Woodland protection and care will make a permanent, effective industry possible.

NEW JERSEY PRODUCES ONLY 1/10 OF THE SAWN LUMBER SHE USES. HER WOODLANDS COULD SUPPLY HER WHOLE NEED.

FARM SETTLEMENT AND UNDEVELOPED LANDS

Farm settlement.—The farm-registry work has been continued with few slight changes. The depression now being felt by agriculturists has resulted in a falling off in the number of persons seeking land for farming purposes. This condition was noticed during the latter part of 1921 and has continued to some extent up to the present time. Inquirers have been supplied with definite information regarding the opportunities offered, descriptions of farms have been distributed, and when necessary farms and tracts of land have been inspected.

Advertising.—The paid advertising during the year 1922 cost about $250 and consisted only in the insertion of a small advertisement two or three times each in seven different farm papers covering various types of farming. For the money invested a satisfactory number of replies was received, but it is to be regretted that a larger sum is not available in order that a more extensive effort might be made to attract the right type of farmers to this State.

Several articles have been prepared by or in cooperation with this office which have appeared in different publications. Among these was a feature story in a large eastern farm paper on the farming opportunities in New Jersey. Some of the material presented came from this office. Reprints of this article were obtained and several hundred copies distributed with the farming booklet.

Results.—In most cases it is impossible to obtain direct word regarding families which have located as a result of this work. Our files show some letters from such persons. Follow-up correspondence also brings positive answers. We know that our literature frequently falls into the hands of parties who come to the State but of whom we have no record. In other cases action is not taken immediately so that returns must be cumulative and extend over a long period.

An attempt has been made to determine to some extent the effect of this work on the movement of farm settlers to New Jersey. A survey was made of recorded farm deeds in several South Jersey counties. In Salem, Cumberland, Atlantic, Ocean and Monmouth Counties, deeds recorded during a period of five months in 1920-21 show 154 farms (5206 acres) sold to persons from other states. During the same period in the year 1921-22, and in the same counties, the survey shows that 166 farms of 6039 acres had been sold to outside parties. Several county agricultural agents have reported numerous families located in their respective counties as a direct result of our effort. The Ocean County agent reports that at least twenty-five families located in Ocean County through this office. Local farm agencies which have cooperated with us in the distribution of several hundred copies of the

booklet, "New Jersey for Progressive Farmers," report many sales to outside parties. One agency reported 25 farms, totaling 2212 acres, sold to settlers from southern and western states. Over eight thousand copies of the farm booklet have been distributed to date, each one being forwarded upon individual request. This publication has been of immeasurable value in supplying definite and detailed information about our farming sections and our unexcelled opportunities. We now have on file about 3500 names of persons who have written regarding farming opportunities while hundreds of letters have been received from families thanking us for the information or assistance given.

Movement of settlers.—It is evident that there has been an increased demand for farming lands in the East during recent years. While this movement has slackened somewhat due to the present depression in the agricultural and business world it seems that New Jersey is beginning to get its share of farm settlers and that the movement is toward, rather than away from the State. As a criterion of this movement and to check the figures obtained by the survey of recorded farm deeds, data have been compiled from the records of several large farm agencies operating in New Jersey and the figures of a representative agency of this type are given. Of the total number of 426 farms sold in New Jersey, residents testified to their confidence in the farms of their home state by purchasing 176 of them during the year. The remaining 250 farms were sold to families from 17 states and foreign countries. Through this same agency 189 farms in other states were sold to New Jersey families. These figures indicate that the State gained 61 families as a result of these sales alone.

Types of Land.—Land sought by new settlers can be divided into three general classes: (1) developed farms or those now being operated, (2) run-down or idle farms, and (3) undeveloped land. Farms of the first class are found in all parts of the State, the section depending on the type of farming desired. Many farms now idle are to be had in several of the northern counties where dairy farming predominates, although occasional farms of this kind can be found in all sections. During the war period and shortly afterward the scarcity of labor on these large-sized farms resulted in numerous farms in that part of the State being left idle. Properties of this type are obtainable at a low price and offer opportunities to a certain class of ambitious settlers having small capital. Undeveloped land is in demand by foreigners and others for colonization purposes as well as for small individual farms. Hundreds of acres of such land are to be found in Atlantic, Cape May, Cumberland, Ocean, Burlington and Gloucester Counties.

Undeveloped land.—Numerous requests have been received for information regarding large tracts of undeveloped land. This has been supplied whenever possible from our records, and, when necessary, tracts of such land have been located for special purposes. Land development plans of various kinds have been investigated. This office has also been in touch with the development plan undertaken by the Toms River Chamber of Commerce by which a two hundred acre tract of brush land within 1½ miles of Toms River is being divided into ten and fifteen-acre poultry farms, each of which when completed will be offered to settlers as a going business with easy terms of payment. This type of agricultural development is along the right line and speaks well for the progressiveness of the community and organization which are sponsoring it.

INDUSTRIAL AND RECREATIONAL DEVELOPMENT

Industries.—Through the medium of a 32-page booklet entitled, "Industrial Opportunities in New Jersey," over four thousand copies of which were distributed during the years 1922 and 1923 an effort has been made to supply reliable information to those seeking new industrial locations and to call attention to the many opportunities offered in all parts of the State, especially in the smaller towns and rural sections, for development purposes. Through various agencies, especially the local chambers of commerce, boards of trade and other commercial organizations, an attempt has been made to distribute this publication so that it will not be wasted. Many of the trade papers have carried reading notices describing the booklet and its contents. While development work of this kind takes years to make itself felt it is believed that a beginning has been made.

Resorts.—No concentrated effort has ever been made to advertise properly the wonderful facilities which are offered in New Jersey for recreational purposes. Many communities individually have published and distributed pamphlets and leaflets of various kinds but the time is now ripe, and the need apparent, for an organized drive to place before the people of the country the playgrounds possessed by no other state or country. Anticipating this demand for publicity material featuring our resorts a speciail effort has been made to collect data and photographs covering all sections but it is to be regretted that funds are not available to place this material in booklet form. Especially is this unfortunate when it is realized how much can be accomplished in this field with the proper kind of literature.

SPECIAL PUBLICITY

Educational edition of industrial booklet.—The great demand from school authorities, teachers and pupils for copies of our industrial

booklet was felt as soon as the publication was off the press. As it was impossible to supply this demand from our small quantity of five thousand copies and because the material contained therein would be valuable for school use and thereby help to create state pride, the matter was brought to the attention of the Commissioner of Education. A special edition of 3,000 copies, for school use only, was published at the cost of that Department.

Articles.—A series of special articles dealing with the advantages and attractions of our State and another series outlining the work of the various branches of the Department were prepared and published in the monthly "Bulletin" of the Atlantic City Chamber of Commerce. In addition, material was supplied for a special publication called the "Tourists Guide of New Jersey" which has a wide circulation throughout the United States among hotels, automobile clubs, and places where tourists can be reached. Photographs and other data were also furnished for a series of articles on automobile tours in New Jersey. Whenever possible material has been sent out covering some phase of the mosquito extermination work, resulting in considerable space being obtained in the press in various sections.

NEEDS

Although a certain amount of good can always be accomplished by carrying on work of this kind in a limited way, little real progress can be made without adequate funds being available to conduct all phases of it in a systematic and business-like manner. Surely no state can profit more by such publicity than New Jersey. For years exaggerated accounts of the mosquito pest and misrepresentation of the adaptability of our light soils for farming purposes have resulted in an unfavorable impression and loss of money to the State in ways which can only be discounted by an active advertising campaign. A booklet covering the resorts of the State is an immediate need. There is also a demand for a general publication including substance of the material contained in the agricultural and industrial booklets and that which will appear in the proposed recreational pamphlet. Funds are likewise needed to advertise our advantages in appropriate magazines and papers, to prepare and stage exhibits at various fairs and conventions in other States, to distribute literature efficiently, and for miscellaneous purposes. It is believed that an appropriation of $25,000 divided as follows will not only allow us to make a proper beginning, but will show returns far greater than can be estimated.

Publications and Printing	$ 7,000
Advertising in Publications	13,000
Preparing and staging exhibits outside the State	3,000
Miscellaneous, including distribution of literature, etc.	2,000
	$25,000

PUBLICATIONS

In addition to the annual administrative report for 1921, the staff has prepared and the Department has published:

Report on the Water Resources of the State and Their Development.—A 76-page booklet prepared by Allen Hazen of the engineering firm of Hazen, Whipple and Fuller, New York City. The report is illustrated by maps, charts, and tables, 2,000 copies.

Mineral Production in New Jersey During 1919-1920.—A reprint of the appendix of the 1921 Annual Report, 1,000 copies.

A Question of Unemployment, New Jersey Pays the Freight, and A State Fire Insurance Policy.—Three broadsides explaining the forest fire situation and the need for an augmented Forest Fire Service, 1,000 of each.

List of Firewardens.—A directory of the members of the Forest Service with their addresses, 1200 copies.

A Lookout Guide of New Jersey.—A 12-page booklet intended for motorists and hikers. It contains descriptions, photographs and road maps of the 10 lookout towers in the State which were in operation at the time of printing, 7,000 copies.

Souvenir Post Card for Belle Plain Lookout.—An addition to the series of lookout tower cards, 500 cards.

Forest Fire Prevention and Highway Construction.—A reprint of a 6-page folder published by the Department and distributed by the State Highway Commission in an endeavor to reduce the number of forest fires originating from highway construction, 2,000 copies.

Forestry for Profit—An 88-page booklet of advice and information for owners of New Jersey woodland and others interested in forestry.

Why Forestry in New Jersey.—A small pamphlet giving in popular form sound reasons why practical forestry methods should be employed in New Jersey.

Road Maps of New Jersey.—Revised edition showing the highways of the State as of March 1, 1922, on a scale of four miles to the inch, 1500 copies. Reprint ordered after close of fiscal year.

School Lending Collections.—20-page catalogue of educational material available from the State Museum, revised for 1922, 5,000 copies.