



Fig. 1. Forestry with farming will solve the problem of New Jersey's idle land.

REPORTS OF THE
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
STATE OF NEW JERSEY

ANNUAL REPORT

FOR THE

Year Ending June 30, 1920

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

—
1920

Letter of Transmittal.

To His Excellency, Edward I. Edwards, Governor :

Sir—I have the honor to submit for your information, and for transmittal to the Legislature as required by law, the annual report of the Department of Conservation and Development for the fiscal year ending June 30, 1920. It includes reports by the Board, the State Geologist, the State Forester, and the State Firewarden.

By direction of the Board of Conservation and Development.

Very respectfully yours,

ALFRED GASKILL,

Director.

State House, October 6, 1920.

CONTENTS.

	PAGE.
Personnel,	5
Report of the Board of Conservation and Development,.....	7-28
Membership,	7
Personnel,	8
Unsuitable Offices,	8
Our Undertaking,	9
Mosquito Control,	10
Land Registry,	12
Forestry,	13
A Memorial Forest Park,	16
Water Resources,	18
The Problem of the Passaic Meadows,	20
State Museum,	21
Testing Laboratory,	22
Soil Survey,	22
Potash,	22
Mining,	23
Highway Improvement,	23
Washington Crossing Memorial,	24
Publications,	25
Needs,	26
Financial Statement,	29-31
Report of the State Geologist,	33-78
Topography and Engineering,	33
Bench Marks,	33
Mineral Statistics,	35
Soil Survey,	35
Greensand Marl,	36
State Museum,	48
Testing Laboratory,	53
Oil in New Jersey,	61
Iron Mines,	62
Zinc Mines,	64
Permits for the Diversion of Water,	64
Borough of Mendham,	65
Town of Montclair,	65
Town of Bloomfield,	70
Borough of Sayreville,	70
Borough of Wharton,	70
Elizabethtown Water Co. et al,	71

CONTENTS.

	PAGE.
Report of State Geologist—	
Extensions of Time,	71
Excess Diversion Charges,	72
Collection of Back Charges,	73
Measurement of Water Consumption,	74
Plans for Dams,	74
Inspection of Old Dams,	75
Failure of Dams,	75
Unsafe Dams,	76
Stream Gaging,	77
Underground Water Studies,	78
Report of the State Forester,	79-90
Forestry Has Arrived,	79
Policy and Organization,	79
Why We Need Forestry,	80
Forest Fire Protection,	80
Aid to Woodland Owners,	81
Examples of Applied Forestry,	82
Timber Markets,	85
State Forests,	86
Shade Trees,	89
Insects and Diseases,	90
State Aid,	90
Report of the State Firewarden,	91-111
The Fire Season,	91
Number and Areas of Fires,	92
Causes of Fires,	93
The Forest Fire Service,	95
The State Force,	95
Local Organization,	95
Lookouts,	97
Federal co-operation,	99
Value of the Service,	99
Needs of the Service,	100
Violations of the Law,	100

ILLUSTRATIONS.

		PAGE.
Fig.	1. Forestry with farming will solve the problem of New Jersey's idle land, .....Frontispiece	
	2. Ranger's headquarters,	14
	3. A trout stream,	14
	4. Pine plantation twelve years old,	14
	5. Road cleared for fire protection,	14
	6. A popular publication,	20
	7. Illustration from "New Jersey for Progressive Farmers,"	20
	8. A dairy farm on low-priced, newly-cleared land,	25
9-11.	Comfortable homes on Jersey farms,	25
12.	Map from "New Jersey for Progressive Farmers,".....	28
13.	Twenty-five of New Jersey's most important commercial woods are described on charts like this for school study,	48
	14. Room in which bituminous road material is tested,.....	58
	15. Crushing test of a block of road concrete,	58
	16. Site of a water power development in Ocean County,....	70
	17. A stream gaging station. Measurements are taken at the point where the wire crosses the stream,	70
	18. A maturing forest with the next generation started,....	79
	19. Pine woodlot in South Jersey,	82
	20. Typical hardwood woodlot,	82
21-22.	Idle fields, unfit for farming, put to work by planting forests,	86
	23. Thrifty pine plantation eight years old,	86
	24. Pine plantation twenty-six years old, already profitable,	86
	25. Roadsides cleaned like this are a public benefit,	91
	26. Roadsides untended like this invite accidents and fires,..	91
	27. The result of an unkempt roadside and a smoker's carelessness,	91
	28. Beating out a surface fire,	96
	29. Sanding out a forest fire,	96
	30. A water crew on a hot fire,	96
	31. McKeestown Station,	101
	32. Kinney Station,	101
	33. Edison Station,	101
	34. Batsto Station,	101
	35. Windbeam Station,	101
	36. Cedar Pond Station,	101
	37. Culvers Station,	101

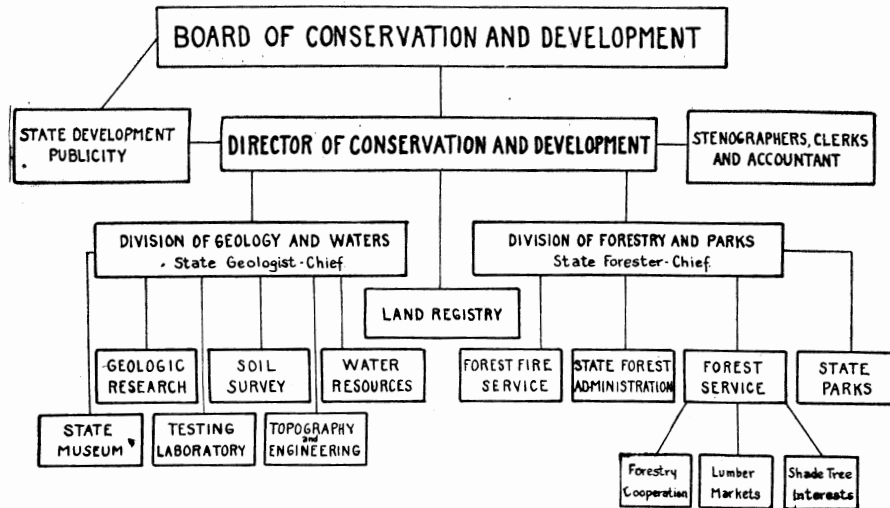
The Department of Conservation and Development.

OFFICE, STATE HOUSE ANNEX, TRENTON.

The Board of Conservation and Development.

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 W. EDWIN FLORANCE,New Brunswick
 JOHN L. KUSER,Bordentown
 SIMON P. NORTHRUP,Newark
 WILLIAM E. TUTTLE, Jr.,Westfield
 JOHN A. WATERS,Gloucester City
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 HENRY B. KUMMEL, Trenton,*State Geologist*
 M. W. TWITCHELL, Trenton,*Assistant State Geologist*
 J. VOLNEY LEWIS, New Brunswick,*Consulting Geologist*
 H. T. CRITCHLOW, Trenton,*Water Engineer*
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 W. M. BAKER, Lawrenceville,*Assistant Forester*
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 KATHRYN B. GREYWACZ, Trenton,*Acting Museum Curator*
 EDWARD C. STOVER, Jr., Trenton,*Publicity Agent*
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 L. L. LEE,*Senior Soil Classifier*
 WILLIAM LINDSAY, Trenton,*Assistant State Firewarden*
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 LEONIDAS COYLE, Bridgeton,*Division Firewarden*
 LEROY S. FALES, Newton,*Division Firewarden*



Report of the Board of Conservation and Development

This report covers the official year ending June 30, 1920. In reviewing the work that has been done the Board realizes the magnitude, diversity and importance of the interests committed to its care. It finds at the end of five years' activity that a material advance has been made in the development of our latent, or neglected resources; that the Department's standing, outside the State as well as within it, is well established; that co-ordination of effort through a union of allied interests makes for efficiency; and that an effective co-operation with other State agencies is in force.

The Board believes that out of many elements has been created a coherent State Department, whose varied activities give breadth to its efforts and deepen the public interest. The aim has been to develop, as well as to conserve, the State's resources. To that end it has consistently sought, and still seeks, the means to carry out several projects of great importance to the public. Provision for these is not expenditure, but investment. New Jersey has a great future if all that nature has endowed us with is wisely husbanded. The Department's accomplishment, and its plans for the future, are here summarized, fuller details being submitted in the reports of the several administrative officers presented herewith.

MEMBERSHIP.

Several changes have been made. Mr. J. Kearney Rice, appointed by Governor Edge as a member of the Board in succession to Mr. George A. Steele, was obliged to resign on account of ill health without taking his seat, and shortly afterwards died. Mr. W. Edwin Florance, of Middlesex County, was appointed in his stead.

In May Mr. Isaac F. Richey also resigned on account of ill health. The vacancy has been filled by the appointment of Mr. Owen Winston of Morris County.

8 CONSERVATION AND DEVELOPMENT.

On July 1, 1920, Mr. John A. Waters, of Camden County, became a member of the Board in succession to Mr. William J. Kraft.

Mr. Percival Chrystie was elected President for the year beginning July 1, 1920.

PERSONNEL.

A few changes have been made in the personnel of the Department, the most important being the resignation of Miss Helen C. Perry, Curator of the Museum, who retired in March, and Mr. C. C. Engle, Senior Soil Classifier, who resigned in September to enter private business.

Though it has been possible to find acceptable men or women to do the work of the Department, it is increasingly difficult to fill vacancies, especially in the technical force, under the salary schedules now ruling, and it seems to be clear that unless the State shall make more liberal provision for compensating the skilled men in its service, both quality and quantity of the work done is sure to deteriorate. The act passed by the last Legislature, under which bonuses amounting to \$7,067.60 were paid members of the Department helped somewhat the deficiencies in the salary schedules, although its application in several cases was inequitable. The Board holds that the Department's interest and the State's interest are identical in requiring a better provision for its employees, of whom there are now 63, 11 more than last year.

Of these 23 are on the pay rolls of co-operating departments, or of the Federal Government.

UNSUITABLE OFFICES.

The Department has been seriously handicapped by restricted, inconvenient, uncomfortable, and unsanitary offices. Its records are constantly exposed to the danger of loss by fire. The State's failure to provide adequate accommodations in or near the State House for its working forces is costly and reprehensible, it being, under present conditions, impossible to maintain high efficiency.

REPORT OF THE BOARD.

9

It should be noted that this is only one or several departments which are so burdened.

OUR UNDERTAKING.

The Board holds that the maintenance of a growing department is only the beginning of its work. Nor is all accomplished when knowledge of our minerals and soils is increased and made available, our potable waters parcelled out to municipal applicants, a forest fire service kept at a high level of efficiency, and our forests conserved.

It should not be necessary for a State agency to urge, and advertise, the State's attractions and the opportunities it presents, yet knowledge of what Jersey is and may be is lacking to such an extent that the Department clearly has a task to carry to the understanding of our people the truly marvelous resources that they possess, yet neglect. In a word, it is found necessary to break down barriers of ignorance and prejudice, and, with a skilled technical organization, actively to combat the belief that outside our cities and shore resorts there is little of the State that is worth consideration.

Almost nobody realizes that New Jersey is really rich in minerals; or that our farmlands rank with the most productive in the country; or that our hills and lakes are as worth while as our seacoast; or that almost half our area now carries forests which require only a fair chance to produce near at hand the timber that everyone needs.

There are indications that manufacturers are turning from the large cities to find locations in smaller communities, because there labor is better controlled, and can be better provided with all which contributes to their social welfare. New Jersey must not be backward in taking advantage of this situation.

It is the Board's deliberate opinion that the key to the State's normal, reasonable development is the removal of the mosquito incubus. Our ill-name is partly deserved, though in fact the pest is no worse here than in many other places. If we rid ourselves of it, there appears to be no reason why the State's population, its wealth, and its general well-being should not be many times **magnified.**

10 CONSERVATION AND DEVELOPMENT.

It is a source of satisfaction that New Jersey continues to grow in population at a rate greater than that found in any other of the older States; yet so long as our growth is largely limited to the metropolitan sections, while other sections are backward, the State's agencies are under obligation to use every practicable means to bring its whole territory into a productive condition, to diversify to the utmost, and to co-ordinate its concentrations.

A contrast with Belgium, now so much in the public mind, is worth while. Belgium's area is 11,373 square miles; New Jersey's 8,224 square miles. Belgium has a population (1910) of 7,423,784, equivalent to a density of 652 per square mile. New Jersey has (1915) 2,844,342 residents, equal to 346 per square mile, or 406 per square mile if land area only be counted. Belgium is rated as an industrial State, as is New Jersey, yet 60 per cent. of her total area is in cultivated farms, as against 40 per cent. of New Jersey's. Eighteen per cent. of Belgium's area is in forests in good condition—46 per cent. of New Jersey's area is in forests in bad condition. Belgium has (1912) 5,401 miles of railroad; New Jersey, with more mileage in proportion to area than any other State, has 2,133 miles. Belgium's seacoast, upon which is a continuous line of thriving resorts, is 42 miles long; Jersey's is 137 miles and only 10 per cent. developed! These figures might well make a Belgian envious, though they are offered chiefly to show that on the Belgium standard Jersey still has ample room for growth, and ample reason to be assured that ordinary business sense dictates a fuller utilization of our wonderful resources and an organized effort to be more self-sustaining than we are.

MOSQUITO CONTROL.

The effort to have this work pushed by the State has not yet succeeded, though the counties and local interests are still carrying it with energy. This position is not creditable when the whole world is applauding New Jersey as the leader in salt marsh mosquito control and well in the van in respect to local and malarial forms.

Jersey has many kinds of mosquitoes and, while she is actually no worse off than most other parts of the world, it is greatly to

REPORT OF THE BOARD.

11

her credit that so much has been done to rid her people of the pests. Disease-bearing kinds are few and very local; those that breed about houses in fresh water are controllable by municipal or county effort. The species that breed on our salt marshes, and may fly as far as forty miles, are those with which the State government is urged to concern itself. This Board is convinced that by appropriating no more than \$150,000 or \$200,000 a year, for five years, the State can be rid forever of the pests. Enough work has been done, chiefly with county funds, practically to assure the success of such an effort. If the program be carried out with penal labor, as this Department has proposed, the credit will be the greater in every way.

The estimate made five years ago that not more than \$750,000 would be required to finish the work on the salt marshes necessarily must now be somewhat increased, though the area to be dealt with has been reduced. The sum required is, however, relatively small in view of the carefully-made, and unchallenged, estimates that to free our State of the pests that have so greatly hampered its development would add to the ratables within twenty years at least *500 million dollars*. Enterprises of every kind in every part of the State literally wait upon this action. It will be good business to make the investment.

The people of the eleven counties which maintain mosquito commissions deserve unlimited credit for their effort, and for their accomplishment. Most of their appropriations, however, which aggregate \$262,000 for the current year, are, very properly, devoted to local fresh-water work. The State's \$16,500 must be used partly for technical studies and overhead. Thus, on the present basis, it will take fifteen years to clean up our salt marshes. That is too long to wait for a betterment that the State—every section of it—ought to have quickly. A large part of the advantage will come through the mere announcement that New Jersey has determined to rid herself of the mosquito incubus within five years. There appears to be no guess, but assurance, about the practicability of the program.

LAND REGISTRY.

The very evident success of the effort to awaken interest in New Jersey's undeveloped lands through the maintenance of an office equipped to furnish precise and trustworthy information appears to have justified its organization. Started in June, 1919, with an appropriation of only \$7,000, the Land Registry first made an effort to meet the, then assumed, demand of the returning soldiers for farming opportunities. It listed a number of farms in different localities, and of various values, and directed every inquirer to two or three specific locations suited to his farming and financial abilities. It soon developed that few of the returning soldiers were interested. Those who were farmers went home and began work; only rarely did others care to change their occupations, even when ready made farms were offered on attractive terms.

With a list of several hundred farms for sale, or rent, and with a fund of precise knowledge concerning farming conditions in the State, the bureau then spent about \$400 in advertising in agricultural papers. That led directly to a considerable number of reading notices and special articles which cost nothing, but brought responses from all over the country. The Land Registry is now in communication with upwards of 1,600 farmers in forty-two States and six foreign countries, who apparently are seriously looking toward New Jersey for farming opportunities.

Coincident with this undertaking an attractive booklet called, "New Jersey for Progressive Farmers" (Fig. 6), and containing precise information about our soils, markets and other essentials, was prepared and 10,000 copies printed. About 3,000 copies have already been distributed outside the State and the demand for them is constant. The booklet and the Department's work have been referred to in practically every agricultural paper in the country, and the eyes of many farming interests are turned toward us.

Consistently holding that farming is a trade or profession, and that its returns are directly determined by the skill and capital put into it, the Land Registry has directed its efforts toward

REPORT OF THE BOARD.

13

attracting capable farmers to a State where they are assured good opportunities to live while making a living.

It is too soon to measure results of this Land Registry effort. The bureau was unable to present its case with any strength before the farmers were in the midst of their busy season. In any event the returns must be cumulative, yet several County Agents have reported farm sales in their territory, and one selling agency reports that during the year 1919 it sold 230 New Jersey farms to families from 28 States and two foreign countries. A working agreement has been established with a considerable number of farm agencies, the bureau is in the closest touch with the Department of Agriculture, with the Agricultural Experiment Station, with the County Agricultural Agents and with two or three bureaus of the Federal Government. As this is written, negotiations are underway looking to the establishment of colonies of Greek and Russian farmers.

The importance, indeed necessity, of this effort to stimulate farming rests upon the fundamental need for food. Our city people are shortsighted in the degree that they belittle the farmers and their interests and fail to realize that the comfort of non-agriculturists is absolutely dependent upon successful farming. New Jersey must feed her people, and no less an authority than the Director of the Agricultural Experiment Station says that our soils are capable of producing a billion dollars' worth of crops a year.

Having thus made a beginning in the development of our farming resources, the Land Registry has set about the formulation of plans to advertise the State's industrial, residential and recreational attractions. Those features will be given special attention during the coming year and the effort to attract competent farmers continued.

FORESTRY.

New Jersey has had her part and share in the nation-wide discussion of the need for a national forest policy which has distinguished this year above all others. Though the public is still largely misinformed respecting the objects and methods of for-

14 CONSERVATION AND DEVELOPMENT.

estry, the sources of the country's permanent lumber supply, the quantity that may be needed, and the means by which that need shall be satisfied, there is emerging some understanding that the control of forest fires, rather than forest planting, and the production of timber near the points of consumption, rather than at a distance, are the vital features in the situation.

It is with some satisfaction, therefore, that this Board can point out that just these two features have been at the center of New Jersey's policy for fifteen years. With two million acres of forest land, the State imports and uses twenty times as much lumber as it grows, and entirely without other reason than that it has been easier to buy ordinary lumber outside than to stop the fires and grow it at home.

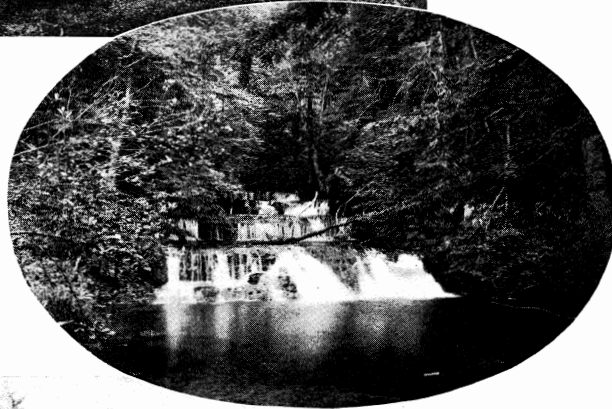
It is probable that at least a third, perhaps a half, of our woodlands will ultimately be converted to agriculture, yet the remainder must be devoted to forestry or given over permanently to unproductiveness. Naturally the latter alternative cannot be permitted, since the land is capable in every way of a high timber production.

As the Forester points out (page 82), the year has recorded a very positive accomplishment in that the owners or administrators of not less than 80,000 acres of woodland have undertaken practical forestry, and that our favorable location in respect to markets, with other advantages, gives promise of a rapid extension of this movement throughout the State. Commenting upon New Jersey's effort, the Chief Federal Forester, who retired last spring after ten years' service, wrote recently, "I am greatly impressed by the advance that you have made, by the splendid constructive plans you are promoting, by the broad foundations on which you are building."

State forests.—Our State Forests have been reduced by 87 acres and now total 17,064 acres, including Swartswood Lake, but their use by the public, and their increase in value through the growth of the timber on them, has been distinctly marked. Still holding the position that there is no justification for withdrawing large areas of forest from private possession, but that the owners should be encouraged and aided to develop their



Ranger's
Headquarters.



A Trout Stream.



Pine Plantation
Twelve Years Old.

Road Cleared
for Fire
Protection.



Figs. 2-5. STATE FOREST VIEWS.

16 CONSERVATION AND DEVELOPMENT.

ing attractive roadways is of the simplest. If road shade can be made a feature of our highway program, and then a clearing up of the road margins be added to it, New Jersey will lead all other States in making her territory agreeable and attractive to those who travel within her borders.

Gypsy moth.—Mention must be made of the late discovery within the State of this destroyer of forests and trees (See p. 90). Necessarily the pest must be controlled, but the means have not yet been developed.

Needs.—To develop our forest resources as they should and can be more money to employ more men is required. The recommendations of the Forester and Firewarden are endorsed—in particular that urging provision for an increase in the number of fire observation stations and for a forest patrol to be maintained in localities and at seasons when the hazard is especially great. Both forms of security have proved their worth, and if our woodlands are to become valuable as lumber producers, and no less valuable as playgrounds, we must multiply the means by which forest fires are *prevented* and not be satisfied to control those that, without such a service, are bound to be started. This is the State's own obligation; it cannot be passed on to the forest owners because, in the main, the public creates the hazard.

A MEMORIAL FOREST PARK.

The proposal made two years ago that the State create on the Kittatinny Mountain in Sussex and Warren counties a great forest part for the benefit of the whole people has been widely approved, but, as yet, the Legislature has declined to make an appropriation for the purchase of additional land.

Early this spring, the project took on a new phase through the suggestion of the Director that the park be established as the State's memorial to its sons who had made the supreme sacrifice in the Great War. The underlying thought is that no more fitting memorial can be established than one which, in a manner, springs from the heart of the home State and is built of its rocks, its woods, its waters—the eternal things to which the heart of man always turns.

REPORT OF THE BOARD.

17

The State now owns in that section 7,231 acres of land and a lake of 560 acres. The proposal is to increase this holding to about 40,000 acres and to dedicate the whole to the soldiers and sailors.

The people of New Jersey need a playground in the hills, easy to reach, roomy enough for as many as can enjoy it, and with the simple attractions that make camping pleasant. All these this property offers. It is a series of rough mountain ridges, completely forested, and full of natural beauty. It extends from the Delaware Water Gap to the New York line, a distance of 36 miles, varies in width from three to five miles and is from 600 to 1,800 feet high. It contains the best trout streams in the State, yet is within three hours of Newark and Jersey City, by train to several stations, or by motor. The proposed Delaware River road will follow its whole western boundary.

To the companions of those to whom the memorial may be reared, the various organizations of veterans, the tract offers ample opportunity for the erection of a variety of monuments. They can be of stone or bronze, can take the form of a building to shelter visitors, or of an outlook from a mountain top. There is room for all, and, by concentrating them within this one area, the region may become in time a place of pilgrimage.

The proposition carries with it the understanding that the State, through this Department, shall maintain the property forever, which, in fact, can be easily done at no more expense than would be involved in maintaining a like area as a commercial forest, since there is no thought of "improving" it more than to make every part accessible and usable. The State is committed to forestry; the property it now owns costs about \$2,000 a year to maintain, but is rapidly reaching the point of self-support. The 30,000 or 35,000 acres that should be acquired need not cost over \$250,000; they probably can be secured for less, since it is the belief of the Board that it is advisable to take over only wild forest land and to exclude as far as possible all clearings and improvements. On this basis the maintenance cost need never be more than \$10,000 a year, and after 20 years will be elimi-

18 CONSERVATION AND DEVELOPMENT.

nated entirely as the yield of the forest will then easily cover all legitimate expense.

The argument heretofore made in this connection that this undertaking would do much to redeem and to build up the adjacent portions of the State is in a sense out of place since the memorial idea has been advanced; yet contains no real impropriety because the forest will be more usable and the region better worth visiting if the adjacent farms are occupied and the villages busy.

WATER RESOURCES.

Possibly the most important interest committed to this Board is the proper conservation and distribution of potable waters. The continued growth and prosperity of numerous communities in North Jersey is dependent upon the development of every available source of this fundamental necessity. There is not, and cannot be for many years, any real shortage for there are several watersheds in that section, notably the upper Raritan and parts of the Passaic, that are little drawn upon, yet the time is clearly in sight when every source within our boundaries must be developed to its utmost and employed most wisely in view of our expanding population and limited area it seems to be quite as clear that we must depend in large measure upon purified water rather than upon unpolluted sources. Fortunately, modern skill can now remove from a moderately contaminated water all dangerous and all unsightly elements and make it as acceptable for human use as any but deep well, or the rarest untreated, surface, waters.

In its administration of water resources the Department finds itself hampered by the lack of long term measurements of the actual flow of many streams whose importance for water supply is great. In the absence of this precise data reliance must be placed upon calculations of stream flow based on temperature and rainfall records. However valuable these may be, they do not possess the finality of actual measurements. The Board therefore has been deeply disappointed that its efforts to secure money for stream gaging and other water supply studies have

REPORT OF THE BOARD.

19

been unsuccessful. It did succeed, at the end of the year, in having created a Water Supply Fund, as provided by the act of 1907, and it hopes that at least the sums collected in that will be made available by the Legislature. This fund on July 1 amounted to \$1,743.87 and should reach at least \$25,000 before next year's appropriations are made.

Studies needed.—The two things necessary to be done are:

(a) To establish and maintain indefinitely at least twenty gaging stations upon the streams most available for water development;

(b) To determine definitely what areas are most suitable for early development, and particularly whether some South Jersey areas, chief of which is the Wharton tract, are not capable of serving the metropolitan sections. South Jersey has ample water for all its anticipated needs and can easily spare enough for two or three million people if it can be economically transported. A special study by competent engineers is required to determine this point and the Department will continue to urge that it be made.

Diversion permits.—In determining the applications which have come before it for permission to develop potable water supplies (see p. 64), the Board has had constantly in mind the probable need in the not distant future for a much greater delivery of water to some of our cities than they now require. It has consistently held that the present and near future needs of a community within a given watershed must have preference over the needs of any outside municipality, and that the future needs of an outside municipality now using water from a given source must, in general, have preference over those of any outside municipality not now so supplied.

Upon this principal the application of Montclair for permission to use the water of Split Rock Pond was denied (see p. 65), though the validity of some of its objections to the water now supplied it was recognized.

Decisions sustained.—Not a little satisfaction is found in the action of the Supreme Court upholding the decisions of the Board in the action of Jersey City against the Borough of Wharton

20 CONSERVATION AND DEVELOPMENT.

(see p. 70), and in the action of the City of New Brunswick against the Elizabethtown Water Company, and the affirmation of the latter by the Court of Errors and Appeals (see p. 71).

Excess diversion tax.—At the minimum rate of \$1.00 per million gallons the sum due the State for water diversion under the operation of Chapter 252, P. L. 1907, for the calendar year 1919 was \$23,318.49 as certified to the Comptroller on February 14, 1920. Of that amount \$10,989.58 is unpaid, bringing the total arrears to \$71,266.24. If the Court of Errors and Appeals shall affirm the decision of the Supreme Court upholding the claim of the State against Jersey City, a series of long-standing controversies will be settled and the Water Supply Fund be augmented in the amount of \$71,266.24. The Board is gratified that a bill which would remit this tax upon municipalities that own their waterworks failed of enactment by the last Legislature. Such a measure would work injustice by penalizing the communities that buy their water.

Dam inspection.—The failure of several dams during the summer and fall of 1919, fortunately without loss of life, emphasized the need of the systematic inspection contemplated by the laws of 1912 (Chap. 243) and repeatedly urged by this Board. With the establishment of a Water Supply Fund it is hoped that this service can be provided for next year. It can well be co-ordinated with the stream gaging recommended on page 27 and page 77.

Underground waters.—In most parts of the State generous supplies of pure water are obtainable from shallow or moderately deep wells. Through years of record-keeping there has been accumulated a mass of data from which it is now possible to determine with reasonable accuracy the water prospects anywhere. A report covering this subject is almost ready for publication.

THE PROBLEM OF THE PASSAIC MEADOWS.

As announced in the Department's Report for 1919 a review was published of the investigations and recommendations made during the past fifty years relative to controlling the floods and redeeming for agriculture the soil in this area. The report showed that the problem is full of difficulties, as it is of great possibili-

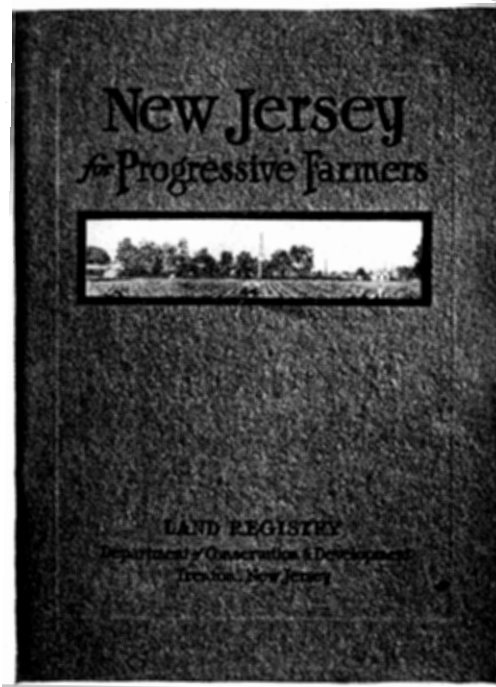


Fig. 6. A popular publication.



Fig. 7. Illustration from "New Jersey for Progressive Farmers."

22 CONSERVATION AND DEVELOPMENT.

Museum as it should, and can, be developed, without more assurance than can be given now that adequate appropriations, exhibition space and work rooms will be provided.

TESTING LABORATORY.

Much satisfaction is found in the fact that this organization has been able to meet the exacting requirements of the State Highway Department. Though the preparation of specifications and the testing of materials used in road construction have practically excluded all other activities, there can be no doubt of the value in highway work of the precise and uniform procedure that has been established. Some understanding of the magnitude and diversity of this work will be gathered from the Geologist's report (p. 53), and from the simple statement that during the year no less than 19,644 determinations were made.

And though road work has assumed such importance in the activities of the laboratory, the organization and its equipment are so complete that they can at any time be adapted to a wider range of investigations.

SOIL SURVEY.

Although this work has been considerably hampered by a shortage of competent men, 796 square miles of the State's area have been covered during the year at a cost to the State of \$5,470.68, and a little more to the United States Bureau of Soils, in co-operation with which the whole work is carried on. The total cost per mile of survey was \$11.54—a modest sum beside the value it represents to our farming interests.

The classification and mapping of soils in this State is now so well advanced that it is expected that our whole territory, exclusive of the extreme northeastern section, where there are relatively few farm lands, will be covered by 1922.

POTASH.

The study of our greensand marls with reference to their value as a source of potash, undertaken in 1918 in co-operation

REPORT OF THE BOARD.

23

with the U. S. Geological Survey, has been completed and the report made ready for publication. But as the Federal Survey cannot have it printed for some time, the Geologist has embodied in his report a detailed summary of the facts established and the conclusions reached. (See p. 36.)

The significant points are that although these marl deposits are calculated to contain enough potash to supply the needs of the United States for a thousand years at the average rate of importation for the years 1910-1914, and that while the material is easily accessible, no process of making the potash available is yet in successful commercial operation, although much promising experimental work has been done. In this situation these deposits must be regarded as no more than a *potential* mine of wealth whose development is a problem awaiting solution. It is believed, however, that the precise information concerning the location, depth, and character of the beds that is now available should be of great value to all who are interested in the production of commercial potash for our farms and industries.

MINING.

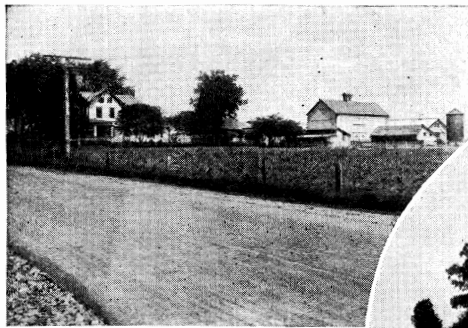
This Department has only a supervisory and advisory interest in the mining properties of the State, yet the reference made by the Geologist (p. 62) to the reopening of several iron mines deserves notice. It is significant of the common ignorance respecting our State's resources that New Jersey is rarely considered a mining State, and that few know of the iron she has produced since colonial days. The important fact at the present time is that while many, not all, of our iron ores are rated as low-grade, the present high market price of the metal, and particularly our great advantage in respect to freights, make possible the profitable extension of this industry.

HIGHWAY IMPROVEMENT.

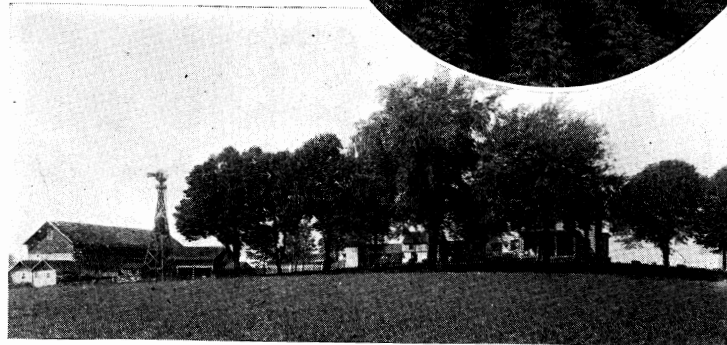
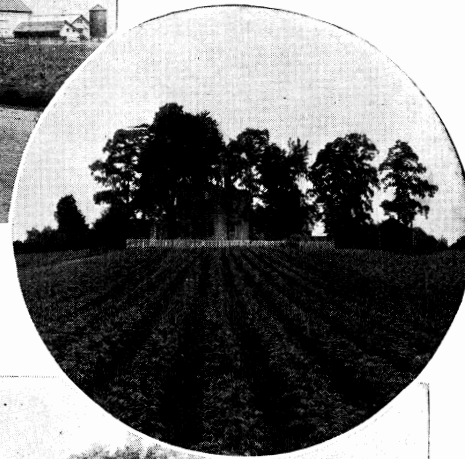
In full accord with the policy of highway development to which the State is committed, this Board still is convinced that the construction and maintenance of a system of first-class roads is only a part of the State's duty and interest. If the hope of a



A dairy farm on low-priced, newly-cleared land.



Comfortable Homes on
Jersey Farms.



Figs. 8, 9, 10 and 11. ILLUSTRATIONS FROM "NEW JERSEY FOR
PROGRESSIVE FARMERS."

REPORT OF THE BOARD.

25

widely known as that of which the people of New Jersey are so negligent. Pennsylvania, whose historical connection with the great exploit is less intimate than ours, has made an appropriation and is going ahead with a memorial on its side of the river.

If the Legislature deems it unwise to carry out the ambitious park plan formulated some years ago, let some other disposition be made of the unavailable part of the 100-acre farm that is now simply waiting, and let at least the purchase of the old McKonkey ferry house, and the construction of a moderate memorial, be provided for. With no more than \$50,000, something entirely creditable can be built. The Board will continue to recommend this appropriation.

PUBLICATIONS.

In addition to the annual administrative report for 1919, numerous press bulletins and considerable material for special articles in newspapers and magazines, the staff has prepared and the Department has published:

New Jersey for Progressive Farmers.—A 64-page illustrated booklet. It sets forth the exceptional opportunities for farming in New Jersey, with respect to location, climate, soils, marketing, living conditions, etc., and gives precise information regarding the adaptability of each section to certain kinds of farming. It contains 9 maps and 81 photographic engravings. (See figs. 6-12.)

The edition of 10,000 copies is distributed mainly to prospective settlers outside the State. A number will also be used as text-books in the public schools.

New Jersey.—A special 24-page number of the State Chamber of Commerce magazine, illustrated. It contains articles on New Jersey conditions, industrial and agricultural opportunities, resorts, natural resources and water supply.

Three thousand copies were distributed to chambers of commerce, libraries, officials, newspapers and individuals within and outside the State. Eleven hundred copies were provided by the Department of Public Instruction for use as text books in certain schools. Five hundred copies have been made available for this Department.

26 CONSERVATION AND DEVELOPMENT.

Why Forestry in New Jersey?—A 12-page folder, with 14 illustrations and a full-page forest map of the State presents the argument for forestry, and the way the Department helps woodland owners. Of the edition of 3,000, a good part is still available for distribution to those who are interested.

Campers are Welcome.—A 6-page leaflet, illustrated, in 2,000 copies, inviting the public to make use of the State forests as camping grounds.

Forest Fire Prevention and Highway Construction.—A 6-page single sheet folder, in 2,000 copies, prepared specifically for contractors and others engaged in road work near the woods. It is distributed chiefly through co-operation with the State Highway Department.

Forest Firewardens' Manual.—A 40-page text book, in 1,000 copies, of instruction and guidance for the field force of the Forest Fire Service.

Township Officials' Forest Fire Handbook.—A 12-page booklet, in 500 copies, designed to instruct and assist township officials in the conduct of Forest Fire Service business.

List of Firewardens.—A 24-page directory, in 1,200 copies. Revised annually.

School Lending Collections.—A 12-page catalogue, in 4,000 copies, of educational material available from the State Museum.

The Problem of the Passaic Meadows.—A 20-page report by H. B. Kummel, Ph.D., with a full-page map, in 1,000 copies, summarizing the problem and the various solutions which have been offered. Available to all interested.

Road Map of New Jersey, on a scale of four miles to an inch. Revised edition, 1920. Two thousand copies on sale at 25 cents each.

Somerville Atlas Sheet, on a scale of one inch = 2,000 feet. Revised edition. One thousand copies on sale at 40 cents each.

NEEDS.

The Department believes that it is performing a service of high value to the public; it touches their interests at many points; its aim is always above its abilities. With a real appreciation of the

REPORT OF THE BOARD.

27

support that it has had from the Legislature, as well as from the public, this report would lack much if it did not contain a summary of the more important things that need to be, but cannot be, done for want of money. Fully realizing that the Legislature must fail to satisfy all requests, it is submitted that the following deserve early and earnest attention. Some of the projects have been urged for several years :

1. An appropriation of \$200,000 to begin the control of salt marsh mosquitoes with prisoner labor.
2. An appropriation of \$20,000 for an expert study of the water resources of South Jersey, particularly of the Wharton tract.
3. An appropriation of \$10,000 to make a systematic inspection of the dams of the State, some of which may be in a dangerous condition, and to maintain a series of gaging stations for the collection of authentic data respecting stream flow.
4. An extra appropriation of \$10,000 to strengthen the forest fire service so that our woodlands may be assured the protection necessary to the production of timber.
5. An appropriation of \$80,000 to purchase land for a Memorial Forest Park.
6. An appropriation of \$50,000 for a memorial at Washington Crossing.
7. An appropriation of \$1,800 for a Forester to work with small forest owners, under a co-operative agreement with the U. S. Department of Agriculture and the State Agricultural Experiment Station.
8. An appropriation of \$2,800 for an arborist, or forester, to assist shade tree commissions and others having interests in shade trees.
9. An appropriation of \$5,000 to provide for an extension of the activities of the State Museum, so that it may more effectively serve the educational interests.

Every item of this program represents an investment which cannot fail to return to the people of the State many times the outlay. All are in the interest of true conservation, which in our view seeks to develop for use at a reasonable cost every

28 CONSERVATION AND DEVELOPMENT.

resource and every opportunity with which we, as a State and a people, have been endowed.

THE BOARD OF CONSERVATION AND DEVELOPMENT.

By ALFRED GASKILL,
Director.

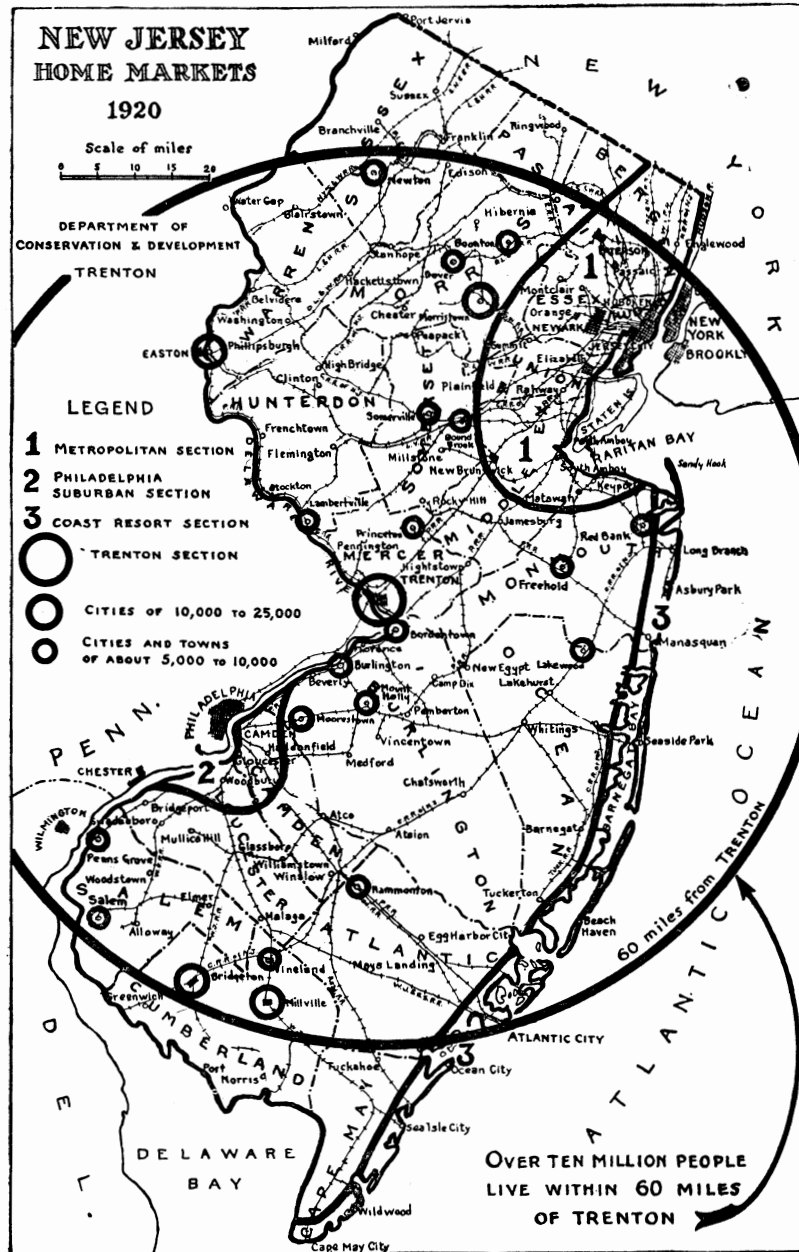


Fig. 12. Map from "New Jersey for Progressive Farmers."

30 CONSERVATION AND DEVELOPMENT.

DIVISION OF GEOLOGY AND WATERS.

Geologist, Assistant Geologist and Special Assistants		
—Salaries,	\$8,109.50	
Geologist, Assistant Geologist and Special Assistants		
—Traveling expenses,	587.10	
Water Supply—Salaries,	2,640.00	
Traveling expenses,	320.89	
Soil Survey—Salaries,	3,229.00	
Traveling expenses,	2,202.26	
Testing Laboratory—Salaries,	3,900.72	
Traveling expenses,	43.24	
Equipment and supplies,	2,417.11	
Museum—Salaries,	3,593.50	
Traveling expenses,	103.61	
Supplies,	1,222.44	
Printing maps,	575.00	
Incidentals,	76.71	
	<hr/>	
Total,		\$29,021.08

DIVISION OF FORESTRY AND PARKS.

Foresters (including Director)—Salaries,	\$8,040.00	
Traveling expenses,	634.84	
Firewardens—Salaries,	9,608.53	
Traveling expenses,	5,582.23	
Fire service equipment,	178.84	
Fire lookout towers,	3,000.00	
Township fire bills,	6,929.32	
Maintaining State Forests—Salaries and labor,	2,315.36	
Materials,	407.78	
Tax lieu,	331.82	
Incidentals,	49.69	
	<hr/>	
Total,		\$37,078.41
Reverted to State Treasury,		618.11
		<hr/>
		\$38,047.50

LAND PURCHASE ACCOUNT.

Balance of appropriation,	\$85.05
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WATER SUPPLY FUND.

(Available only under an appropriation.)

Receipts from February 1 to June 30, 1920,	\$1,743.87
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REPORT OF THE BOARD.

CASH ACCOUNT.

RECEIPTS.

Balance on hand July 1, 1919,	\$630.90	
Sale of maps and reports,	1,468.55	
Fire penalties,	2,633.12	
Rentals and sales from State forests and parks,.....	442.35	
Miscellaneous,	43.79	
	<hr/>	
Total,		\$5,218.71

DISBURSEMENTS.

Paid State Treasurer—		
From sales, rentals, etc.,	\$1,961.52	
From fire penalties,	760.93	
Paid township treasurers from fire penalties,	2,164.06	
Court fees and refund of penalties,	34.56	
Balance June 30, 1920,	297.64	
	<hr/>	
Total,		\$5,218.71

Report of the State Geologist.

The following paragraphs set forth for the year 1919-1920 the work of the Division of Geology and Waters, including the Testing Laboratory and the State Museum.

TOPOGRAPHY AND ENGINEERING.

Bench marks.—The work of establishing additional bench marks throughout the State for the use of engineers and others was continued during the field season of 1919 under the immediate charge of Mr. Loren P. Plummer. He was in the field with a rodman July 7-14 and November 3-29, during which time the following lines were run to continue the work commenced earlier in the season and described in the last Annual Report.¹

12. Glassboro to Swedesboro via Elmer, Daretown and Woodstown—26 miles.

13. Woodstown to Salem via Alloway and Quinton—14 miles.

14. Woodbury, Bridgeport, Center Square, Pennsgrove, Center Square, Swedesboro—32 miles.

15. Elmer to Bridgeton—13 miles.

16. Glassboro to Vineland, with 5 miles rerun—22 miles.

The initial elevation at Robbinsville was an adjusted bench mark on the Perth-Amboy-Bordentown line run in 1916. This elevation was carried throughout the above routes, as well as through routes 7-10 described in last year's report. The results of checks on existing benches on these routes as determined from 1885 to 1888 and the leveled distance from Robbinsville are as follows:

¹ Annual Report of the Department of Conservation and Development for the year ending June 30, 1919, p. 32.

34 CONSERVATION AND DEVELOPMENT.

<i>Route No.</i>	<i>Distance from</i>	<i>Difference with 1888</i>
	<i>Robbinsville.</i>	<i>Bench Marks.</i>
	<i>Miles.</i>	<i>Feet.</i>
12. To Swedesboro,	104	— 0.01
12. To Daretown,	90	— 0.36
12. To Woodstown,	97	— 0.08
13. To Salem,	111	— 0.14
14. To Swedesboro,	119	+ 0.13
15. To Bridgeton,	99	— 0.47
16. To Vineland,	94	— 0.57

The benches set on these lines were adjusted to the elevations as determined in the early work except at Daretown, where slight changes were made in the elevation as originally published. Slight changes were also made at Woodbury and Gloucester on routes run earlier in the field season.

In accordance with custom the primary benches are indicated by crosses cut on relatively permanent structures, such as public and semi-public buildings, abutments of substantial bridges, monuments, etc. The secondary marks are not distinguished by a cross, but are easily identifiable points such as rail joints, switch frogs, etc. Since these points are subject to slight changes of elevation, their heights are given only to the nearest tenth of a foot, and no distinguishing marks have been placed on them. Their elevations have, however, been as carefully determined, checked and adjusted as those of the primary marks, and they are listed in the belief that where a high degree of accuracy is not needed, they may serve equally well and save running levels from a more distant primary mark.

In preparing the following statement of cost, the work of the entire field season, with the preparation of the report, has been included, and not merely that of this fiscal year. It covers all the field work from April 1, 1919, to November 29, 1919, and the office work. Five hundred eighty-three (583) primary, 325 secondary marks were established and 18 old marks were recovered. The entire cost was—salaries, \$1,391; travel expense, \$890.26; miscellaneous, \$16.87; total, \$2,298.13; total miles of level run, 347; cost per mile, \$6.62; cost per primary bench mark, \$3.82; cost per mark for both primary and secondary elevations, \$2.48.

GEOLOGIST'S REPORT.

35

The results of the season's work have been tabulated, descriptions written and the report is ready for publication as a bulletin of the Department.

MINERAL STATISTICS.

The Department usually co-operates with U. S. Geological Survey in the compilation of mineral statistics for the calendar year. It was not possible to do this during the past year owing to the taking of the U. S. census, the Federal Survey acting as agent for the Census Bureau. Results for New Jersey have been promised the Department, but owing to the great amount of labor involved in taking the census and the greater mass of information compiled, no statistics are available at date of writing. If received in time the customary summary will be published as an appendix to the Geologist's report.

SOIL SURVEY.

The classification and mapping of the soils in co-operation with the U. S. Bureau of Soils has proceeded without interruption except as imposed by winter weather. Field work was carried on from July 1, 1919, to December 19, 1919, and from April 10, 1920, to June 30. The Bernardsville area in North Jersey and the Chatsworth area in the southern section were completed in December, 1919, except for the collection of some soil samples. In April, 1920, a few days were spent in collecting these samples, and then the work was commenced in the Trenton area, which is the territory covered by atlas sheet No. 28, with a small tract southwest of Burlington, the extreme southeastern portion of sheet No. 27.

Messrs. C. C. Engle, L. L. Lee, and William Seltzer of this Department, and A. L. Patrick and E. B. Deeter of the U. S. Bureau of Soils were engaged in the field. In August, 1919, Mr. Engle, chief of the Department's force, resigned and was succeeded by Mr. Lee, William Seltzer of Vineland being appointed to fill the vacancy. Late in the fall Mr. Patrick resigned from the U. S. Bureau of Soils and Mr. Deeter was soon after trans-

36 CONSERVATION AND DEVELOPMENT.

ferred to another State for the winter season, leaving the two State's men to complete the season's work. In April, 1920, Messrs. Lee and Seltzer began field work on the 10th and were joined by Mr. Deeter on the 26th, but owing to many resignations from its force, the Bureau of Soils was not able to detail a second man to the State until after the close of the fiscal year.

Between July 1, 1919, and June 30, 1920, the field parties classified and mapped the soils on 796 square miles, distributed as follows:

Chatsworth area,	479 sq. mi.
Bernardsville area,	192 " "
Trenton area,	125 " "

The total cost including preparation of reports on the Bernardsville and Chatsworth areas was for the State, \$5,411.68; for the U. S. Bureau of Soils, \$3,776.69; total, \$9,188.37, or \$11.54 per square mile. In addition to the above cost, the Bureau of Soils makes certain analyses of the soils, edits the reports and performs certain inspection service, the cost of which is not included in the above.

The Trenton area comprises 794 square miles. It had been hoped to complete this area during the present field season of 1920, but owing to the inability of the Bureau of Soils to furnish its quota of experienced men, it will probably be impossible. Soil classification and mapping is a highly specialized class of work, requiring much experience gained only after long training. The loss of experienced men cannot readily be made good, and the scale of salaries paid so many government employees in technical positions is too low to hold good men or to attract promising successors in these days of high wages in private employ.

GREENSAND MARL.

The report of the Department for 1918-1919 contained a preliminary paper on the greensand marl deposits, a study jointly undertaken for the Department and the United States Geological Survey by George R. Mansfield of the Federal Survey. During the year the necessary analyses were made and Mr. Mansfield

prepared his final report, which will be published by the United States Geological Survey. Inasmuch as this may be somewhat delayed, a summary of some of the more important conclusions is here presented with the approval of the author and permission of the Director of the United States Geological Survey. All of the statements are based on Mr. Mansfield's work, and many of them are quoted directly from his manuscript, even though the quotation marks are not used.

Distribution and occurrence.—The greensand marl occurs in nearly horizontal beds 20 to 50 feet thick which reach the surface along a belt about 100 miles long and an average width of 2 miles, which extends from southwest to northeast from Delaware Bay to Atlantic Highlands. Three beds are recognizable which were originally known as the Upper, Middle and Lower marl. More recently the geographic names Manasquan¹, Hornerstown and Navesink have been applied.

In Monmouth and in a portion of Burlington County, these three beds are separated horizontally by thick beds of sand, but further southwest the sand bed which separates the Hornerstown and Navesink beds disappears and these two marl beds unite. Neither of the three beds outcrops at the surface continuously, owing to a cover of later gravel and sand of varying thickness. The Manasquan marl is covered along its line of outcrop much more deeply than the other beds, so that its actual occurrence at the surface is much more restricted than that of the other beds. The beds dip or incline at a low angle—30 to 50 feet per mile to the southeast—so that they underlie all of the State in that direction, but for much of the area at great depth. Along the coast from Asbury Park southward, only the deeper wells reach them.

Scope of field work. During the field investigation, 19 holes, varying in depth from 9 to 70 feet, were sunk, generally into or through the greensand marl beds. Their average depth was 37 feet. Sixteen of these borings were made at five localities: Salem, Woodstown, Sewell, Somerdale and Marlton. These places occur at intervals of 8 to 12 miles along the marl belt. At each

¹The Eocene portion of the old Upper marl is now called the Shark River.

38 CONSERVATION AND DEVELOPMENT.

locality the holes were so spaced as to test an area of $2\frac{1}{2}$ acres. These borings were all in the Hornerstown-Navesink marl bed. The other three holes were near Birmingham and Pemberton and were in the Manasquan marl. The samples taken represented, so far as was possible, all material passed through from the top of the marl bed to the bottom. It was also planned to have the samples represent uniform intervals, but this was not always possible. Visits were also made to many other parts of the marl belts and all available well records and sections were collected and studied.

Density and moisture content. Density and moisture determinations were made on several samples in order to determine the weight of a cubic yard of marl in the ground. The analyses showed that marl taken directly from the pits and loaded wet may contain from 18.5 to 25 per cent. by weight of water. The average weight of dried samples was about 80 pounds per cubic foot, or 2,160 pounds per cubic yard. The average weight of four samples of moist greensand as taken from the ground was about 93 pounds per cubic foot, or 2,500 pounds per cubic yard. The specific gravity determinations of the greensand grains ranged from 2.925 to 3.063, so that the material in the ground, if massive and without voids, would average about 186 pounds per cubic foot, or more than 5,000 pounds per cubic yard. But the marl is much less compact than that, so that its weight in the ground lies between these two extremes, and for purposes of calculation may be taken at 133 pounds per cubic foot, or 3,580 pounds per cubic yard. On this assumption the voids would equal 28 per cent. of the mass of the marl bed.

Salem area—estimates of tonnage and value. The tract investigated lies on both sides of Walnut Street, about three-quarters of a mile S. 23° W. of the Salem courthouse, and on the farms of Louis Fogg and T. R. Miller. The overburden of gravel proved thicker (23 to 25 feet) than anticipated when the site was selected. The average thickness of the marl is at least 20 feet, and the average potash content weighted according to the thickness shown by the respective samples is 6.62 per cent.

Assuming 28 per cent. voids, which gives a weight in the ground of 133 pounds per cubic foot, one acre would con-

tain approximately 3,800 tons. If an 80 per cent. recovery be postulated, and the March, 1920, price of \$2.50 per unit of 20 pounds be assumed, the available potash in a ton of greensand from this locality (6.62 per cent. K_2O) would be worth \$13.24, and in an acre \$76,000. This price probably cannot be maintained. At \$1.50 per unit under the same conditions, the values would be \$7.94 per ton and \$57,000 per acre. It must be clearly understood that these prices and others which will be given have only theoretical interest, since they depend upon the potash being made available by processes, the success of which has not been commercially demonstrated. Well records show that the marl occurs quite generally under the region of Salem with a thickness of from 25 to 40 feet, but the overburden is nearly everywhere so thick as probably to prevent immediate exploitation.

Woodstown district—estimates of tonnage and value. Considerable marl of good value was formerly dug near Woodstown, and is still readily accessible. Railroad transportation is available and Salem Creek is navigable as far up as Course's Landing and perhaps to Sharptown. Several factors, therefore, favor Woodstown as a site for commercial development of the marl.

The area selected for testing is a field belonging to Isaac K. Lippincott at the north boundary of the borough, east of the road between Woodstown and Auburn. Three holes were drilled there and nineteen samples taken for analysis. The per cent. of potash varied from 2.92 to 7.88, the weighted average for the entire thickness of the marl in the 2.5 acre tract being 6.80 per cent. The average thickness of the marl in the tract is 32 feet. Assuming the weight of a cubic foot of greensand to be 133 pounds, an acre here will contain 6,300 tons of potash (K_2O). With a recovery of 80 per cent., and the March, 1920, price of \$2.50 per unit of 20 pounds, the potash in a ton of greensand is worth \$13.60, and in an acre of ground, \$126,000. At the more probable figure of \$1.50 per unit, the potash in an acre would be worth three-fifths that amount, or \$75,600. These values are hypothetical, because the potash must be recovered by processes not yet commercially demonstrated.

Well borings show that a maximum thickness of 50 feet of greensand may be expected in the vicinity of Woodstown. In the

sample area the overburden averages about 10 feet in thickness. It undoubtedly thickens eastward, and would have to be determined for any given locality. The analyses show that the higher and lower portions have somewhat less potash than the middle portion, but practically all parts of the bed are usable. The low content of 2.6 per cent. potash occurred only in one hole in a 1.5 foot layer. Water stands in the holes within a few feet of the ground and would have to be considered in any plan for recovering the marl. The hills south of the creek and west of Sharptown afford good thicknesses of marl within reach of water transportation.

Sewell district—estimates and values. The pits near Sewell have long been known for their excellent marl, which was extensively used for agricultural purposes. More recently it has been used in experiments in potash extraction. Excellent railroad facilities are available, and there are large areas of relatively level ground underlain by marl, on which the overburden does not seem excessive. Although boring was limited to a 2.5 acre tract, the earlier workings, natural exposures, and well records furnished reliable information for a much larger area. Hence the following conclusions have a wider application than to the field tested.

Three holes were sunk on the property of the West Jersey Marl & Transportation Company, east of the railroad track and one-half of a mile south of the station. The average thickness of the overburden on this site is about 9 feet, but elsewhere on the company's property it averages nearly 14 feet. Twenty-eight samples were taken, in which the potash content ranged from 3.47 to 7.90 per cent.; the average for the entire thickness of 34 feet in the 2.5 acre tract being 6.50 per cent. Assuming again a weight of 133 pounds per cubic foot, an acre contains 6,400 tons of potash (K_2O). With 80 per cent. recovery and the March, 1920, price of \$2.50 per unit of 20 pounds, the potash in a ton of greensand would be worth \$13.00, and in an acre of ground \$128,000. At the more probable price of \$1.50 per unit, the same quantities would be worth \$7.80 and \$76,800, respectively. As in the previous estimates, these values are hypothetical, since they depend upon the successful extraction of potash by methods not yet commercially demonstrated.

Marl of suitable quality is present in sufficient quantity near Sewell to justify large scale operations. It can be worked in open pits by steam shovel or other types of excavator. Water is not so near the surface as at some localities tested, but it would be encountered in handling the lower portions of the deposit. As at Woodstown, the middle portion of the deposit is richer in potash than the top or bottom, the difference being about 1.5 per cent., but all may probably be profitably worked by any process applicable to the middle portion.

Somerdale district—estimates and values. In the vicinity of Somerdale, Camden County, the greensand occupies a rather broad belt, and the overburden is apparently not excessive. The Pennsylvania and Reading railroads provide excellent transportation facilities.

A drilling site was selected on the southeastern edge of the belt near Somerdale station, in a field belonging to Thomas McMichael. Three holes were bored here, and one a quarter of a mile northwest of the station. Twenty-four samples were taken. Their potash content ranged from 3.51 to 7.66 per cent., the weighted average for the entire tract being 6.66 per cent. The maximum thickness of the overburden is 6½ feet and the average 3½ feet. The green marl averages about 9 feet in thickness and carries 7.54 per cent. of potash (K_2O). The chocolate marl below averages 18 feet in thickness and carries 6.21 per cent. of potash. The entire marl bed averages 27 feet in thickness and carries 6.66 per cent. of potash. Assuming, as in previous estimates, a weight of 133 pounds per cubic foot, the total potash in an acre of this tract would amount approximately to 5,200 tons. On the basis of 80 per cent. recovery and \$2.50 per unit of 20 pounds (March, 1920), the potash in a ton of greensand would be worth \$13.32 and in an acre of the tested tract, \$104,000. At the lower unit price of \$1.50, the same quantity of potash would be worth \$7.99 and \$62,400, respectively. As in previous estimates and for the same reasons these are not present values, but are only theoretical.

The tract tested at Somerdale station is part of a larger area of suitable size, and of sufficient potash content to warrant commercial exploitation. The area lies only 9 or 10 miles from the

42 CONSERVATION AND DEVELOPMENT.

Delaware River at Camden, and it is crossed by two railroads. The water level was not reached at a depth of 40.5 feet and the marl was relatively dry. To the northwest of the tested tract the thickness diminishes to zero, whereas to the southeast thicknesses of 40 to 45 feet of marl may be expected, but the overburden is probably thicker also.

Marlton district, Elmwood Station—estimates and values.—In the vicinity of Marlton the greensand belt has a width of about 2 miles, and the marl was formerly dug extensively. The site selected for testing was a field of Alfonso Fusco, at Elmwood Station, 1.8 miles east of Marlton. Two holes were sunk, 330 feet apart, and 20 samples collected. Their potash (K_2O) content varied from 4.82 to 7.61 per cent. the weighted average for the 101 feet of marl represented by the samples being 6.50 per cent. The overburden was thicker than anticipated, being 16 to 17 feet. The black marl averages 9 feet 7 inches in thickness and contains 6.01 per cent. of potash. The chocolate marl averages 28 feet and contains 6.32 per cent. The green marl averages nearly 13 feet in thickness and has 7.26 per cent. of potash. Numerous wells drilled within 3 miles east or southeast of Marlton show an average thickness of about 49 feet of marl, beneath an average of 37 feet of overburden. Near Marlton the overburden is thinner.

At the tested site an acre would contain approximately 9,400 tons of potash (K_2O). At \$2.50 per unit of 20 pounds and 80 per cent. recovery the potash in a ton of greensand would be worth \$13.00, and in an acre of this tract \$188,000. At \$1.50 per unit, these values would be \$7.80 and \$112,800 respectively. These estimates have no relation to the present value of the land, since they depend on the extraction of the potash by processes whose successful commercial operation has not yet been demonstrated.

The tract tested is part of a much larger area suitable for commercial development and located on a railroad 16 miles from Camden and Philadelphia. Water rises near the surface and will have to be reckoned with in any plan for the recovery of the marl.

GEOLOGIST'S REPORT.

43

Birmingham and Pemberton.—Three holes were bored in the Manasquan marl east of Birmingham on the property and with the aid of the Norcross & Edmunds Company. The potash content of five samples taken from two borings near Birmingham is 1.83, 2.75, 3.27, 3.61, and 3.63 per cent. Three samples from another hole, S. 65° E. and 4200 feet from the South Pemberton station, showed 2.99, 4.29, and 4.61 per cent. These analyses indicate that the portion of Manasquan marl represented by them is distinctly inferior in potash content to the Hornerstown and Navesink marls.

Other regions.—Funds were not available for thorough tests of the marl belt northeast of Medford, but records from 7 wells in the region between Medford and Pemberton show an average thickness of about 45 feet for the combined Hornerstown and Navesink beds. Northeast of Sykesville these two marl beds are separated by the Red Bank sand, but the data at hand indicate that they tend to maintain thicknesses which if added would at least equal and probably exceed their combined thickness southwest of Sykesville. Each of the beds is present in commercial thickness over considerable areas in Monmouth County.

In Monmouth County the Cream Ridge and Marlboro districts probably afford the most favorable conditions for commercial development of the Navesink marl, and the Hornerstown, Freehold and Eatontown districts are probably best for the exploitation of the Hornerstown marl.

From the somewhat meager data at hand it appears that the Manasquan marl bed where it is accessible is the thinnest of the three and contains from 2 to 4 per cent. less potash than the averages for the combined Hornerstown-Navesink beds.

Summary of estimates and values.—Generally in the districts prospected three phases of the marl were recognizable, which may be called gray marl, green marl, and chocolate marl in order from top to bottom. Their average thickness and potash content for the five districts are as follows:

Gray marl,	10 feet 7 inches.	6.11 per cent. K ₂ O.
Green marl,	10 " 8 "	7.39 " " "
Chocolate marl,	14 " 6 "	6.29 " " "

44 CONSERVATION AND DEVELOPMENT.

The average content of potash for the entire Hornerstown-Navesink marl bed and all districts as shown by these tests is 6.60 per cent. Inasmuch as the samples represent the entire thickness of the marl bed at each boring, and the localities tested extended nearly half way across the marl belt from southwest to northeast, this figure can be taken with considerable confidence as accurately representing the potash content in Salem, Gloucester, Camden and Burlington Counties. Since it is in harmony with results of previous analyses of marl from Monmouth County, it is believed that it is also fairly representative of the Hornertown and Navesink marl beds throughout the whole State.

The marl beds extend for a distance of about 100 miles from southwest to northeast, from Delaware Bay to Atlantic Highlands. The average width of the belt is 2.1 miles, and as shown by these borings and many well records the average thickness of the combined Hornerstown-Navesink beds may be taken as 40 feet. The accessible portion of the greensand mass may thus be considered as a triangular prism 100 miles long 2.1 miles wide and 40 feet thick along its southeast border but wedging out along its northwest border. The total potash content of such a prism would be approximately 513,905,000 short tons. Of this quantity part has been removed by stream erosion and part is so covered by overburden that it may not be regarded as accessible. But even if the above estimate be cut in half for these reasons, there remains about 257,000,000 short tons of potash (K_2O) which could be mined by open-pit methods.

The average annual importation for the years 1900-1914 inclusive was 257,143 short tons of K_2O . At this rate the New Jersey greensand deposit can furnish enough potash to supply the needs of the United States for nearly 1,000 years, even if only the material obtainable by open pit methods were used. Since the marl beds extend southeast beneath an increasing thickness of later deposits for many miles from their line of outcrop, the available quantity of potash would be enormously increased should the nation's needs ever warrant or compel underground methods of mining.

Commercial development.—Small amounts of potash have been manufactured from New Jersey greensand and marketed, but

there has as yet been no large scale commercial operation or production.

The Eastern Potash Corporation has under construction near New Brunswick a plant designed to treat 1,000 tons of greensand per day. Finely ground greensand is digested with milk of lime for 30 to 60 minutes with steam at 200 pounds pressure. The digested material is twice filtered and a solution containing about 80 per cent. of the potash in the charge is evaporated from an original strength of about 2 per cent. to about 45 per cent. of potash. The residue is mixed with sand for the manufacture of tile or brick, the hydrous calcium silicate and excess lime hydrate serving as binders, and the product being hardened by steam.

The Atlantic Potash Company has mined considerable greensand near Marlton and has marketed some potash made therefrom at its experimental plant near Stockertown, Pennsylvania. In general the process consists of preheating the greensand to 350° C., mixing it with calcium chloride, roasting the mixture at about 850° C., leaching the product, and finally obtaining potassium chloride by evaporation and crystallization.

The R. S. Ryan Company in 1918 erected a small plant 2 miles north of Medford. Greensand and limesand or limestone are ground, mixed with salt and heated in a rotary kiln. The clinker is leached in water and the potassium and sodium chlorides are removed by evaporation and crystallization. Most of the salt (sodium chloride) is recovered and used over again. Potassium chloride, running 80 to 90 per cent. with a little potassium sulphate was produced.

The Coplay Cement Manufacturing Company, of Coplay, Pa., has made some experimental use of greensand from New Jersey in connection with the extraction of potash from the fine dust escaping from its kilns in the manufacture of cement. The addition of greensand to the cement mix increased materially the amount of potash in these fines and did not injure the quality of the cement.

So far as known none of these plants is now (August, 1920) producing potash.

The development of a potash industry based on the New Jersey greensand depends on the ability of manufacturers to compete

46 CONSERVATION AND DEVELOPMENT.

not only with foreign potash, but with American producers as well. The somewhat meager data at hand seem to indicate that the cost of producing potash from greensand is greater than from alunite and some of the western brines, but the greensand product has the advantage of proximity to markets and low freight costs. It is highly probable that the cost of German potash will hereafter greatly exceed and perhaps be as much as double pre-war prices, so that the American potash industry has a fair chance of being on a nearly equal basis with the foreign. Whether or not greensand will have a place in the American industry will depend on how well the greensand operators may be able to compete with the western producers.

Mechanical analyses.—In addition to the analyses necessary to arrive at the above results, certain other questions dealing with other phases of the general problem were investigated. Some of the results obtained are briefly summarized. Fifteen composite samples derived from 87 originals and representing all of the 6 localities explored, were repeatedly washed and the material remaining in suspension for 30 seconds after each stirring was decanted. The percentage of fines or “clay” thus determined ranges from 2.7 per cent. to about 60 per cent. and the average, weighted according to the thickness of bed represented by each sample, is 19.5 per cent.

The residues of coarse material obtained by the above wet separations were dried and subjected to magnetic separation, the glauconite grains being attracted to a glass plate placed against the poles of a powerful electro-magnet. In this way the magnetic particles, chiefly glauconite, were separated from the quartz and other non-magnetic material in the greensand. The former made up more than 90 per cent. in 10 of the 15 samples and averaged 89.9 for all beds represented. Chemical analyses (see below) indicated that the mud or “clay” associated with the glauconite grains and decanted in the wet separation as described above is also largely glauconite. Combining the results of the wet and dry separations, the glauconite grains were found to average 73.1 per cent. of the entire thickness of greensand examined at each of the six localities.

The coarser material, both magnetic and non-magnetic, was sieved to determine the size of grains and amounts of each. The glauconite grains ranged from more than 1/20 to less than 1/100 of an inch, but the greatest number by weight passed the 20-mesh sieve and were retained on the 40-mesh. Nearly as many were retained on the 60-mesh after passing the 40-mesh.

The quartz grains, also, fall mostly between 20-mesh and 60-mesh.

Shape of grains.—The largest sized glauconite grains are irregular, botryoidal, or mammillary in general form, suggesting aggregates of rounded grains rather than casts of foraminiferal shells, although some grains do suggest such forms. Many appear to be rounded nodules with irregular cracks of lighter color. The medium-sized grains (40 and 60-mesh sizes) show similar shapes and markings but a greater degree of regularity as if reduced by wear from a larger size. The smallest sizes have evidently been much worn and at least in part represent material that has been transported and redeposited.

Complete chemical analyses were made of the "fines" and the coarse residue of two of the washed samples, and potash determinations were made of the "fines" of all the others. These showed that in general the potash content of the "fines" was from 0.1 to 1.5 per cent. lower than that of the corresponding unwashed sample, although in one case it contained 0.11 per cent. more and in another 3.18 per cent. less. Although concentration by washing would increase the proportion of potash in the resulting residues, the amount of potash lost in the discarded "fines" would be so nearly equal to the gain that the expense would not be justified.

Solubility of potash in the greensand.—A number of analyses were made to determine the amount of soluble potash in representative samples. The results ranged from nothing to 500 parts of potassium per million, which indicate that the amount is very small. In spite of its low solubility, however, recent experiments show that plants in their early growing stage will assimilate potash from greensand as effectively as from the usual soluble commercial potassium salts.¹ This corroborates the experience of the

¹True, R. H., and Geiso, F. W., Journal of Agricultural Research, Vol. 15, No. 9, pp. 483-492, December 2, 1918.

48 CONSERVATION AND DEVELOPMENT.

earlier generation of New Jersey farmers who applied the greensand directly to the soil with satisfactory results.

Analyses of several samples of water with which the marl is saturated showed 9.6, 10 and 5.2 parts of potassium per million in solution. The great disparity between the amount in solution and the amount required for saturation suggests that potassium is being withdrawn from solution, perhaps for the formation of glauconite, but a careful comparison of the potash content of different portions of the marl does not reveal unequivocal evidence of secondary enrichment.

STATE MUSEUM.

General statement.—The development of the Museum during the year was most pronounced in the growth of its work with schools, libraries, Y. M. C. Associations and other organizations throughout the State. On the other hand, the activities dependent upon adequate exhibition space in the State House received a serious setback and the attendance has been greatly curtailed. Ever since the reorganization of the Museum those in charge have felt the limitations imposed by the lack of sufficient space to display effectively the Museum collections and to assemble the special exhibits which have been such a successful feature of its work. Nevertheless, an earnest effort was made to establish and maintain a series of exhibits which would be a credit to the State, and the hope was entertained that in the near future more adequate quarters might be provided in an enlarged State House. Instead of becoming better, however, the condition became worse. In December the State House Commission decided that it was necessary to take about one-third of the Museum room for offices. In spite of protests and much against its judgment the Department was compelled to crowd its exhibits into the remaining space. The encroachment at first promised to be only temporary during the session of the Legislature, but it has apparently become permanent.

The first results of this crowding were the suspension of the special temporary exhibits and the great loss in attendance consequent thereon. It was also necessary to give up the organized

PITCH PINE

PITCH PINE (*Pinus rigida*, Mill)

IDENTIFICATION. The most common pine in New Jersey is Pitch Pine, one of the yellow, or hard, pines. The size of the tree and the quality of the wood are inferior to the Shortleaf Pine (*Pinus echinata*), but superior to Frank Pine (*Pinus virginiana*), both also native species. These are easily distinguished by their two needles, while Pitch Pine always has three rather long, stiff needles in a bundle.

RANGE AND HABIT OF GROWTH. Pitch Pine grows along the Atlantic Coast from Maine to Georgia, and as far west as western New York and Pennsylvania, eastern Kentucky and Tennessee. In New Jersey, it is most abundant on the flat, sandy areas of the southern and central portions. In North Jersey it grows chiefly on dry, rocky ridges, in small, pure stands or mixed with chestnut, oak and other hardwoods. This species rarely exceeds eighty feet in height and two feet in diameter. On the better soils, growth is quite rapid and the form of the tree good, but on poor soils and where forest fires prevail, the trees are crooked in form, with heavy, contorted branches.

IMPORTANCE AND USES. Although Pitch Pine lumber is not of high grade, it is much used in local industries. The wood is heavier than white Pine, darker in color, and contains much resin. It is fairly hard, but brittle, rather coarse-grained and not suitable when exposed to moisture. In south Jersey large quantities are used for coarse lumber, boxes and fuel. Scotch pines are used for millwork. In former years much Pitch Pine was made into charcoal, and the resin was collected and made into turpentine, resin and pitch, (whence the common name, Pitch Pine). The charcoal industry has fallen out and the other has yielded entirely to the greater productivity of the southern species.

VALUE IN FORESTRY. Pitch Pine is a very valuable species in New Jersey because it is adapted to the poor, unworkable soils, and grows well where other species would fail. It also resists fire better than any other tree. Natural reproduction is usually abundant and healthy, so that only protection from fire is needed to insure a future stand of this pine in many sections of the state.



Cones and Needles.



Cross-section, showing 11 annual growth rings, and one false ring - between red lines.

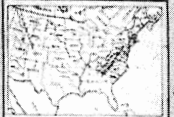


Bark.



Tree trunk.





Distribution.

Fig. 13. Twenty-five of New Jersey's most important commercial woods are described on charts like this for school study.

GEOLOGIST'S REPORT.

49

work with school children owing to the impossibility of longer accommodating classes. This naturally greatly diminished the value of the Museum to the nearby schools, and eliminated much of its educational work.

While recognizing the crowded condition of the State House and the pressure upon the State House Commission for more room for many departments, it is felt that the Museum activities have not been appraised at their proper value, or some means would have been found to provide other room for offices without this injury to an important educational work.

Nevertheless, those in charge have endeavored to make the best of the situation. The state-wide lending work has been stressed, with great success. As shown in detail below, more material has been loaned to a larger number of schools and more widely distributed than in any previous year.

It was with regret that the resignation of Miss Helen C. Perry was received about the middle of the year, since the success of the Museum from its reorganization was in very large measure due to her energy, perseverance and initiative. Owing to the uncertainties as to the future, no attempt was made to find a permanent successor, but upon Miss Perry's retirement, Mrs. Kathryn B. Greywacz was promoted to the position of Acting Curator.

Permanent exhibits.—In spite of the restrictions imposed by crowded exhibition space, the permanent exhibits on natural history, industries and geology have been open to the public throughout the year. These exhibits had to be shifted about and rearranged temporarily, and many changes will be necessary when more room is available.

Special exhibits.—During the first six months of the year the following special exhibits were held:

July 4-31, 1919. A War Souvenir Exhibit, including helmets, shells, fire-arms, maps, photographs, decorations, foreign money, and many curios brought from overseas by Trenton soldiers. The exhibit of Overseas Army Insignia was also continued throughout this month. Attendance, 1,975.

August 1-31. The special feature for this month was an exhibit of all the material which the Museum lends to the schools of the State. Attendance, 1,912.

50 CONSERVATION AND DEVELOPMENT.

September 29-November 1. An exhibit showing the resources of the Republic of Colombia, its opportunities for export and import trade and something of its people. It was prepared by the Newark Museum Association and had been previously shown in Newark, Boston and New York. Attendance, 2,875.

November 1-30. An exhibition of the Handicrafts of Wounded Soldiers consisted of painted wooden toys, basketry, pottery, weaving, metal work, jewelry and wood-carving, made by the American wounded at Base Hospital No. 3, Colonia, New Jersey. This exhibit illustrated the curative value of handwork. Attendance, 1,484.

December 1-15. In connection with Trenton's Health Week, the Museum held a Tuberculosis Exhibit of Charts loaned by the Department of Health.

December 1-29. A collection of drawings executed by French school children was exhibited. The wonderful coloring, design and finish of the work attracted much attention especially from teachers and students of art. Attendance, 2,202.

Local school work.—During July and August the school children of Trenton were invited to join the outdoor Nature Study Clubs organized at the Museum, to study birds, flowers and trees. The Flower Club, under the direction of Miss Margaret Widman, was most popular and met once a week during the entire summer. New Museum Representatives for each school in Trenton and vicinity were selected by the principals, and to them were sent monthly bulletins, announcing current exhibits. These Representatives then arranged to send to the Museum such classes as would derive the most benefit from each particular exhibit. In this way, splendid co-operation existed between the schools and the Museum, and many classes studied both the special and permanent exhibits. It was with much regret that the schools received bulletins, in January, announcing that the Museum would be unable to continue its work with school classes because of the curtailment of its space and the consequent crowded conditions.

Loan collections.—The demand for lending collections has been constantly increasing so that new and duplicate material is being prepared continually. The loan collections at this time include: Industrial process charts, which illustrate the process of manu-

GEOLOGIST'S REPORT.

facture of about thirty of the leading industries of the country; natural history cases of birds, mammals, fish, sea life, butterflies and moths, insects, common rocks and minerals, Indian relics, models of volcanoes, glaciers, and seacoast; and mounted pictures of natural history subjects, Sahara life, Eskimo life, the rubber industry, and many other series of pictures particularly adapted for the classroom. Sets of charts on health and hygiene, agriculture, and miscellaneous subjects were also circulated during the year. The Museum has just purchased a set of 600 stereographs and a number of stereoscopes which it will add to its lending collections. These should be most useful to small schools that have no facilities for showing lantern slides and motion pictures.

NUMBER OF LOAN COLLECTIONS CIRCULATED.

	1917-1918	1918-1919	1919-1920
Industrial process charts,	189	500	745
Mounted pictures,	448	866	1,121
Natural history cases,	9	29	36

Lantern slides.—The lending of lantern slides has increased about 275 per cent. during the year. As a result of co-operation with State Departments of Health, Child Hygiene, Public Instruction, and Agriculture, and the generosity of manufacturers and numerous railroad companies throughout the United States, to whom appeals were sent for industrial and travel material, over 3,000 lantern slides have been added by gift or loan to the collection. This increases the former collection by 75 per cent. and aggregates nearly two thousand dollars' worth of slides put at the Museum's disposal free of charge. About 300 new slides were purchased, and these, as well as the slides given or loaned to the Museum, were arranged in lecture sets with accompanying manuscripts, of which there are now about 125. It is concluded that teachers find the lecture sets with manuscripts more useful than the general slide collections, since more than 80 per cent. of the slides lent were in these sets.

	1917-1918	1918-1919	1919-1920
Number of slides circulated,	3,671	7,314	27,662

52 CONSERVATION AND DEVELOPMENT.

Motion picture films.—At the beginning of the year the Museum experimented with the lending of thirty motion-picture films which were loaned by the Ford Motor Company, the Department of Health, Bureau of Child Hygiene, and manufacturers. The demand for films increased so that in January the Ford Motor Company supplied the Museum with 48 more films to be circulated. As a great many schools, Y. M. C. A's and other organizations are installing motion-picture machines, the Museum is planning to enlarge its collection of films next year by co-operating with the Bureau of Commercial Economics of Washington, D. C., and other film services. This promises to be an important branch of the Museum's educational work.

Library and community exhibits.—Special exhibits have been prepared and loaned to 53 libraries or community centers for longer or shorter periods. They are as follows: water color sketches of wild flowers; series of mounted pictures on such subjects as forestry and lumbering, mushrooms, official war views, and the rubber industry; the process of manufacture of a rubber tire; the making of beleeck ware; the making of a newspaper; and special groups of the school lending collections.

Attendance.—The table below shows to what extent the attendance was reduced after January by the limitation of space and necessary abandonment of the class work and special exhibits. The previous year the attendance was 23,855.

	<i>Number of Classes or Clubs.</i>	<i>Number of Pupils.</i>	<i>Total Attendance.</i>
July,	18	145	2,368
August,	10	76	1,912
September,	8	18	1,835
October,	32	688	2,706
November,	11	231	1,484
December,	22	787	2,202
January, .....	...	.....	1,143
February, .....	...	.....	777
March,	3	69	1,054
April, .....	...	.....	806
May,	2	44	677
June,	5	128	945
	111	2,186	17,909

GEOLOGIST'S REPORT.

53

Average attendance per day,	61
Average attendance per month,	1,492
Attendance for the year,	17,909

Needs. The needs of the Museum are the measure of its opportunity for service to the people of the State. A modern Museum is not a mere collection of curious or unusual things, an assemblage of "antiques and horrors," nor is it only a mass of specimens with dusty and unintelligible labels. Rather, it is an institution of education and service. A State Museum can and should serve the people of the State along many lines. In its collections it should display the resources and activities of the State and the possibilities of further development. Its educational work includes all classes, but in particular it must serve the school children—those adjacent to it and those throughout the State. The former it can reach by their visits individually and in classes, the latter by loans of specimens, pictures, lantern slides, etc. There can be no limit to the needs of a living State Museum in a State as full of activity as New Jersey. The present Museum needs many things—adequate rooms, funds for material, funds for workers; but beyond and above these there is one supreme need—the need of a better appreciation by State officials and the Legislature of what the State Museum can do for the State. Given this, all other needs will be adequately met.

TESTING LABORATORY.

During the year the laboratory has been occupied almost entirely with the work for the State Highway Department. So much has this work increased that the new building which seemed so ample in every respect when planned, has proved to be too small in some respects, and considerable rearrangement of space has been necessary. In particular, the rooms designed for cement testing have been entirely inadequate and much additional space has had to be found.

So, too, with the personnel: Instead of the Director, one clerk, and two or three assistants, which were all that were necessary two years ago, 3 clerks and 10 to 15 technical assistants have all been needed to accomplish the work demanded.

In order that the variety and quantity of the work done at the laboratory may be better understood, it seems advisable to set forth in some detail the tests which are made, the number of samples tested and the total determinations made during the year.

Bituminous pavements.—Under this head are included bituminous concrete, sheet asphalt, bituminous macadam, and surface treatment for maintenance. In general the raw materials used are crushed stone, sand, mineral filler, asphalt, tar, or asphaltic oil. The tests made on each of these raw materials to determine whether they conform to the requirements of the specifications are as follows:

Stone.—Samples of the stone used are forwarded to the laboratory. Visual examination is usually all that is necessary to determine its nature—whether trap, limestone, etc. If necessary, simple tests are applied. The chief test made is to determine the sizes present in the sample and the amount of each. This is done by passing a weighed portion through a nest of sieves, weighing the amount retained on each and computing the percentage of the whole.

Sand.—Samples of sand are passed through 8 sieves, the amount remaining on each weighed and the per cent. of the whole computed.

The amount of asphalt necessary to be used to make a dense, waterproof pavement varies with the changes in the proportionate amounts of materials of different sizes present in the aggregate. Hence it is necessary to require that sand and crushed stone and mineral filler used be of the grade called for by the specifications.

Mineral filler.—The mineral filler when used is usually ground limestone or Portland cement. A sieving test is made of a sample from each carload used.

Asphalt.—Six separate tests, several made in duplicate or triplicate, are made on each sample of asphalt received, each carload being sampled.

1. The specific gravity is determined according to standard methods—one determination.

2. The consistency is determined by the penetration test, which is the distance a definite size needle under a 100-gram load will penetrate the asphalt in 5 seconds at a temperature of 77° F. The final figure is the average of 3 tests.

3. Evaporation test to determine the amount of volatile matter. A 20-gram sample in a tin dish of standard size is placed in an oven for 5 hours and kept at a constant temperature of 325° F. It is then re-weighed upon cooling and the per cent. of loss calculated on the original weight of material used.

4. Second penetration test. The residues left from the evaporation test are tested with the penetration needle as above described to determine their hardness, three determinations being made of each. The average depth of penetration must not be less than 50 per cent. of the penetration of the original material. In other words, the asphalt, after the evaporation test is made, must not be more than twice as hard as the original sample.

5. Test for ductility. A mass of asphalt 1 square centimeter in cross-section at a temperature of 77° F. in water is slowly pulled apart at a definite rate of speed. The length of thread thus formed before breaking is the measure of the ductility. Two determinations are made on each sample.

6. Flash point. The asphalt is slowly heated and with increasing temperature the volatile matter is driven off. The flash point is the temperature at which a distinct flicker or flash is seen over the surface upon the application of a small light. This affords a check on the third test above to determine amount of volatiles. One determination is made.

Tar.—If tar is used instead of asphalt, there is some difference in the tests.

1. The specific gravity is determined as for asphalt.

2. The consistency is found by the float test, *i. e.*, the time taken to displace a given amount of tar at a fixed temperature by water. The stiffer the tar, the longer the time.

3. The tars used in road work fall into two general classes, coal tar and water-gas tar. The specifications call for one or the other. They can be readily distinguished by the amount of free-carbon content. This is determined by dissolving the tar in

carbon disulphide (CS_2), the insoluble residue being carbon. Coal tar carries more free carbon than water-gas tar.

4. The volatile matter is determined not by an evaporation test as with asphalt, but by fractional distillation, the total per cent. distilled up to 170°C ., 235°C ., 270°C ., and 300°C ., respectively, being determined. This necessitates 4 weighings, but only one complete test is made.

5. Melting point test. From the residue remaining after the above distillation, 2 cubes, 1 c.c. each, are made, cooled to a given temperature, and suspended by a wire in water 1 inch above the bottom of a glass beaker. Heat is applied at a given rate to warm the water 5°C . per minute. The temperature at which the tar softens enough to touch the bottom of the beaker is taken. The result is the average of two determinations.

Asphaltic oils.—These oils are used in maintenance work. The tests made are the same as for asphalt, except that in place of the penetration test, a viscosity test is applied. This is determined by the time taken for a specified quantity (50 c.c.) at a given temperature to flow through a small hole of specified size in the testing machine. The shorter the time, the more liquid the oil.

Finished pavement.—The above tests all relate to the raw materials. It is important, however, that they be used in the proportions demanded by the specifications. To insure this, blocks of the freshly laid pavement are cut out and forwarded to the laboratory. The sample is first listed and numbered for future reference. A portion is then treated with benzol to dissolve the bitumen, which is separated from the sand and stone in a centrifugal machine, making 3,000 revolutions per minute. The solution equals the benzol used plus the asphalt or tar in the pavement. The dry, clean residue of sand and stone is weighed and sieved to determine the amount of aggregate in proportion to the bitumen and the grading, *i. e.*, the sizes and amount of each. Results are compared with the demands of the specifications.

Portland cement pavements.—The raw ingredients are Portland cement, sand, crushed stone or gravel. Each of these is tested before use, and samples of the concrete mix as it goes into the road are also examined.

Cement tests.—Each carload of cement to be used on State Highway work is sampled before shipment. At the laboratory the following tests are made:

1. Fineness. The cement is passed through a sieve with 200 holes to the linear inch; 80 per cent. must pass.

2. Time of set. The rate at which cement hardens or sets after mixing with water is determined as follows: Pats 3 inches in diameter and $\frac{1}{2}$ inch thick in the center, tapering to a knife edge at the margin, are made and stored in an atmosphere of uniform humidity. The time of initial set is the time it takes for the cement to become so hard that a weighted needle does not indent the surface. The time must not be less than 1 hour. The pat is tested every few minutes until set. The final set has been reached when a much heavier needle makes no impression. The time must not exceed 10 hours. Both tests are made on one pat.

3. Soundness test. The same pat after ageing for 24 hours is put in a steam bath for 5 hours. This hastens the curing. At the end of this time the pat must show no cracks, checks, crazing or warping, and must be firm.

4. Strength tests. A mortar of cement and a standard sand is made into briquettes with cross section of 1 square inch. After curing for 7 and 28 days, the briquettes are pulled apart to determine the tensile strength, which must reach a specified figure for each period. The result is the average of 3 trials for each period.

5. Specific gravity. The specific gravity of the cement is determined by a Le Chatelier specific gravity flask. Benzene 60° Baume.

6. Loss on ignition. A sample is heated to 900°-1,000° C. for 15 minutes and the loss of weight found,—one determination being made.

7. Insoluble residue. A weighed portion is dissolved in acid, filtered, dried, and the insoluble residue weighed.

8 and 9. The sulphuric anhydride and magnesia in the cement are both determined by standard chemical methods, since both are regarded as deleterious substances.

Sand.—The sand used in laying concrete pavements is sampled at intervals of 1,000 feet along the road and the following tests are made:

58 CONSERVATION AND DEVELOPMENT.

1. Mechanical analysis. A weighed portion is passed through a nest of 8 sieves and the per cent. of each size of particles is determined.

2. Elutriation test. The amount of clay, silt, and soluble matter present is determined by drying and then repeatedly washing a 500-gram sample and pouring off the matter in suspension through a 200-mesh sieve, repeating the operation until the wash water is perfectly clear. The residue is then carefully dried,—a slow operation,—and weighed. The difference in weight of washed and unwashed sample divided by 500 gives the percentage of loss.

3. Organic matter. The presence of organic matter in sand is highly objectionable since it causes marked diminution in the strength of the concrete. A portion of the sand is placed in a solution of sodium hydroxide, and the resulting color compared with a standard scale. The organic matter present produces a yellow to black color.

4. Strength tests. Both tensile and crushing strength is determined. For tensile tests briquettes with 1 square inch in cross section are made of the sand and cement in fixed proportions, and are broken at the end of 7 and 28 days. Three determinations are made of each sample for each period and the results averaged. These figures are compared with results of breaking the same number of briquettes made at the same time under identical conditions of the same cement and a standard sand.

5. Compression tests. For compression tests, cylinders 2 inches in diameter and 4 inches high are made of the sand and cement and crushed at the end of 7 and 28 days. Here also 3 trials are made for each age, the results averaged and compared with results attained in crushing the same number of similar cylinders composed of the same cement and a standard sand in the same proportions. The strength tests, therefore, require the making and breaking of 12 briquettes and 12 cylinders for each sand sample tested.

Stone or gravel.—The crushed stone or gravel used is sampled along the road at intervals of 2,000 feet. At the laboratory a mechanical analysis through 6 sieves is made to determine whether it is properly graded, and it is also examined to deter-

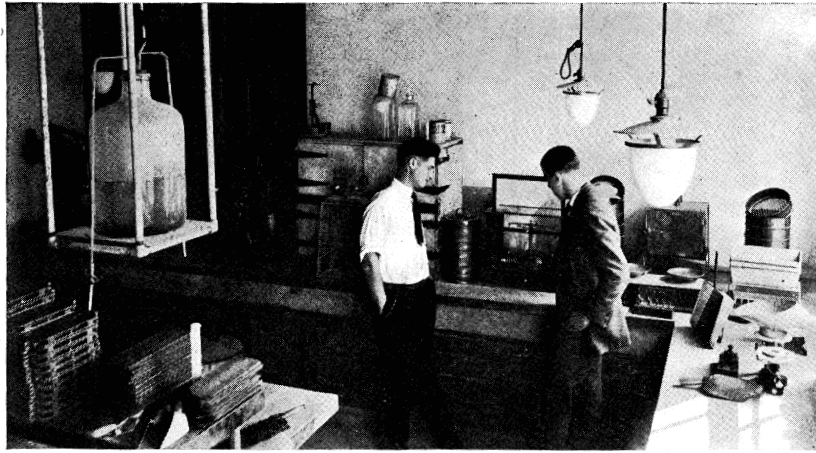


Fig. 14. Room in which bituminous road material is tested.

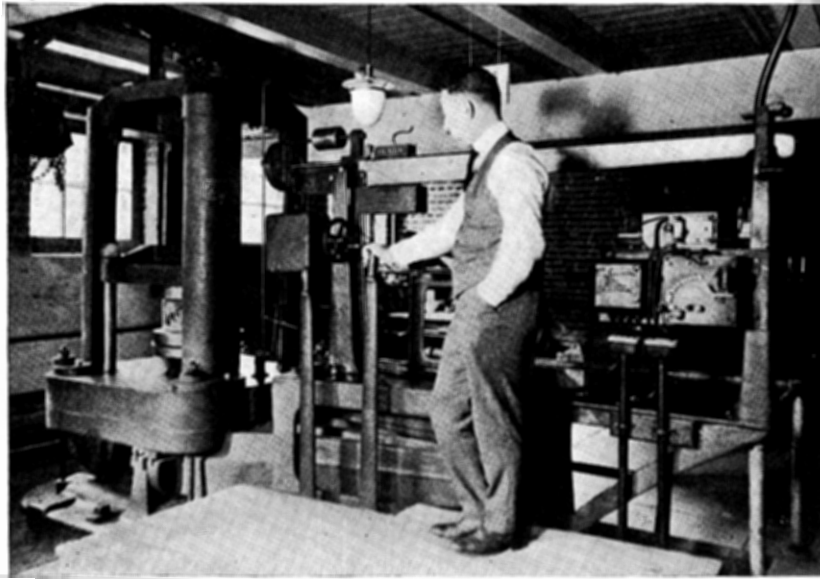


Fig. 15. Crushing test of a block of road concrete.

THE TESTING LABORATORY IS DEVOTED LARGELY TO DETERMINING THE QUALITY OF ROAD MATERIALS.

mine its kind, *i. e.*; trap, limestone, granite, etc., the presence or absence of dirt, dust or other objectionable ingredient, and its freshness or degree of disintegration. Usually visual inspection is sufficient. In cases of doubt, various tests are applied.

Concrete.—The concrete made from the above raw materials is frequently sampled as it comes from the mixer on the job and molded in a 6-inch cube, which is forwarded to the laboratory. The surplus water in the mix results in a weak concrete, which in the road cracks or disintegrates readily under heavy traffic. Determination of the strength is, therefore, important, and the cube is crushed after it has hardened for 28 days, a minimum strength being required by the specifications. As a check on these results, and for the purpose of affording a standard to which the concrete must approach, three 6-inch cubes are made up at the beginning of each road job of concrete mixed on the job with the maximum permissible amount of water. Large samples of the sand, gravel and cement to be used are also sent to the laboratory and 3 other cubes made under laboratory conditions. The average of the 3 cubes made on the job is used as the standard for comparison with subsequent samples taken by the inspector. The average of 3 cubes made in the laboratory from materials taken on job furnish data for comparison of laboratory and field tests, laboratory tests being usually looked upon as ideal and impossible of attainment in the field. Cubes which show a low strength are studied to determine the reason for failure, whether due to insufficient cement, excess of water, or other cause, and the proper official is notified.

Gravel road.—Some gravel roads are constructed. The gravel used must contain sufficient clay or similar material to act as a binder, and the pebbles must be hard enough not to wear under traffic. To give satisfactory results the various sizes of material must be present in proportions which will make a compact mixture. The tests applied are these:

1. Clay content. The clay content is determined by repeatedly washing the gravel and decanting the material in suspension. The per cent. in loss of weight is the measure of the clay and silt present. Sometimes the water of the decanted portion is evaporated off and the clay allowed to dry. Its value as a binder

60 CONSERVATION AND DEVELOPMENT.

is indicated by the degree to which it cracks on drying, a rich plastic clay shrinking and cracking more than a lean sandy one.

2. Mechanical analysis. By sieving a sample is first separated into gravel and sand. Weighed portions of each are passed through sieves of appropriate mesh, and the per cent. of sizes present determined. Results for each are calculated back and expressed in percentage of weight of the original sample.

Drain-tile tests.—The ability of drain-tile to bear the load of broken stone and dirt by which they are covered is determined by subjecting them to a crushing test, by which the pounds pressure per square inch necessary to break them is found.

Drain tile are also subjected to an atmospheric test to determine the amount of water absorbed when placed in boiling water for 5 hours. The more porous the tile the greater the absorption.

During the year preparations have been made to test paving brick, steel used in bridge work, and several other materials as may be determined.

The kinds of materials tested at the laboratory for the State Highway Commission, the numbers of samples and the determinations made are shown in the following table:

GEOLOGIST'S REPORT.

SUMMARY OF TESTS AT LABORATORY, JULY 1, 1919, TO JUNE 30, 1920.

KIND OF MATERIAL.	Number Received.	Average Number of Determinations on Each Sample.	Total Number of Tests.
Asphalt Cements,	218	6	1,308
Asphaltic Oils,	30	8	240
Bituminous Concrete and Sheet Asphalt Pavements,	640	2	1,280
Concrete Specimens,	9	3	27
Concrete Cubes,	602	2	1,204
Gravel for Portland Cement Concrete, ...	114	3	342
Gravel for Dressing on Bituminous Treated Road Surfaces,	3	1	3
Gravel, Road,	92	1	92
Mineral Filler (Limestone Dust),	22	2	44
Miscellaneous Materials,	32	4	128
Portland Cement,	1,658	6	9,948
Paving Brick,	4	2	8
Sand for Portland Cement Concrete,	390	7	2,730
Sand for Sheet Asphalt and Bituminous Concrete,	39	2	78
Slag,	30	3	90
Steel,	5	2	10
Stone,	341	4	1,364
Tars,	122	6	732
Tile,	8	2	16
Total,	4,329		19,644

OIL IN NEW JERSEY.

In spite of the opinion repeatedly expressed by geologists of the Department in published reports and in letters, that the probability of finding oil in commercial quantities in New Jersey is extremely remote, belief in its occurrence still persists and finds individuals ready to spend considerable sums in exploration. In so far as these efforts are founded on rational hypotheses, established theories, or observed facts indicating or favoring the occurrence of oil, they are to be commended, provided those whose money is spent know the hazards of the undertaking. Such efforts, whether successful or not, prove or disprove the theories involved. Random drilling with no better basis than a "hunch"

62 CONSERVATION AND DEVELOPMENT.

that oil will be found is to be deplored. The information gained is not worth the financial loss involved.

Prosperstown.—During the year extensive drilling operations were carried on at Prosperstown on the Ocean-Monmouth County line. A very expensive drill rig was erected, a force of experienced drill runners employed and extensive preparations made to sink a hole several thousand feet deep if necessary. The clays, sands, and marl beds of the Coastal Plain series were readily penetrated, several horizons of fresh water passed, and the underlying crystalline rocks entered very close to the depth at which the Department geologists estimated they would be struck. Oil was not found in the upper beds, and it is needless to say was not discovered in the underlying crystallines. The rig is now (August 1920) being dismantled preparatory to making another attempt further east, where the Cretaceous and Tertiary beds are thicker. It is regretted that the effort was not successful, but the outcome was only what had been expected by the geologists of the Department.

IRON MINES.

Replogle Mine.—The Ringwood, Oxford, Mount Hope, Richard, and Scrub Oak groups of mines were operated during the year. The Replogle Steel Company in the latter part of 1919 took over the mines, ore-fields, and blast furnaces of the Wharton Steel & Iron Company, and also the Wharton & Northern Railroad. At the Scrub Oak, now known as the Replogle mine, shafts have been extended to open up the ore at the 400-foot level and diamond drilling undertaken to prove the ore body at the 800-foot level. Some difficulty was experienced in concentrating the ore by the magnetic concentrators owing to its content of non-magnetic ore,—hematite or martite, and Wilfley tables were installed. Experimental runs with these gave satisfactory results.

The blast furnaces of the company at Wharton are being rebuilt and enlarged, and until that work is completed the hoisting of ore at the mine is being held back. The company has enlarged its holdings by the purchase of the old Dickerson mine property south of the Scrub Oak. Its ore reserves have been quoted at 100,000,000 tons, but it can hardly be claimed that this

amount of ore is "in sight." There is, however, nothing in the nature of the ore or the accepted theories of its origin which limit the downward extension of the ore bodies, or the possibilities of the discovery of deep-lying ore bodies which do not reach the surface. Furthermore, the perfection of methods of mining and ore concentration make it now possible to utilize ores which a generation ago were of no commercial value. In this connection it is of interest to note that the Replogle or Scrub Oak ore body was mined in a small way near its south end in the "sixties." An old survey notebook of 1864 quotes a remark by a prominent mining man of that day as saying "Better give \$8.00 per ton for rich ores than have Scrub Oak ore given to you." But in 1918-20, practical mining men have not hesitated to spend a million dollars or more in developing this same ore body.

Beach Glen mines.—In the spring of 1920 preparations were underway to re-work the Beach Glen mines northeast of Rockaway. Magnetic surveys were being made and some of the old workings were being cleared out. The surveys show good attraction for several thousand feet northeast of the old main shaft, and the exploration work reveals a mass of rock streaked "fat and lean" with thin seams of magnetite. As this condition is said to persist for 40 to 50 feet in width, the indications point to a considerable body of low-grade ore, which must be concentrated before shipment.

Pequest mine.—This mine, formerly known as the Ahles mine, has not been worked for a number of years, but when closed down there was a large stock pile of ore. During the past year the Pequest Company has been washing the ore for market and the Berkleigh Manufacturing Company of Easton, Pennsylvania, is drying, roasting, and grinding the settlings, which are sold as amber.

The ore of this mine, unlike that of most New Jersey mines, is a mixture of soft brown limonite, containing nodules of pyrolusite and crystals of magnetite, and often containing boulders of limestone in which the limestone is partially replaced by limonite. A portion of the ore as shipped in 1905 was separated with the aid of a magnet and by washing into three portions. One of these containing 63 per cent. of the mixture, was hard, granular

64 CONSERVATION AND DEVELOPMENT.

and magnetic. Another comprising 15 per cent. of the crude material, was soft, ocherous and non-magnetic. The remaining portion, 22 per cent. was a mixture of these.¹ The finest, ocherous, non-magnetic ore is that used for paint.

Youngstown.—In the fall of 1919, parties began sinking a shaft in the foot wall of an ore-body about $\frac{1}{4}$ of a mile due north of Youngstown and $2\frac{1}{2}$ miles south of Dover. When visited in May, 1920, the shaft was down 95 feet and a drift extended 27 feet eastward from center of shaft, but had not reached ore. A magnetic survey is reported to have shown strong attraction and a diamond drill to have found at least 5 feet of very rich magnetite.²

In addition to these newer developments the older iron mines continued active production and the development of reserves. At the Mount Hope group particularly large reserves are indicated by the more recent work.

ZINC MINES.

The zinc mines at Franklin and at Ogdensburg have maintained their customary production, the operations at Ogdensburg being still of an exploratory nature to outline and open up the orebody.

PERMITS FOR THE DIVERSION OF WATER.³

The jurisdiction of the Department, as successor to the State Water Supply Commission, over the diversion of water for potable purposes, is set forth in Chapter 252, Laws of 1907, and Chapter 304, Laws of 1910. During the year the Board has acted upon four applications, as listed below. The application of the Town of Montclair is worthy of special mention in that it called forth voluminous expert testimony regarding the present standards for potable water supply. This case also emphasized the

¹ Geol. Survey of New Jersey, Vol. VI, Iron Mines and Mining, p. 112.

² Later in the year the work was reported abandoned.

³ The paragraphs relating to water resources have been prepared mainly by H. T. Critchlow, Water Engineer of the Department.

GEOLOGIST'S REPORT.

difficult nature of the water supply problem of the northeastern part of the State and the fact that more co-operation is necessary for its prudent and economical solution.

Boro of Mendham.—The plans of the Boro of Mendham for an additional supply of water from springs and Indian Brook was approved January 6, 1920, after a public hearing on December 2, 1919, the amount to be diverted being limited to 200,000 gallons per day during any month.

Town of Montclair.—The plans of the Town of Montclair were disapproved after hearings on January 6, 23, March 19, 26, April 9, 23, May 3 and 4, 1920. Owing to the importance of the principles involved in this application the decision is here quoted in full.

IN THE MATTER OF THE APPLICATION OF THE
TOWN OF MONTCLAIR FOR THE APPROVAL OF
ITS PLANS FOR A NEW WATER SUPPLY FROM
SPLIT ROCK POND AND BEAVER BROOK. } DECISION.

Before the Board of Conservation and Development.

The Town of Montclair on December 22, 1919, filed its application for the approval of this Board of its plan in said application set forth of obtaining a new water supply from Split Rock Pond and the outflow, Beaver Brook, in Morris County, for the inhabitants of said town.

The application includes the usual prayer for the Board's approval of the Town's exercise of the right of eminent domain to acquire the necessary land, water rights, appurtenances and right of way, and of the proposed diversion of the waters of said pond and brook.

Notice of the application was given and hearings held, as provided by law, at which all parties interested were given opportunity to be heard.

The applicant appeared by its officials and counsel on behalf of the application: the cities of Jersey City and Bayonne, the Montclair Water Company, and the Morris Canal Banking Company appeared by counsel in opposition thereto.

Testimony being voluminous and a number of hearings being required for the presentation of their respective evidence and argument, all parties waived upon the record the statutory requirement that decision be rendered within ninety (90) days.

The fact that this Board is charged with general supervision over all sources of potable and public water supply, to the end that they may be economically and prudently developed; the importance to the State of such a development of its waters; the limited amount of potable water in the northern part of the State as compared with the constantly increasing requirements; and the realization that the decision on this application will necessarily have an important effect upon many other communities, have all

66 CONSERVATION AND DEVELOPMENT.

impelled the Board to examine and weigh the evidence and the rights of all interested parties with care.

The Town of Montclair is now supplied by the Montclair Water Company with water taken from the Passaic River at Little Falls, after treatment, which, in brief, comprises sedimentation, filtration and chlorination, the same water being furnished fourteen (14) other municipalities, including Paterson, Passaic and Bayonne. The amount supplied in 1919 averaged 44,000,000 gallons daily, Montclair's proportion being only about three (3%) per cent. of the whole—a fact somewhat significant in the consideration of the principal ground urged by Montclair in support of its application; that is, the unfitness of the water from the sanitary standpoint.

It was admitted by the applicant that the present supply is sufficient in quantity to meet all needs, but strongly urged that the waters of the Passaic River above Little Falls are so grossly polluted as not to be fit for home use even though filtered and sterilized before delivery; that such pollution is increasing in amount and will continue to increase; that upon at least one occasion an epidemic of intestinal disease resulted from the use of such waters; and finally, that by reason of the treatment given, chemical compounds of the water are formed which attack the pipes, making necessary frequent repairs to plumbing.

There can be no doubt that the sources of such pollution as exist are for the most part extremely obvious, somewhat localized within a comparatively short distance of the intake, and so situated and of such character as to be apparent to all who travel the roads in that vicinity, and that as a result a strong sentiment exists in the Town of Montclair against the use of this water, even after its treatment.

The Board recognizes that a widespread public sentiment of this character constitutes a natural objection to the use of water thus affected and that where some other source of supply can be obtained without injury to other municipalities and without conflict with the principles controlling the prudent and economical development of the State's water resources, it might safely support the finding of "public necessity" for a new supply.

It must be recognized, however, that unlimited supplies of potable water do not exist within reasonable reach of the metropolitan districts; that water supplies ideal in all respects cannot probably be obtained for all communities of Northern New Jersey; and that, particularly in view of rapidly increasing population, and the comparatively limited water supply sources, it is practically inevitable that so long as the water can be made wholesome and safe, the Passaic River must continue to supply a considerable part of that portion of the State.

It is, therefore, evident that sentimental objection to the present supply may better be overcome by removing those obvious forms of pollution which are most offensive, rather than by abandonment of the supply.

Nor can the Board ignore the fact that the applicant has made no attempt, either by itself, or in co-operation with the Water Company or State Department of Health, to abate any of the conditions of which it complains, even where abundant statutory authority exists.

It is not germane to this decision, but may be appropriately noted in connection with the present case, that the Board is strongly of the conviction

GEOLOGIST'S REPORT.

67

that additional powers and increased appropriations should be given the State Department of Health, through which better sanitary regulation may be exercised over public water supply sources. Promiscuous bathing in close proximity to intakes should be prohibited, and every effort made by all parties in interest to prevent the pollution of all water supplies.

The continued development and prosperity of the metropolitan district unquestionably depends upon an adequate supply of safe and attractive water which can be furnished only by the protection, conservation, development and equitable distribution of present supplies.

In our opinion, however, the degree and effects of the pollution of the Passaic water are unwarrantably exaggerated by the applicant. There is undisputed testimony to the effect that insistence upon the extraordinarily high standards for raw water advocated by the applicant's several experts, would compel the abandonment of raw waters which, as now treated, produce wholesome supplies, and would leave large sections of Northern New Jersey practically without water.

It further appears beyond question that this water, before treatment, is of better quality than numerous other raw waters which are successfully treated and safely used for drinking purposes, the stream receiving less sewage effluent, showing a lower bacterial count, and draining a region with considerably less pollution, per square mile, than several of the other approved public water supplies of the State.

The Little Falls filtration plant is of a highly approved type and efficiently operated, the chlorine gas treatment there employed being recognized as the best form of sterilization in use. The treatment given effectively removes all but occasional and minute traces of pollution. The epidemic referred to, if due to the water, was presumably due to the admixture of unfiltered water during a time of national emergency when the supply of filtered water was insufficient. Despite the fact that the applicant was but one of fifteen municipalities using this water, there does not appear to have been any marked occurrence of intestinal disorders at this time except in a limited area supplied by a part of the distribution system. On the contrary, the testimony of the health officials of several of the municipalities using this water, is to the effect that there was no serious occurrence of intestinal disorders in their respective communities at the time. Since that time the capacity of the filter plant has been increased 33 per cent.

Further, health records of Montclair, as well as of all other cities supplied with this water, show an exceptionally low typhoid fever death rate and an absence of diseases commonly accepted as resulting from the use of impure water.

The statistics and testimony furnished by Dr. R. B. Fitz Randolph of the State Department of Health are obviously entitled to the highest degree of confidence and are to the effect that this water not only compares most favorably with the public supplies of other cities, but that, after treatment, it is of a high degree of purity and entirely safe for use.

In view of the foregoing, the principal question in this case is whether the proposed taking will unduly interfere with the opportunity of other municipalities to obtain a needed supply.

The proposed plan contemplates the diversion of water from Split Rock Pond. This pond with the territory draining into it is an integral part of

68 CONSERVATION AND DEVELOPMENT.

the Rockaway watershed, the pond itself covering 315 acres and the drainage area above the proposed intake being 6.7 miles—something over 1/20 of the entire watershed of the Rockaway River above the Boonton Reservoir which supplies Jersey City.

By the construction of a dam, the flow line of the pond can be raised 5 feet and a reservoir created with storage capacity of about 800,000,000 gallons, from which the applicant claims that 4,000,000 gallons per day can be drawn without any interference with the present normal dry-weather flow of the stream below.

Although the cost of such construction is without particular bearing upon the question involved, it may be noted in passing that the applicant's estimate, \$1,319,329, included no item of cost of right of way, 88,000 feet, more or less, from the pond to Montclair; was dated January, 1918, and presumably based upon prices then prevailing; and appears open to criticism for probable inaccuracy.

The Board believes that, generally speaking, a sound and logical policy of water development requires provision for the present and reasonably anticipated future needs of communities within a watershed before permitting the withdrawal of waters therefrom by a community located elsewhere.

It appears from the evidence in this proceeding and is, in fact, a generally recognized principle that good engineering practice in planning public water supplies requires provision for a period extending into the future from twenty-five to thirty years, which principle is recognized by the applicant in its plans for diversion of 4,000,000 gallons, although presently requiring but 1,330,000 gallons.

The Town of Montclair is not located within the Rockaway watershed, within which are situate the municipalities of Wharton, Dover, Boonton and Rockaway, having public water supplies, surface and underground, which draw upon it. These communities now use 1,466,000 gallons per day and it is credibly estimated that, by the year 1945, their daily needs will approximate 3,000,000 gallons.

The City of Jersey City, previous to the passage of the Water Supply Act of 1907, although not located in this watershed, had acquired under legal authority certain rights therein and constructed a pipe line and reservoir capable of furnishing 50,000,000 gallons per day.

The present average daily draft by Jersey City from this reservoir is approximately 54,000,000 gallons, and at times its needs considerably exceed this amount, so that on occasion it is necessary to purchase emergency supplies of as much as 10,000,000 gallons per day from the Montclair or associated water companies. The undisputed estimates of Jersey City's experts are that said city's need will be 70,000,000 gallons per day by the year 1930, and 100,000,000 gallons per day by the year 1950.

The city's present reservoir and pipe line are, therefore, at the present time steadily taxed above their fairly estimated capacity, and it is clear that a permanent additional supply is presently necessary and must be provided in the near future. The construction of a new pipe line has, in fact, already been initiated as the first step to this end.

The additional supply may be obtained either: (1) by raising the dam at Boonton Reservoir to furnish more storage; (2) by constructing other

GEOLOGIST'S REPORT.

69

reservoirs at appropriate places in the watershed; or (3) by going to another watershed.

The Board finds that in view of Jersey City's prior acquisition of diversion rights against private riparian owners, and its large investment in the existing reservoir and pipe line under statutory authority, the economical and prudent development of this watershed demands that the reasonably anticipated future needs of that city be given preference over the needs of a community not situated therein or now using water therefrom.

So far as a determination of the point is affected by economic considerations, the testimony of Jersey City that the proposed development of Split Rock Pond would cost Montclair \$79 per million gallons, whereas the utilization of its supply by Jersey City would cost only \$8 per million gallons, is noteworthy.

In order to determine whether any surplus water, applicable to Montclair's requirements, remains after provision for the present and reasonably anticipated future needs of the communities found to have preferential claims thereto, the maximum safe yield of the Rockaway watershed must be found.

The determination of this question becomes of extreme importance, because of the fact that the amount of water which can be continuously taken from a watershed is not unlimited even where reservoirs have been constructed for the storage of flood waters, and the yield for potable purposes is determined by the rainfall of extreme dry years, which may come only irregularly and at long intervals, but which will, nevertheless, result in empty reservoirs and a water famine if the draft is greater than the safe maximum. Mr. Potts, testifying as expert for Jersey City, stated this maximum for the Rockaway shed as 100,000,000 gallons per day. Mr. Critchlow, the Board's own engineer, showed that in the Report on Water Supply, Volume III, of the Geological Survey Reports, a generally recognized authority on this subject, the maximum safe yield, with storage, was 666,094 gallons daily per square mile; that is, 78,000,000 gallons for the entire watershed above Boonton, this estimate being based on an extremely dry year when the rainfall amounted to only 31.63 inches as against the average of 44.09 inches. This estimate per square mile is accepted by Mr. Knight, expert for Montclair.

From measurements made at the Boonton Reservoir during 1918-1919, Mr. Critchlow estimated a maximum yield from the watershed for that dry period at 90,000,000 gallons daily, with complete storage, but it was shown that the rainfall was twenty (20%) per cent. greater than for the period of most extreme drought.

Further, all of these estimates are based upon the assumption that the water now drawn from the Rockaway watershed by the Morris Canal will be available for use in the shed. If the canal is maintained as a waterway, the amount of water available for potable purposes will be less than the above figures. Accordingly, the Board finds that the maximum yield of the Rockaway watershed in dry years will probably not substantially exceed 90,000,000 gallons, and that in periods of extreme drought it may fall considerably short of such amount.

A comparison of the yield with the present and prospective needs of the several municipalities deemed to have preferential claims show that their

70 CONSERVATION AND DEVELOPMENT.

combined demands will equal the capacity of the watershed in less than twenty-five years.

The Board accordingly finds that there is no surplus water in the Rockaway watershed which can be allotted to Montclair, and that the proposed plan will therefore unduly interfere with other municipalities now dependent upon that source by taking water necessary for their use.

The plan submitted by the Town of Montclair is accordingly disapproved and permission to take a new supply from the proposed source is denied.

In testimony whereof, we, a majority of the members of the Board of Conservation and Development, do hereto set our hands and cause the official seal of the Board to be affixed hereto and attested by its Secretary, this 24th day of May, 1920.

SIMON P. NORTHRUP,
President.

HENRY CROFUT WHITE,
W. EDWIN FLORANCE,
J. L. KUSER,
WILLIAM J. KRAFT,
PERCIVAL CHRYSTIE,

Members of the Board of Conservation and Development.

Attest:

ALFRED GASKILL,
Secretary.

Town of Bloomfield.—On May 24, 1920, the Board approved an agreement for five years whereby the City of Newark is to deliver water to certain areas in the Town of Bloomfield, where lack of pressure is responsible for poor service, and whereby in case of need the East Jersey Water Company, which is under contract to supply Bloomfield, will supply Newark with an amount of water equal to that delivered by Newark to Bloomfield.

Boro of Sayreville.—After a public hearing the Board on May 24, 1920, approved the plans of the Boro of Sayreville for a new water supply from wells, the amount to be diverted under the permit being limited to an average of 250,000 gallons daily during any month.

Boro of Wharton.—The writ of certiorari on the application of Jersey City, granted April 19, 1919, and argued in the June Term, 1919, was dismissed by the Supreme Court in October, 1919, and the decision of the Board in granting the application of the Boro of Wharton to take water from the Rockaway River was thereby sustained.



Fig. 16. Site of a water power development in Ocean county.



Fig. 17. A stream gaging station. Measurements are taken at the point where the wire crosses the stream.

GEOLOGIST'S REPORT.

71

The chief ground of attack was that the North Jersey District Water Supply Commission and not the Board of Conservation and Development had jurisdiction in this case. The Court held that the Act of 1916, P. L. 139, does not deprive the State Board of its special oversight and powers in all cases over the District Commission. An appeal was filed February 17, 1920, in the Court of Errors and Appeals and the case was argued in the following June Term. Final decision was pending at the close of the fiscal year.¹

Elizabethtown Water Company et al.—The writ of certiorari on the application of the City of New Brunswick, granted January 28, 1919, was dismissed by the Supreme Court and the decision of the Board in granting the application of the Elizabethtown Water Company et al. to take water from the Raritan and Millstone rivers near their junction above Bound Brook was thereby sustained. The decision was filed January 16, 1920, the opinion being given by Justice Bergen. (See 108 Atlantic Reporter, p. 865.)

This decision was upheld by the Court of Errors and Appeals June 14, 1920, for the reasons given by the Supreme Court.

EXTENSIONS OF TIME.

On account of general adverse conditions for doing construction work extensions of time were granted in the following cases: Commonwealth Water Company, six months from July 1, 1919; Peoples Water Company of Keansburg, six months from July 1, 1919, and a further six months from January 1, 1920. The company failed to begin work within the time limit as thus extended and the grant expired July 1, 1920; Boro of Haledon to January 1, 1921, for completion of its new reservoir; West Monmouth Water Company one year to November 1, 1920, for completing the Englishtown water-supply system; Palisades Interstate Park Commission, two years to April 3, 1920, for completing Greenbrook Park dam in Bergen County.

¹ Since writing the above, the Court of Errors and Appeals has upheld the action of the Supreme Court in dismissing the appeal. The action of the Board therefore stands.

EXCESS DIVERSION CHARGES.

Charges for 1919.—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 State Water Supply Commission. For surface supplies, Chapter 252, Laws of 1907, makes certain provision for excess diversion charges.

For the year 1919 the Board fixed a rate of \$1.00 per million gallons, the minimum rate provided by law. Certification to the State Comptroller of the amounts due the State as per table below was made February 14, 1920; the amount from each being equal in dollars to the figures shown in last column. Of the sum certified, \$12,328.91 was paid before July 1, or within a few days thereafter. The cities of Bridgeton, Jersey City, Newark, New Brunswick, Trenton and the Millville Water Company are in arrears, and the amounts due from these municipalities have been certified by the State Comptroller to the Attorney General for collection.

GEOLOGIST'S REPORT.

EXCESS DIVERSION OF SURFACE WATERS, YEAR 1919.

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	2,261,500	671.56
Boonton, Town of.....	143,628	235,790	92.16
Bound Brook Water Co.....	157,972	319,062	161.09
Bridgeton, City of.....	497,276	684,376	187.10
Buckhorn Springs Water Co.....	68,219	73,832	5.61
Burlington, City of.....	293,387	382,213	88.83
Butler Water Co.....	102,200	344,299	242.10
East Jersey Water Co.....	3,314,820	9,350,270	6,035.45
Frenchtown Water Co.....	35,588	55,604	20.02
Hackensack Water Co.....	7,924,941	11,010,455	3,085.51
Hackettstown, Town of.....	94,681	188,705	94.02
High Bridge, Boro of.....	50,443	66,160	15.72
Jersey City, City of.....	14,016,000	19,511,226	5,495.23
Lopatcong Water Co.....	146,000	401,500	255.50
Middlesex Water Co.....	639,006	1,147,884	508.88
Millville Water Co.....	433,766	519,479	85.71
Monmouth Co. Water Co.....	160,308	231,453	71.14
Newark, City of.....	13,228,208	16,404,200	3,175.99
New Brunswick, City of.....	936,725	2,086,818	1,150.09
New Jersey Zinc Co.....	58,400	63,088	4.69
Newton, Town of.....	161,403	244,185	82.78
Rahway, City of.....	555,397	999,257	443.86
J. A. Roebling's Sons Co.....	42,340	113,925	71.58
Somerville Water Co.....	472,067	612,317	140.25
Tintern Manor Water Co.....	1,147,782	1,367,293	219.51
Trenton, City of.....	4,923,850	5,819,310	895.46
Washington Water Co.....	125,232	142,880	17.65
Totals.....	51,319,579	74,637,081	23,317.49

COLLECTION OF BACK CHARGES.

Of the amount due the State on account of unpaid back charges, the sum of \$825.86 was collected from the Tintern Manor Water Company and the City of Rahway.

The appeal filed by Jersey City in the Court of Errors and Appeals to review the action of the Supreme Court in entering judg-

74 CONSERVATION AND DEVELOPMENT.

ment against Jersey City for the sum of \$22,285.34, being the amount due for six and one-half years' back charges, has been pending before the Court during the year.¹

The Department, acting on the advice of the Attorney General, has not pushed cases against other delinquents pending final determination of this suit.

MEASUREMENT OF WATER CONSUMPTION.

During the year 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 their consumption. The results of this work have been valuable in showing that most of the smaller gravity systems are using considerably more water than is reasonable and necessary. In many cases the large consumption is no doubt due to leakage from the piping system, plumbing fixtures, and the unnecessary wasting of the water.

Tests have been made as follows :

July 3 to 9, 1919—Lambertville Water Co., gravity system.
July 17 to 24, 1919—Bound Brook Water Co., to calibrate Venturi meter.
Aug. 16 to 24, 1919—Town of Newton, gravity system.
Aug. 26 to Sept. 24, 1919—Butler Water Co., gravity system.
Oct. 9 to 17, 1919—Boro of Haledon, gravity system.
Oct. 30 to Nov. 3, 1919—Washington Water Co., gravity system.
Nov. 3 to 7, 1919—Boro of Hackettstown, gravity system.
Nov. 15 to 21, 1919—Bound Brook Water Co., to calibrate Venturi meter.
Nov. 26 to Dec. 2, 1919—Town of Boonton, gravity system.
May 28 to June 11, 1920—Town of Boonton, to measure consumption and the yield from the infiltration tunnel.
June 17 to 25, 1920—Boro of Sussex, gravity system.

PLANS FOR DAMS.

Plans approved.—During the year the Board issued permits for the construction of new dams and the repair of old ones, as follows :

September 9, 1919, the Town of Morristown for the repair of Pocohontas Lake dam, and Arthur Whitney for the repair of

¹ Since writing the above, the court has sustained the action of the Supreme Court, and Jersey City has paid the amount claimed.

GEOLOGIST'S REPORT.

75

a dam on North Branch, Raritan River; October 7, 1919, A. C. Pearson for repair of Peon Lake dam, Stony Brook; May 24, 1920, Monmouth County Water Company for repair of dam at Jumping Brook pumping station on North Branch of Shark River; May 24, 1920, North Jersey District Water Supply Commission for the construction of a dam and reservoir on the Wanaque River at Midvale, Passaic County. This dam will form an impounding reservoir flooding an area of 2.2 square miles at an elevation of 275 feet above sea level, and having a capacity of 11,000 million gallons, and will make available a gravity supply of 50 million gallons per day for the metropolitan district. The construction will include an earth dam with a concrete and clay puddle core-wall, concrete gate-house, concrete overflow weir, and overflow and inlet channels in rock. The dam will be approximately 1,750 feet long from bank to bank. The earth embankment will have a top elevation of 285 feet above sea level and will be about 1,200 feet long, with a maximum height above the original surface of the ground of about 75 feet. It will take about five years to complete the dam, conduit, and other works necessary to deliver water to Newark and the other municipalities that may join in the project, even if work be promptly started.

Ocean County Electric Company.—On February 10, 1920, the Ocean County Electric Company filed plans for the construction of a concrete dam on Toms River just above the Town of Toms River. These plans were to supersede those approved by the former State Water Supply Commission January 16, 1916. This dam will impound water for a hydro-electric development of considerable importance. Since the claim has been made that this is a navigable stream, the plans will not be acted upon until the consent of the United States authorities has been obtained by the applicant.

INSPECTION OF OLD DAMS.

Failure of dams.—Excessive rains during July 15-23, 1919, caused the failure of six dams in Morris County as follows:

A masonry and earth-fill dam on the North Branch, Raritan River, near the village of Ralston, owned by Arthur Whitney

76 CONSERVATION AND DEVELOPMENT.

used for pleasure purposes and for running a small hydro-electric plant, was breached by overtopping of the earth wing. The released flood waters destroyed the old grist mill building which housed and hydro-electric plant. This dam was repaired under the supervision of the Department as set forth above.

An earth-fill dam with concrete masonry spillway on a small brook at Mendham Station (N. J. & Pa. R. R.) owned by John Hoffman, was breached at the spillway section and broke the pipeline which supplies water to the Boro of Mendham.

The Peon Lake dam (formerly Bowden's Pond) on the west branch of Stony Brook, four miles due north of Boonton, owned by A. C. Pearson and C. G. Phillips, and used for pleasure purposes, was breached by overtopping of the earth wing. Timely warning by the owners to the inhabitants below saved live stock which were grazing in the path of the flood waters. Plans for the repair of this dam were approved as set forth above.

The Brant dam on the Whippany River near Morris Plains, owned by James A. Muir, was breached by the overtopping of the earth embankment. The released flood waters damaged the highway bridge and earth embankment forming the approach to the bridge.

The Huff dam near Boonton and the Kayhart dam at Montville were also reported to have failed during the same freshet.

Unsafe dams.—In addition to the above failures four other dams were reported in an unsafe condition as follows:

The Jaqui dam on the Whippany River, the Angus dam on a small tributary of the Whippany, the Kennedy dam on a mountain stream above Long Valley, and the Openaka Lake dam near Dover. These were all investigated by the Engineer of the Department, and where conditions demanded, repairs were ordered made.

The above paragraphs emphasize the importance of a state-wide inspection of all existing dams, many of which may, either through poor design and construction or lack of proper maintenance, be a menace to life as well as property during freshets. Chapter 243, P. L. 1912, and supplements thereto, charges this Board, as successor to the former State Water Supply Commis-

GEOLOGIST'S REPORT.

77

sion, with the supervision over the construction and repair of dams above a certain height. From lack of funds and personnel it has been possible for the Department, since it assumed charge of this work in July, 1916, to inspect only new structures and any existing dams concerning the safety of which complaint has been made. Further than this it is not possible to go, under existing conditions, although the importance of and the economic saving which would certainly result from carrying out a thorough inspection of all the dams in the State is realized. It is hoped that funds will be made available to carry out this important provision of the statutes. It is estimated that an appropriation of at least \$5,000 should be made for a number of years for this work.

STREAM GAGING.

In the report for last year the importance of stream-flow data in connection with the study of water-supply problems was emphasized. The stream-gaging work in this State was abandoned by the State Water Supply Commission in 1914 because of withdrawal of legislative support. The Department asked for funds to re-establish this work in its budget for 1920-21, but the request failed to receive approval, regardless of the fact that the judgment of the Department had been confirmed by numerous communications from Boards of Fire Insurance Underwriters, water-works engineers and others, all emphasizing the importance of accurate stream-flow records.

The urgent need of reliable and continuous information on stream flow has been further proven in the Board's consideration of the applications for new water supplies during the past year. The application of the Town of Montclair to take water from Split Rock Pond and Beaver Brook (See p. 65) is a case in point.

The Water Supply Commission of Pennsylvania has urged upon this Department the importance of co-operative work in studying the water resources of the Delaware River. The potential use of this important interstate stream for water supply, water-power, etc., can only be accurately determined by the aid of information regarding the flow at several points over a period of years. Some work is being done by the United States Geological

78 CONSERVATION AND DEVELOPMENT.

Survey and New York State, but more work should be started at once in order to properly develop the usefulness of Delaware River. The recent passage of the Federal Water Power Act will no doubt lend encouragement to the development of this stream for power use.

The sum of \$10,000 annually should be appropriated to maintain this work through a term of years long enough to embrace at least the usual extremes of rainfall.

In connection with its studies of the storage possibilities of Raritan River, the Department has, in part, through co-operation with the Taylor-Wharton Iron and Steel Company of High Bridge, continued the operation of two gaging stations. Observations of gage heights have been continued throughout the year and discharge measurements made as follows:

South Branch at High Bridge—September 26, 1919. June 24, 1920.

South Branch at Stanton—September 26, October 31, 1919. June 23, 1920.

UNDERGROUND WATER STUDIES.

Dr. M. W. Twitchell has continued his studies of and compilation of data regarding ground water supplies. Well records have been collected, analyzed and tabulated. Numerous letters of information and advice have been written in response to inquiries as to ground waters.



Fig. 18. A MATURING FOREST WITH THE NEXT GENERATION STARTED.
Once in this condition, New Jersey's woodlands can supply the greater part of our timber needs.

Report of the State Forester.

ALFRED GASKILL.

FORESTRY HAS ARRIVED.

The year marks the beginning of a new era in forestry. National necessity has awakened public interest, and the importance of forestry practice as a part of any National program is realized. This fact has been noticeably demonstrated in New Jersey, through the recognition by all classes of woodland owners, that their holdings must be made productive. Manufacturers recognize the need of an assured supply of lumber to satisfy their wants in the future. Forestry schools report that never before in their history has there been such a demand for foresters, particularly by private industries. The State force of foresters is hard pressed to meet all the requests for assistance from woodland owners.

This situation is, in a way, one of the good results of the great war, for it clearly was the way extraordinary demands were met for many kinds of timber—pine for cantonments, oak for ships, spruce and ash for airplanes, walnut for gun stocks and airplane propellers, that showed what our limitations were as well as what we could do. Huge quantities of cordwood also came out during the fuel shortage—again proving that we still have the means to produce wood. Then, during and following the war, came the paper famine,—a stimulated demand that the established mills could not satisfy. All these conditions drew attention to our need of provision for the future.

POLICY AND ORGANIZATION.

The National situation finds New Jersey with an established forest policy and an efficient, if all too small, organization. The problems that we face have been foreseen and the Division of Forestry, built up from a modest beginning in 1905, has been making constant progress in meeting these problems. In brief they are: (1) To make our idle land produce the lumber that

80 CONSERVATION AND DEVELOPMENT.

our people need, and (2) To do it by stopping forest fires and giving nature a chance.

The Division of Forestry and Parks now includes a State Forester and two assistants, six rangers in charge of the State Forests, a State Firewarden and four assistants, seven watchmen for the forest fire lookout towers, and nearly four hundred local firewardens. Six professional foresters are included in this personnel, but more are badly needed to keep up with the rapidly increasing work.

WHY WE NEED FORESTRY.

We have approximately two million acres (45% of the State's area) of woodland, the greater part of which is in poor condition through past abuse and neglect, and at present is producing little or nothing. From a half to two-thirds of this woodland area is permanently unfitted for any other use than growing forests; but, given proper protection and care, it will produce lumber. The taxable valuation of this unproductive land is now less than \$6,000,000 and it yields less than \$1,000,000 a year net to the owners; yet, without counting off what may be cleared for farming, it can be made worth more than \$200,000,000 and yield annually \$10,000,000. We import twenty times as much lumber as is produced at home, and yet our lands are capable of supplying the greater part of this demand, at a great saving to the public in both lumber costs and in freight bills.

Our woodlands have great recreational value, once the unsightly burns, desolate slashings and monotonous brush areas are replaced by thriving forests. Under proper development the wooded mountain and lake region of North Jersey and the pines of South Jersey should rival the coast resorts in popularity.

FOREST FIRE PROTECTION.

Standing firmly by the proposition that forest protection is absolutely essential before any constructive development is practicable, our progress in forestry must be measured by the efficiency of our forest fire service. That, as the report of the State Firewarden shows, is strengthening steadily, though it yet lacks much of what is required.

FORESTER'S REPORT.

81

Since there is little prospect that everybody who traverses or uses our forests will avoid setting fire we must continue to press for enough watchers and patrolmen to locate every smoke and have the fire put out before it becomes serious. It can be said that the area within which forest fires are common is being steadily reduced; that more and more forest is made secure, that most of our fires burn over old burns in sections where it has not been possible to establish adequate control. Especially significant is the recorded fact that responsibility for 62% of all the fires was fixed upon the offenders. That is an achievement of which the Fire Service can well be proud, for it is unmatched anywhere.

Much good to the forests is anticipated from the operation of the game laws enacted by the last Legislature making the deer hunting season from December 16th to December 25th and giving farmers the right to kill or trap rabbits or deer when their trees or crops are injured. By making the deer hunting dates later than heretofore the danger of forest fires is lessened while the rabbit law will tend to keep irresponsible city gunners out of the woods and brushlands.

AID TO WOODLAND OWNERS.

That the policy of encouraging forestry practice among the private owners of woodland by offering them co-operative assistance has been both wise and helpful is amply shown by our records. From those it has been found that more than 100 active co-operators—individuals, commercial concerns, municipalities and public institutions—are practicing intensive forestry such as improvement cuttings, close utilization of products and fire protection, on approximately 10,000 acres of woodland, while over 40,000 acres more, under the same ownership, have been protected and improved to some extent, and definite plans made for more intensive management. Over fifty new co-operators are planning to extend forestry management to approximately 12,000 acres as soon as labor and economic conditions become more favorable.

Progress also has been made in forest planting. While natural reproduction is usually adequate and satisfactory in most parts of the State, it is often advisable to re-establish forest growth by

82 CONSERVATION AND DEVELOPMENT.

planting on land unwisely cleared and unfit for agriculture, or where all reproduction has been destroyed by fire. More than 1600 acres have been thus planted by persons co-operating with the Department and another 300 acres will be planted within a short time.

Including the State Forests, referred to below, there are upwards of 80,000 acres of woodland within the State upon which forestry practice is now established or definitely planned for the immediate future. The owners have been won to a realization of the practicality of forestry and are pledged to its practice.

The ownership and management of woodlands in this State fall naturally into three classes; *a.* small woodlots as parts of farms or estates; *b.* large tracts operated by commercial organizations; *c.* public properties such as municipal watersheds, parks and State Forests. Each class of ownership is necessary to the best development of a well balanced State, and each class of owners should and can maintain its woodland property for its own benefit as well as for that of the public. Both private and public-owned woodlands are essential;—both are capable of efficient and profitable management,—neither should be encouraged to the exclusion of the other.

EXAMPLES OF APPLIED FORESTRY.

To illustrate the assistance given woodland owners, and to show how this aid helps to make the properties more productive and profitable, three specific examples are cited:

1. *A Farm woodlot.*—In Morris County, three miles from the nearest town and railroad, is a farm of perhaps 500 acres, containing 100 acres of woodland and 100 acres of abandoned fields, on land so steep and rocky, or of so little fertility, that it cannot be farmed profitably. This combination of good and poor land is common on North Jersey farms.

The owner asked for assistance about eight years ago, when the chestnut was dying from the blight. He was advised to salvage the dying and dead trees as promptly as possible while they were still merchantable, and at the same time to make his woods, consisting of the ordinary stand of second-growth mixed hard-



Fig. 19. Pine woodlot in South Jersey.



Fig. 20. Typical hardwood woodlot.

EXAMPLES OF WOODLAND MADE PRODUCTIVE BY FORESTRY.
GROWTH STIMULATED BY UTILIZATION OF CROWDING AND
INFERIOR TREES. FIRE DANGER REDUCED BY BRUSH DIS-
POSAL. NATURE PROVIDES REPRODUCTION IN OPENINGS.

woods, more profitable and productive by an improvement cutting. A forester demonstrated on the ground how this cutting should be made.

The work of improvement started immediately and has continued during slack and spare time up to the present. Approximately 85 acres have been cleaned and thinned and the remaining 15 acres will be finished next fall or winter. All dead, dying, unhealthy, misformed and over-mature trees of all species, and all chestnuts, were removed, while the healthy and straight young trees of the best species were left standing for further growth. The woodland is now in far better condition than it was before the operation started (Fig. 18), since it has been thoroughly cleaned of all crowding and inferior growth, and the tract is producing a crop, constantly increasing in quantity, quality and value. Further cutting will be done at intervals as the trees mature, and Nature will furnish reproduction to replace the trees removed.

The timber cut during the operation has been wisely marketed in its most profitable form. There has been no waste, for everything was utilized—fence posts, rails, lumber, electric poles, furnace poles, clothes poles, basket logs, ties, piling and cordwood. The total cost of producing and marketing these products has been \$2,684, and they have been sold for \$6,526, netting a profit or income from the land of \$3,842, equal to over \$45 per acre. This is a good return when it is considered that only inferior and crowding material has been removed. Future cuttings will undoubtedly show a greater profit.

At the time this operation was started the owner was advised that the most profitable use for his idle fields was to grow trees. Acting upon this advice, over 70 acres were set out in pine within four years, and the owner plans to continue planting until all his idle lands are thus put to work. The young seedlings were spaced six feet apart, or 1200 to the acre. The cost of all planting stock, material and labor has amounted to \$17 per acre. Aside from the interests on the investment, which can be ignored, as all planting outlay was more than covered from wood sales, there will be little or no cost involved in the maintenance of these plantations. When the trees are ready for the first cutting, say in 40 or 50

84 CONSERVATION AND DEVELOPMENT.

years, a yield of 25,000 board feet per acre can be expected. By the time this crop matures it is probable that stumpage will be far higher than at present, although even at present prices the investment will show a profit. If the owner decides to sell his property in the meantime, the growing plantation will greatly increase its market value. This whole undertaking was amply warranted by the fact that the property is in a section where fire control has been established.

2. *Forestry on a large timber tract.*—A permanent industry in North Jersey requires large quantities of lumber and timber, and for the last few years has experienced considerable difficulty in satisfying its needs. It has, therefore, purchased approximately 10,000 acres of rough, mountain woodland in the neighborhood of its works, and employed a professional forester.

The first step in forest management always being protection, the company has co-operated with the State Firewarden in the erection of a fire lookout tower, which, through the company's organization and the State Fire Service gives protection to the company's woodlands and to those of all adjoining owners.

The next step was the utilization of all dead and dying timber, especially the chestnut. This material is now being removed and worked up by three sawmills operating at convenient points on the tract. As soon as the dead timber has been salvaged an improvement cutting over the entire tract will be made, by which inferior and crowding trees will be removed, and the remainder stimulated to the highest production. Each year a certain area will be cut over, and the operation will continue indefinitely. If timber of suitable size can be produced in fifty years (50-year rotation) the property will yield each year the equivalent of a clear cutting on 200 acres.

Other interests are looking to a similar development of our forests upon the basis of low present costs and our exceptional transportation facilities. Quite recently the representative of a large cabinet firm in the Lake states sought advice regarding a location. He is now looking up the necessary woodland.

3. *Management of public-owned woodlands.*—A municipal Water Department, controlling a 2000 acre tract from which its public water supply is derived is developing the property with a

view to safeguarding the water sources, getting a revenue through forestry from the land, and establishing a municipal park. Approximately 1400 acres now support a fair stand of mixed hardwoods, 600 acres consist of agricultural land and old abandoned fields not fit for farming.

Plans for the management of this property were made, and adopted by the Water Department, several years ago and work begun, but unfavorable labor conditions during and following the war caused it to be halted. During the past year work has again been taken up. An improvement cutting of the woodlands is now under way, and a considerable profit has been realized from the sale of cordwood furnished to nearby residents. This cutting will ultimately cover the entire tract, and will remove all inferior and crowding timber, leaving only thrifty, fast-growing trees of the best species.

At the same time more than 50 acres of the idle fields have been planted with pine and spruce, and most of them have thrived. Scotch pine planted in 1910 now averages over 20 feet in height and a profitable yield of timber can be expected.

TIMBER MARKETS.

The outlook for profitable timber production has never before been so bright. Prices of all kinds of lumber and wood products are now fabulously high. Though the present rates are somewhat inflated we clearly are approaching the time when lumber prices will bear some relation to the cost of production, and not be based, as they have been, upon Nature's bounty in virgin growth. Our advantage is that we can grow timber almost as cheaply as any section and can deliver it to the users for less. Freight is an important item in the price of lumber.

While New Jersey will always be forced to import considerable lumber of the better grades, it is obvious that the bulky, "low grade" products, such as railroad ties, mine timbers, electric poles, piling, boxboards, fence posts, cordwood, etc.,—must be produced near the points of consumption. During the past ten years there has been abnormal production because large areas of woodland have been cut over to salvage chestnut killed by the blight. A

86 CONSERVATION AND DEVELOPMENT.

few years more will see this operation ended, and from then on we may expect a demand for such products that will be hard to satisfy. Even now a scarcity of poles, piling and standard ties, especially the larger sizes, is evident.

The uncertainty of adequate coal production and delivery again emphasizes the desirability for the utmost use of wood by our rural population. We have a surplus of it and the householder who can buy cordwood at a reasonable rate will find it economy to use it in preference to coal. The farmer who owns woodland can not only save from \$5 to \$8 on each ton of coal he would ordinarily use, but he can find profitable employment for himself, his help and teams during otherwise slack times.

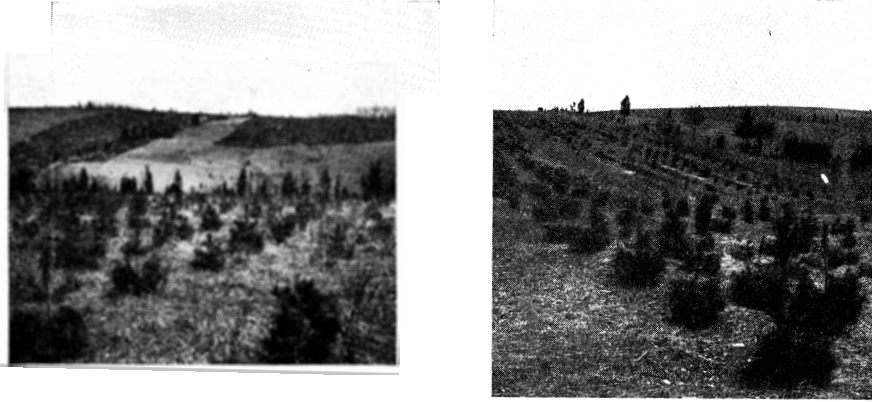
Our file of timber operators, producers and buyers continues to be of service in bridging the gap between producer and consumer. The importance of this work emphasizes the need of another forester whose time shall be largely devoted to a study of the best methods of marketing and utilizing our timber resources. At present the ground cannot be thoroughly covered.

STATE FORESTS.

The forests now owned by the State have not increased, but suffered a nominal reduction of 87 acres through a transfer to the Department of Institutions and Agencies of the tract used for several years by the State Colony for Feeble-minded Males. Since this institution has become so important there was no reason longer to hold the land as a part of the Lebanon Forest; it has developed a higher use. The hope entertained when the colony was established, in 1914, that its inmates would be able to help develop and guard the adjoining woodland has not been realized, yet the location has proven the agricultural value of some of our despised pine land and has made an oasis in the wilderness.

As demonstrations in fire protection and in practical forestry the State Forests continue to prove their worth. They are maintained and administered through forest rangers in in each tract.

Following a decade of protection from fire and abuse, there is now timber approaching merchantable maturity on portions of all



Figs. 21 and 22. Idle fields, unfit for farming, put to work by planting forests.



Fig. 23. Thrifty pine plantation eight years old.



Fig. 24. Pine plantation twenty-six years old, already profitable. In twenty years more 20,000 board feet of lumber per acre can be removed.

FORESTER'S REPORT.

87

of them. Sales of wood, moss and cranberries yield a small income annually. Before many years these tracts should become self supporting; ultimately they will yield a considerable profit.

Fire.—The fire service increases in efficiency. In particular the lookout tower on the Stokes Forest served to locate and have extinguished two fires that threatened that property. One was put out before it had burned an acre, at a cost of only \$5.00, the other burned 14 acres, and cost \$12.00 to fight. The total damage was estimated at \$80.00. A bad fire in the vicinity of the Lebanon Forest burned only 200 acres of State land through prompt and efficient work on the part of the local ranger. Another dangerous fire was stopped at the boundary of this forest by the protective fire-line. Altogether the three fires burned 215 acres of State land, did \$480 worth of damage, and were extinguished at a cost of \$97.70. The Penn, Bass River, Mount Laurel and Jackson Forests suffered no loss. This record is an improvement over that of many former years. Trespass on the forests is practically nil.

Silviculture.—In the spring five acres of old fields on the Stokes Forest were planted to scotch and red pine, for experimental and demonstration purposes, bringing the total of State plantations up to 50 acres. New thinnings and improvement cuttings have been started for the purpose of studying the increased growth of trees and the yield of stands under various sorts of treatment.

Recreation.—During the year the State Forests have greatly increased in popularity as camping grounds for vacationists and tourists. An attractive circular published in July, 1919, inviting the public to use these tracts for their pleasure has resulted in hundreds of inquiries from persons in all parts of the State, and in many taking advantage of the opportunity to spend a few days or weeks near to Nature. Most of this interest attached to the Stokes Forest in Sussex County as the South Jersey forests are less attractive in summer. To meet the increasing demand for camping sites, favorable locations have been improved, old roads and trails renewed and the woods made more accessible and usable.

The Department's proposal that a great forest park be erected on the Kittatinny Mountain as a memorial to the soldiers and

88 CONSERVATION AND DEVELOPMENT.

sailors of the Great War has aroused much favorable comment. If the project shall carry, this beautiful mountain woodland, with its lakes and sparkling trout streams, will become one of the most attractive inland playgrounds in the Country.

Following is the location and character of each State Forest:

STATE FORESTS.

- Bass River Forest.*—Ranger, Samuel B. Allen, New Gretna, 1,633 acres
Is in Burlington County, six miles northwest of Tuckerton, and is typical of the so-called "pine barrens," now recovering from former severe burnings. Considerable cedar swamp is also found on this tract. A number of experimental forest plantations are developing rapidly.
- Jackson Forest.*—Ranger, Jacob A. McKaig, Cassville, 43 acres
Is in Ocean County, 10 miles west of Lakewood on the New Egypt road, near Cassville, and carries a forest of nearly pure pine about 40 years old. It is used to demonstrate the methods of practical forestry and as a resting place for travelers.
- Lebanon Forest.*—Ranger, Victor Bush, Pemberton, 4,812 acres
Is in Burlington County, nine miles southeast of Pemberton, and contains pine, oak and cedar. Several experimental plantations and more recent thinnings are on it, but it is used largely as a demonstration in fire control under particularly difficult conditions. Considerable fire damage has been suffered since the acquisition of the property, but it is in better condition in every way than when it was acquired.
- Mount Laurel Forest.*—Ranger, Harvey Darnell, Moorestown, 21 acres
Is an isolated tract of hardwood and pine in Burlington County, three miles southeast of Moorestown. It is peculiarly accessible and susceptible to forest management, and because of very complete and successful thinning and plantings seven years ago, has unusual value as an example of applied forestry.
- Penn Forest.*—Ranger, George L. Inman, Chatsworth,¹ 2,764 acres
Is in Burlington County, six miles southeast of Chatsworth. It is a tract of almost pure pine in the heart of the wilderness. The forest on much of it is in better than average condition and affords a pointed example of the value of fire protection in developing timber growth under typical conditions in "The Pines."
- Stokes Forest.*—Ranger, Paul B. Haines, Branchville, 7,231 acres
Is in Sussex County, three miles west of Branchville. It is typical of absolute forest land in North Jersey.

¹ Resigned. Lawrence E. Terhune appointed ranger March 1, 1921.

FORESTER'S REPORT.

Under fire protection it is rapidly developing in value, and it has great possibilities as a park. Roads, trails and camping sites are being provided as fast as facilities permit. Through recent additions the forest is now easily accessible from the highway in Culver's Gap and is available for use by a limited number of camping parties.

<i>Swartswood Lake.</i> —Ranger, Paul B. Haines, Branchville,	560 acres
Is in Sussex County, seven 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.	
Total,	17,064 acres

SHADE TREES.

Under a general public approval and support, the shade-tree interests of the State have continued to thrive and expand. Several new municipalities have joined the ranks of those maintaining Shade Tree Commissions, until there are now nearly one hundred towns and cities that have provided for the protection and improvement of their shade in this way. The proposal of the American Forestry Association that trees be planted and "Roads of Remembrance" established as memorials to the men who gave their lives in the World War has been well received everywhere, and has served to stimulate interest in the better shade tree movement. The desire to make our rural highways attractive by maintaining road-side shade, moves more slowly, though there, too, some results are being obtained. The State Highway Department aims to preserve natural shade where it occurs along State roads under construction and Salem County has made a beginning in road-side tree planting.

Assistance given to Shade Tree Commissions by the State foresters has resulted in better care and better trees in a number of municipalities. Several communities have found that the Oriental Plane, which has been extensively planted, is undesirable or unfit, at least in North Jersey, because when young its thin bark affords insufficient protection to the vital tissue against winter cold and against heat reflected from close pavements. During the past severe winter many trees planted within five years were killed or severely injured.

INSECTS AND DISEASES.

With one exception insect pests and tree diseases have been kept well under control during the year. No new outbreak of the White pine blister rust has occurred, and the pine weevil, although it continues to cause trouble where it is not watched, has not entailed any serious loss. The Japanese beetle, which appeared in western Burlington County, has not been exterminated, as was first hoped it might be, and it has succeeded in extending somewhat the limits of its occurrence, but further study leads to the belief that the insect's power to cause serious damage has been overestimated. Tussock moth and Fall Webworm have been plentiful in various sections, yet both are so easily controllable that no community need suffer from them. The chestnut blight has almost finished its work of cleaning up our chestnuts. But the discovery early in the Summer of a colony of Gipsy moth in Somerset County gives cause for grave concern. This insect has done so much damage in New England, and although millions of dollars have been spent, is still so far from being conquered, that there appears to be no question about our duty. The pest must be stamped out if possible. As this is written plans and estimates of the cost are being made.¹ In any event the plant inspection and control service, vested in the Department of Agriculture, should be strengthened, to the end that every forest, horticultural and home interest shall have greater security against the plant enemies that higher culture and extended communications constantly present.

STATE AID.

The Department undertakes to aid, through its foresters, anyone, individual or public body that asks for advice about forests or shade trees. Unfortunately this service is limited by lack of competent men, but help can be and is given by mail, upon the basis of an intimate knowledge of conditions. In some cases special inspections and advice can be provided for. The cost is nominal. Correspondence is invited.

¹Under an emergency appropriation by the Legislature, suppression work was begun in November, 1920, and has been actively carried on.



Fig. 25. Roadsides cleaned like this are a public benefit.



Fig. 26. Roadsides untended like this invite accidents and fires.



Fig. 27. Result of an unkempt roadside and a smoker's carelessness.

Report of the State Firewarden.

C. P. WILBER.

To conform with the natural division of the fire season and with similar statistics for the entire country, the tabular and statistical matter following are for the *calendar* year 1919. The general Statement of conditions and progress is for the fiscal year July 1, 1919, to June 30, 1920.

THE FIRE SEASON.

The very unusual mildness of the winter, with its absence of snow and preponderance of clear weather, is reflected in a surprising number of fires, even in the northern part of the State, during January and February, 1919. But, although twelve per cent. of the year's fires occurred before the first of March, none of them were serious. March and April developed true spring fire conditions and closed with 61% of the year's total fires chargeable to this annual period of cleaning up. Though the spring was not marked by any unusual drought, the high winds and more than usual warm weather, with the lack of foliage and rapid drying out, resulted in the inflammable conditions usually met with at this time of the year, and made fires frequent and often serious. May conditions were unusually favorable, because of rainfall greatly in excess of normal years, and fewer fires occurred than usual. June, though dryer than the average, found foliage well forward and gave no serious difficulty. From July to the end of the calendar year there occurred the most unusual period of safety from fires on record. Rain was both abundant and abnormally frequent, and so safeguarded the usual danger season of late summer and fall that less than 8% of all recorded fires occurred in the last six months of the year.

92 CONSERVATION AND DEVELOPMENT.

Analysis of the above figures pointedly emphasizes again the necessity for an adequate permanent fire lookout system, and patrol for temporary and local situations and in seasons such as the spring and fall when cleaning or protective burning is most common or where hunting or fishing is localized.

Large and serious fires do not occur where existing lookouts are operating, although the number starting is often large. The number of fires which start is markedly reduced in the restricted areas which are patrolled with the limited means available. The fact that from 60 to 75 per cent. of each year's fires occur in March, April and May and 10 to 20 per cent. in November is indicative of the possibilities of a temporary intensive patrol for these periods. Facility for the reasonable and necessary extension of these means of fire prevention and control is the only, and is a thoroughly proven and trustworthy, means of rapidly and adequately remedying the situation. (See page 100 and 101.)

FOREST FIRES BY MONTHS, CALENDAR YEAR 1919.

<i>Month.</i>	<i>Number of Fires.</i>	<i>Per Cent. of Total.</i>	<i>Month.</i>	<i>Number of Fires.</i>	<i>Per Cent. of Total.</i>
January,	16	3	July,	19	3
February,	52	9	August,	3	..
March,	127	21	September,	2	..
April,	243	40	October,	2	..
May,	84	14	November,	24	4
June,	33	5	December,	1	..

NUMBER AND AREAS OF FIRES.

(See Tables 1 and 2)

For the calendar year 1919, reports of 607 fires have been received, a considerably smaller number than the average for recent years, and much below the record for the preceding year. Of these, 27 per cent, or 164, were stopped before they had burned two acres, 57% burned less than 10 acres and only 11 per cent. burned more than 100 acres. The average area per fire was 77 acres, very appreciably lower than for any of the 5 years previous. The average damage per fire (\$105) is larger than for two years previous. This is due, not to greater damage done, but to

FIREWARDEN'S REPORT.

93

increased emphasis on an accurate and adequate appraisal of the loss by fire, and an awakening interest and intelligence on the part of local wardens to the material damage which fire does in young growth.

The total area burned was 46,927 acres, far lower than for many years past, and the total loss recorded was \$63,638. (See Tables 1 and 2.)

CAUSES OF FIRES.

Railroads.—The number of fires charged to railroad operation is not only smaller than ever before, but lower in proportion (29 per cent.) to the total than for any year since the record has been in anyway complete. Credit for this condition is almost, if not altogether, due to the increasing interest and co-operation of those in charge of the railroad rights-of-way. It has annually grown more apparent that, so long as coal burning motive power is used, the prevention of railroad fires must come through making the rights-of-way fireproof. It likewise is more and more evident that the reduction of fire damage to the woodlands from this cause is practical and its elimination feasible by simple, and not extravagant, provision of adequate protective areas. To make effective such measures, an increase in the regular force of men employed as firewardens, or means for providing patrol for brief seasons each year for a few years are needed.

Brush burning.—Each year fires from this cause come more and more to the fore among those of known origin. Likewise, they are proven to be a class of fires which can be controlled wherever it is possible to have patrol. Whether it be broadcast protective burning around cranberry and similar properties, or the burning over of meadow land, or the disposing of brush or old crop remnants from newly cleared or previously used land; intensive local patrol which makes the permit law effective for the few weeks involved, thereby restricting reckless, careless or ignorant use of fire, invariably has stopped the trouble. This year 15% of the year's total fires are known to have been due to such use of fire.

Smokers.—Fires set by smokers are most difficult to fix responsibility for. The number reported as from this cause

(15% of the total) represents by no means the whole number of fires so started, for a very considerable part, if not most, of the fires now listed as of unknown origin would be charged to careless smokers if the facts were known. Fires of such origin are almost always entirely unintentional and due to ignorance or oversight. Because of this, and of their universal occurrence, their elimination is a problem of education rather than discipline. Recognition of this fact has led the United States Secretary of Agriculture to seek the direct co-operation of the tobacco industry in bringing home the nature of the situation and the necessity for care by each individual smoker in a nation-wide campaign. This move, if successful and persisted in, cannot fail to benefit our local situation, at present so difficult to meet because of the preponderance of city population within or nearby our borders. (See page 100.) The slow process of elimination by education can be materially hastened by patrol, through its direct personal contact with thousands in and near the woodlands and such relief is urgently needed. (See page 101.)

Miscellaneous.—As is always the case, a small number of fires have started from a variety of causes, no one of which accounts for enough fires to justify separate classification. The number of such fires varies but little in proportion to the total from year to year. This year 6% of the fires came from children at play, burning buildings, ill-equipped or carelessly operated stationary engines or road machinery, and similar causes. Patrol, so emphatically needed for other phases of the situation, will materially help in reducing fires from such sources. Fires from lightning, so common in more arid climates, are practically unknown because of the rain which always accompanies electrical storms throughout the State.

Campers, picnickers and sportsmen.—Like the smokers, those who use campfires for cooking, for warmth, or as smudges, are difficult to control, since the use is so wide-spread, and yet so haphazard. Though thousands are warned each year, and though in general, they are well intentioned, carelessness or ignorance causes the setting of fires from this source to continue. Also, the number of those tempted to make such use of fire is annually increasing as the out-of-doors life grows in popularity



Fig. 28. Beating out a surface fire.



Fig. 29. Sanding out a forest fire.



Fig. 30. A water crew on a hot fire.

FIGHTING FOREST FIRE IS HARD, UNPLEASANT WORK. THE LOYAL AND PERSISTENT ACTIVITY OF THE FIREWARDENS, WHICH IS KEEPING FIRES TO SMALLER AND SMALLER SIZE, IS THE HOPE OF THE STATE'S FOREST RESOURCES.

FIREWARDEN'S REPORT.

95

and the automobile brings its possibility closer to the city dweller. In dealing with the situation an adequate lookout system will keep the fires to small size, and reasonable patrol facilities will tremendously reduce the danger, as has been completely demonstrated where patrol has been possible. (See page 100.)

THE FOREST FIRE SERVICE.

The State force.—Unfortunately it is necessary to record the withdrawal of one member of the State Firewarden's force, and of two Division Firewardens, during the year. One of the field vacancies has been filled by the return of a former division warden from military duty. The other more recent vacancies are still unfilled, the low compensation which it is possible to offer making it difficult to attract well equipped men to the work.

Although seriously handicapped because of changing personnel and even more so by inadequate funds for travelling, the patrol, heretofore done by the regular force has been effectively maintained in a more limited area. Also, personal attendance at the larger and more dangerous fires has been kept up. A new high water mark in fixing responsibility for fires has also been set, for those who caused them have been definitely held for 62 per cent. of the year's fires. This is not only a record of high efficiency, but marks a tremendous stride toward restraining future carelessness with fire, or indifference to forest fire damage.

Supplementing the co-operation with the State Highway Engineer reported last year, a bulletin dealing with the relation of forest protection to highway construction has been issued for joint distribution by the two state departments, to further curtail fires which experience has shown are likely to occur during the course of such work. Also, in addition to the annual printed "List of Firewardens", the "Firewarden's Manual" and "Township Official's Handbook" have been revised and reprinted, a new form of State fire poster has been issued and distributed and a booklet, "Fires For Fun," dealing with the campfire situation has been issued and widely distributed.

Upon the suggestion of the state office, and following up the protective work done on their Greenwood Lake Division, the

Erie Railroad interests have undertaken a comprehensive forest fire right-of-way protective program for the entire forest exposure along their lines and those of the N. Y. S. & W. Railroad in the state.

A number of serious menaces due to logging slash, to real estate development and to the operation of private railroads have been so dealt with that the danger has been removed and probable forest fire difficulty averted.

An unusual amount of administrative work has been transacted due to the general reorganization of the local force at the expiration of the three-year local warden terms in December, 1919, to the provision for, and installation of, a large extension to the lookout system (See p. 97), and to a greatly increased amount of court work by the State's wardens.

Local organization.—Because of a combination of many causes, the outcome of the war period, among them an actual shortage of manpower in the rural districts, and the prevailing high rates of pay for all forms of labor, there has been a noticeable lowering of morale in the whole local fire protective organization. It has been increasingly difficult for local wardens to find necessary help for fire fighting and more difficult to get willing and efficient service from their helpers.

To meet this situation the statutory rate of pay for such service was raised by the 1920 Legislature from the previous rates of \$2 for 5 hours or less and 30c per hour thereafter for wardens and \$1 for 5 hours and 20c per hour thereafter for their helpers; to \$2 for 2 hours or less and 50c per hour thereafter for wardens and \$1 for 2 hours or less and 40c per hour thereafter for fire fighters. This increase and these rates were determined on after consulting with the local governing bodies, and with their practically unanimous agreement. The announcement of the new rates has already gone far toward strengthening the organization and stimulating interest and activity in fire control.

The Fire Service has been enlarged during the year to cover the following nine new municipalities: Somers Point, Atlantic County; Hillsdale and Washington, Bergen County; Hopewell, Cumberland County; Delaware and Kingwood, Hunterdon

FIREWARDEN'S REPORT.

97

County; Spotswood, Middlesex County; Ocean Gate, Ocean County, and Frelinghuysen, Warren County. These bring the total of municipalities now actively organized for forest protection to 168 with 370 local wardens serving.

The annually shrinking average area per fire (see Table I), the great proportion of fires which are put out while still in embryonic stage (see Table II) and the small proportion of fires for which responsibility is not fixed (See page 101) are ample testimony to the efficiency of the local force. Local co-ordination of work at the larger fires is far from satisfactory but is improving yearly under the leadership of the State's force of wardens. Failure to give prompt attention to fires can be improved, but not largely until patrol and lookout facilities can be generally provided. Prevention of fires altogether cannot be generally anticipated in any locality unless adequate patrol is made possible. It is earnestly hoped that these two means of helping the local force may not be long delayed in coming. (See page 100.)

Lookouts.—The lookout stations (See figs. 31-37), at Cedar Pond, Passaic County; at McKeetown, Atlantic County; and at Culvers Lake, Sussex County; have been in operation throughout the season and have materially helped to control the local fire situation in each locality. A large number of people visit these towers, varying from 300 at the most difficult of access to over 1000 at the most accessible. Thus, aside from their value for forest fire control, the towers serve as recreation spots for many, and as points of contact between the fire service and large numbers who otherwise would have little intelligent interest in forest protection.

The \$3000 appropriation by the 1919 Legislature for the erection and maintenance of new lookout stations, contingent upon the securing of private co-operation for the same purpose to an equal amount, has all been made available for expenditure by the enlistment of co-operation to the value of \$4,717.

By reason of this it has been possible to provide for four new stations as follows: (1) *Batsto Station, Burlington County* (See fig. 34).—A lookout room has been built on the tower of the Batsto Mansion through the co-operation of the executors of the

98 CONSERVATION AND DEVELOPMENT.

estate of Jos. Wharton, and has been in service since April 1; (2) *Edison Station, Sussex County* (See fig. 33).—A 45-foot steel lookout tower, and 3 miles of telephone line have been installed on the property of the New Jersey Zinc Co. with the assistance of the company, and have been in service since July 15; (3) *Kinnelon Station, Morris County* (See fig. 32).—A lookout room has been built on an eighty-foot stone tower on the property of the Messrs. Kinney and connected by 2 miles of telephone line, with the help of the owners of the tower, and has been in service since June 15; (4) *Windbeam Station, Passaic County* (See fig. 35).—A 45-foot steel lookout tower and 2 miles of telephone line have been built on the property of the Ringwood Company, with the co-operation of the company, and have been in service since June 15.

In addition, sufficient funds have been available to purchase a 45-foot steel lookout tower, not yet delivered, the location of which will depend upon the possibilities of co-operation for its erection and connection with telephone service, since the funds are not sufficient to do this from the appropriation. It is hoped that this tower may be placed in South Jersey, because the co-operation offered so far has come so largely from the northern section, and has necessitated expansion there for that reason more rapidly than would otherwise have been reasonable, and somewhat at the expense of the southern area. While the generosity of those who have made these increased lookout facilities possible is heartily appreciated and gratefully acknowledged, it is felt that such expansion should not wait for this means of development. It would appear to be the function of the State itself to provide such equipment as fast as funds permit. Unfortunately no additional appropriation is available for the coming year, though too great emphasis cannot be placed upon the vital need for a reasonable annual increase in the number of such stations, until the entire forest area can be afforded protection. The outlay necessary for a complete system of lookouts is not extravagant, and their value is inestimable (See page 100). For lookout and patrol the State's previous expenditures have been many times exceeded by funds from the Federal Treasury and from private owners. It will be unfortunate if the work so well

make the woodlands an asset whose value it is impossible to estimate. Every large and destructive fire has its small beginning. Measured by this standard the record of small blazes, caught and put out while still trifling, takes on new meaning, and the value of such service is indubitable, though impossible to state in concrete terms.

Needs of the service.—The three outstanding needs of the Fire Service are: (1) more fire lookouts, (2) provision for patrol and (3) greater facilities for forest fire propaganda.

(1) Interest, alertness and efficiency in the fire fighting organization cannot effectively provide against failure to know of many fires promptly, in the wilderness sections or in the areas where fires are extremely numerous, often several occurring simultaneously. A system of wardens whose whole time was given to this work would much improve present conditions, but would not be completely effective and would be unreasonably costly. A limited number of lookout stations can insure prompt attention to all fires, and promptness is the foundation of any real success in dealing with the fire problem. The lookout system is no longer an experimental feature in fire protection. Its value has been tested and proven by years of experience within the State, and more largely throughout the nation, by Federal and State governments and private interests. Too great emphasis can not be given to the need for immediate and substantial provision for a State-wide lookout system (See page 92).

(2) Persistent personal warning of the habits of, and danger from fire; personal supervision of areas where carelessness, recklessness or ignorance prevail during periods of special activity or danger; and adequate means of holding to account those responsible for every fire, are beyond the power of the local fire-warden force and a limited State warden force. But, until means to do these things are available, carelessness, indifference and ignorance will continue to threaten the State's forest resources with fire. Fires can be stopped from starting where patrol is possible. Fires have been materially reduced in numbers or almost stamped out in small areas where and while limited patrol heretofore has been operative. Provision should be made for an adequate force to deal with the fire problem in this way now.

FIREWARDEN'S REPORT.

99

begun from such sources is not continued and enlarged by the State itself.

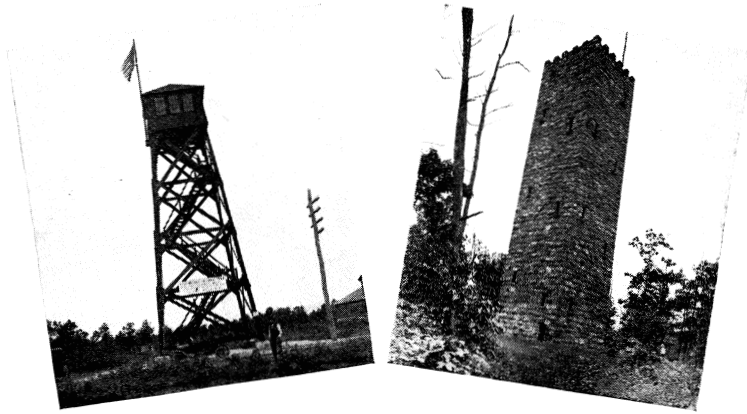
Federal co-operation.—The Federal Forest Service, under the "Weeks Law" has continued the \$2,000 allotment for payment of lookout and patrol salaries again this year. Under the terms of the law the fund is available for services in North Jersey only.

The lookout watchmen at all of the North Jersey Stations have been paid from these funds entirely, both during 1919 and 1920, an item which has in large measure made the expansion of lookout work possible by releasing State funds for construction and equipment of new towers.

Because of the increased number of lookout stations and the large proportion of the Federal funds needed to pay the watchmen, patrol was not undertaken during the spring and summer of 1919, as has been done in previous years. With the opening of the gunning season a patrol of from three to six men was used on areas where trouble from sportsmen's fires has been most serious heretofore. This work was continued into December, the patrolmen extinguishing a number of fires themselves and getting prompt help for others. In addition, they made it possible to hold responsible those who set several of the fires, as well as several technical violators of the permit law, and reached many others with personal warning of the danger from fire and the provisions of the State law dealing with the fire problem.

Value of the service.—If the value, present and potential, of our woodlands were disregarded altogether, the service rendered during the past year in forest fire control is great, for improved property to the value of \$167,000 has been saved from immediate destruction by forest fire. Barns, homes, public buildings and industrial plants, cranberry bogs, crops and forest products are annually saved from fire as they have been this year.

Though noteworthy as the outcome of an admittedly still incomplete forest protection system, these results are insignificant in comparison with the possibility of building up a forest capital of 200 million dollars where the State now has a scant 10 million dollar value. In addition to this commercial consideration, but by no means insignificant in its influence on the development and welfare of the State, their recreational value and attracting power



McKeetown Station.

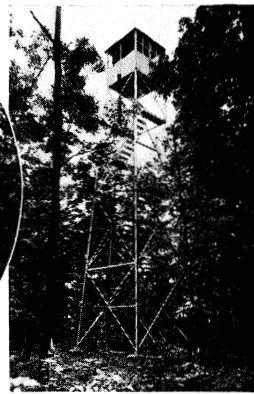
Kinnelon Station.



Edison Station.



Batsto Station.



Windbeam Station.



Bearfort Station.



Culver Station.

Figs. 31-37. SEVEN FOREST FIRE LOOKOUT STATIONS. ONE OF THE MOST PRACTICABLE MEANS OF CONTROLLING FOREST FIRES BEFORE THEY BECOME SERIOUS. SEVERAL ARE USED ALSO AS OBSERVATORIES BY THE PUBLIC.

FIREWARDEN'S REPORT.

101

The cost is not great, and the results measured by the State's own previous experience and a nation-wide familiarity with such methods offer the only sure means of promptly curtailing the number of forest fires (See pages 92 and 98).

(3) New Jersey's forest fire prevention problem differs from that in many areas, because the State is a composite of densely populated areas and wilderness, and yet the wilderness sections are all extremely available to the whole population and are the mecca of thousands of transients as well. A purely local propaganda for fire protection is therefore not effectual. The question must be laid before, and kept before, the large body of non-residents who use or traverse our woodlands from our own centres of population and from outside the State. Also, development of the outlying sections is moving rapidly forward by the influx of settlers, mostly of foreign races. Though well disposed, these newcomers are ignorant of the danger from fire, and of the State's provision for protecting the woodlands. To meet these conditions it is necessary that means be found, on a far larger scale than heretofore has been possible, to interest, inform and caution those going to or passing through the forests, of fire danger and about fire prevention.

VIOLATIONS OF THE LAW.

(See *Tables IV and V.*)

The record for 1919 shows that responsibility for 374, or 62 per cent. of the total fires for the year, has been fixed. This is the highest percentage ever recorded in this State in this connection. This effort, yearly more successful, to establish the origin of New Jersey's fires, is unquestionably doing much to deter the ignorant, careless, or vicious use of fire. It also is pointing out more and more clearly the particular classes of risk which need special treatment and the localities which demand attention. In 83 cases, technical violations of the permit law have been apprehended and dealt with. Of the total violations, 42 per cent. are railroad fires and 58 per cent. came from other causes, marking the first time that the percentage of railroad violations has been on

102 CONSERVATION AND DEVELOPMENT.

the lower side of the total. Of the year's cases 305 or 81 per cent. have been finally disposed of, and of the 157 cases remaining open from previous years, but 24 remained unsettled on Jan. 1, 1920. The penalties collected during the year 1919 amounted to \$4192.48, of which the railroads paid \$1680.45 and other agencies \$2512.03.

TABLE I—FOREST FIRES IN CALENDAR YEAR 1919 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	64,404	122	86,940	165
Embryo Fires, †	239				
1912, Forest Fires,	214	26,291	48	21,501	39
Embryo Fires, †	331				
1913, Forest Fires,	311	53,823	77	67,205	99
Embryo Fires, †	367				
1914, Forest Fires,	396	78,655	92	83,880	99
Embryo Fires, †	451				
1915, Forest Fires,	549	150,258	147	209,090	207
Embryo Fires, †	467				
1916, Forest Fires,	269	51,654	88	69,001	118
Embryo Fires, †	314				
1917, Forest Fires,	486	92,479	106	79,335	90
Embryo Fires, †	385				
1918, Forest Fires,	567	67,272	85	69,835	88
Embryo Fires, *	229				
1919, Forest Fires,	443	46,927	77	63,638	105
Embryo Fires, *	164				

† Burned less than 5 acres.

* Burned less than 2 acres.

FIREWARDEN'S REPORT.

TABLE 2—FOREST FIRES BY RELATIVE AREA BURNED, AND BY COUNTIES, CALENDAR YEAR 1919.

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.	
<i>North Jersey—</i>						
Bergen,	12	5	1	.....	18	11
Hunterdon,	2	3	1	.....	6	.....
Morris,	36	28	.....	.....	64	25
Passaic,	5	6	2	.....	13	7
Somerset,	8	4	.....	.....	12	4
Sussex,	2	8	2	.....	12	4
Union,	3	4	.....	.....	7	.....
Warren,	3	2	1	.....	6	5
Totals,	71	60	7	.....	138	56
<i>South Jersey—</i>						
Atlantic,	27	35	12	1	75	22
Burlington,	5	11	10	3	29	2
Camden,	6	15	7	.....	28	7
Cape May,	8	5	.....	3	26	11
Cumberland,	27	19	7	.....	53	20
Gloucester,	9	3	1	1	14	5
Mercer, .....	.....	.....	.....	.....	.....	.....
Middlesex,	3	10	2	.....	15	4
Monmouth,	15	16	2	.....	33	8
Ocean,	10	22	3	3	38	28
Salem,	2	1	.....	.....	3	1
Fires that burned in more than 1 county, .....	.....	.....	1	.....	1	.....
Totals,	112	137	45	11	304	108
State totals,	183	197	52	11	443	164
Per cent. of State totals,	30	32	9	2	73	27

104 CONSERVATION AND DEVELOPMENT.

TABLE 3—FOREST FIRES BY CAUSES AND COUNTIES, CALENDAR YEAR 1919.

COUNTY.	NUMBER.										Totals.	
	Locomotive.		Brush Burning.		Smokers.		Miscellaneous.		Unknown.			
	FF	eF	FF	eF	FF	eF	FF	eF	FF	eF		
<i>North Jersey—</i>												
Bergen,	9	4	1	2	1	1	1	1	8	3	18	11
Hunterdon,	1				1				4		6	
Morris,	15	9	9	4	19	5	4		17	7	64	25
Passaic,	3	4	3		4			1	3	2	13	7
Somerset,			4	2	1		2		5	2	12	4
Sussex,	2	1			3	1		1	7	1	12	4
Union,			2		1				4		7	
Warren,	3	5	2						1		6	5
Totals,	33	23	21	8	29	7	6	3	49	15	138	56
<i>South Jersey—</i>												
Atlantic,	24	9	15	2	7	3	7	4	22	4	75	22
Burlington,	1		5		7	2	6		10		29	2
Camden,	5	2	7		3		2	1	11	4	28	7
Cape May,	6	9	2	1	1				7	1	16	11
Cumberland, ...	5	3	9	2	9	2	1	5	29	8	53	20
Gloucester,	2	2	4	1	1				7	2	14	5
Mercer,												
Middlesex,	1	1	4			1			10	2	15	4
Monmouth,	14	4		1	7	2			12	1	33	8
Ocean,	9	21	4	1	8	2	2	1	15	3	38	28
Salem,			3			1					3	1
Fires that burned in more than 1 county,					1						1	
Totals,	67	51	53	8	44	13	18	11	123	25	305	108
State totals, ..	100	74	74	16	73	20	24	14	172	40	443	164
Per cent. of State totals,	29		15		15		6		34		73	27

FF—Forest Fires.
eF—Embryo Fires (less than 2 acres).

FIREWARDEN'S REPORT.

TABLE 4—VIOLATIONS OF THE FIRE LAW, CALENDAR YEAR 1919.

CAUSE.	Pending Jan. 1, 1920.	Settled Jan. 1, 1920.	Total.
Brush burning and camp fires,	19	157	176
Careless smoking,	6	10	16
Miscellaneous,	6	19	25
Total,	31	186	217
Erie R. R.,	1	2	3
D., L. and W. R. R.,		18	18
L. and N. E. R. R.,		1	1
Morristown and Erie R. R.,	1	1	2
N. J. Central R. R.,	6	34	40
N. Y., S. and W. R. R.,	1	16	17
Penn. R. R.,	29	21	50
Reading R. R.,		24	24
Tuckerton R. R.,		1	1
Wharton and Northern R. R.,		1	1
Total R. R.,	38	119	157
Total all causes,	69	305	374
Per cent. of total,	19	81	.....

TABLE 5—SUMMARY OF PENALTY WORK DONE, CALENDAR YEAR 1919.

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.
1919 cases,	38	119	157	31	186	217	69	305	374
1918 cases,	19	102	121	4	26	30	23	128	151
1917 cases,		2	2	1	3	4	1	5	6
1916 cases,									
Total,	58	223	280	36	215	251	93	438	531
Per cent. of total,	20	80	.....	14	86	.....	19	81	.....

106 CONSERVATION AND DEVELOPMENT.

TABLE 6—FOREST FIRES BY COUNTIES AND TOWNSHIPS, CALENDAR YEAR 1919.

COUNTY AND TOWNSHIP.	Number.		Acres Burned.	Loss to Forests and Other Property.	Cost to Extinguish.	Paid by.†		
	Forest Fires.	Embryo Fires.				Township.	State.	Offenders.
<i>Atlantic County—</i>								
Absecon (City),								
Buena Vista,	7	3	421	\$225	\$59.90	\$15.45	\$15.45	\$34.00
Egg Harbor,	22	5	2,972	2,600	311.90	140.65	140.65	50.00
Egg Harbor (City), ..	2	1	30	24	53.25	26.63	26.62	.....
Folsom,								
Galloway,	15	6	177	129	119.00	8.00	8.00	107.00
Hamilton,	9	3	2,885	2,015	177.40	67.96	67.94	72.00
Hammonton,	1		3	3	2.25			7.25
Linwood,								
Mullica,	10	3	234	215	104.30	25.50	25.50	57.00
Northfield (City), ...	1		40	40				5.00
Pleasantville,	2		150	115	46.60	23.30	23.30	.....
Port Republic,								
Somers Point,								
Weymouth,	6	1	944	542	193.19	33.48	33.47	136.24
Total,	76	22	7,856	\$5,908	\$1,067.79	\$340.97	\$340.93	\$465.49
<i>Bergen County—</i>								
Franklin,	9	2	222	\$886	\$110.10	\$9.50	\$9.50	\$91.10
Hillsdale,								
Hohokus,	2	5	17	20	20.00	9.00	9.00	10.00
Montvale (Boro.), ...	2	1	40	10	16.00	8.00	8.00	.....
Oakland (Boro.),	3	2	14	17	47.50			47.50
Park Ridge (Boro.), ..	1		5	5	6.00	3.00	3.00	.....
Ridgefield (Boro.), ..		1			2.00	1.00	1.00	.....
Washington,								
Woodcliffe Lake,	1		15	8	4.00			10.00
Total,	18	11	313	\$946	\$205.60	\$30.50	\$30.50	\$158.60
<i>Burlington County—</i>								
Bass River,	1		5,000	\$5,000	\$363.48	\$181.74	\$181.76	.....
Evesham,	4		800	875	170.36	20.37	20.37	\$132.58
Medford,								
New Hanover,	1		5	5	7.00	3.50	3.50	.....
Pemberton,	12		2,315	3,515	325.45	103.62	184.23	37.50
Shamong,								
Southampton,	1		5	5				
Tabernacle,	2	1	153	378	16.30	8.15	8.15	.....
Washington,	3		36	3,520	53.00	26.50	26.50	.....
Woodland,	9	1	2,835	5,510	199.30	71.52	93.03	32.75
Total,	43	2	11,149	\$18,808	\$1,134.89	\$415.40	\$517.54	\$203.83

FIREWARDEN'S REPORT.

TABLE 6—FOREST FIRES BY COUNTIES AND TOWNSHIPS, CALENDAR YEAR 1919.—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.
<i>Camden County—</i>								
Berlin,								
Chesilhurst (Boro.), .	2	3	27	\$22	\$24.95	\$12.48	\$12.47	.....
Clementon,								
Delaware,	3		59	85	22.90	4.50	4.50	\$16.90
Gloucester,	1	3	100	104	34.58	11.79	11.79	11.00
Voorhees,	5	1	367	227	92.00	30.26	30.24	43.00
Waterford,	6		1,045	1,859	123.20	60.60	60.60	10.00
Winslow,	12		1,210	9,943	155.70	37.38	37.37	118.95
Total,	29	7	2,808	\$3,240	\$453.33	\$157.01	\$156.97	\$199.85
<i>Cape May County—</i>								
Dennis,	1	1	4,000	\$2,000	\$75.53	\$37.77	\$37.76	\$5.00
Lower,	1	2	100	50	19.10	9.55	9.55	.....
Middle,	8	6	3,703	4,341	379.90	173.25	173.20	36.45
Upper,	4	2	64	46	71.00	18.50	18.50	84.00
Woodbine (Boro.), .	2		55	30	11.75	5.87	5.88	.....
Total,	16	11	7,922	\$6,467	\$557.28	\$244.94	\$244.89	\$125.45
<i>Cumberland County—</i>								
Commercial,	2		204	\$1,000	\$15.70	\$7.85	\$7.85	.....
Deerfield,	8	1	121	143	36.00	14.50	14.50	\$18.00
Downe,	1		3	3	10.00	5.00	5.00	.....
Fairfield,	2	1	206	206	34.50	17.25	17.25	.....
Hopewell,								
Landis,	13	3	822	437	207.90	60.89	60.91	103.75
Lawrence,	1	1	10	5	7.00	3.50	3.50	15.00
Maurice River,	3	2	47	260	31.40	5.00	5.00	56.40
Millville (City),	24	12	1,294	1,035	428.10	182.15	182.15	75.00
Total,	54	20	2,707	\$3,089	\$770.60	\$296.14	\$296.16	\$268.15
<i>Gloucester County—</i>								
Clayton (Boro.),								
Elk,								
Franklin,	7	4	1,533	\$1,021	\$86.10	\$22.42	\$22.43	\$84.50
Monroe,	6	1	347	242	88.50	35.00	36.00	108.00
Washington,	2		110	55	3.50	1.75	1.75	.....
Total,	15	5	1,990	\$1,318	\$178.10	\$60.17	\$60.18	\$192.50

108 CONSERVATION AND DEVELOPMENT.

TABLE 6—FOREST FIRES BY COUNTIES AND TOWNSHIPS, CALENDAR YEAR 1919.—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.
<i>Hunterdon County—</i>								
Alexandria,								
Bethlehem,	2		24	\$25	\$10.75	\$5.38	\$5.37	
Clinton,								
Delaware,								
East Amwell,	1		22	10	4.20	2.10	2.10	
Franklin,								
Holland,	1		15	15	10.00			\$10.00
Kingwood,								
Lebanon,	2		203	403	24.10	12.05	12.05	
Tewksbury,								
West Amwell,								
Total,	6		264	\$453	\$49.05	\$19.53	\$19.52	\$10.00
<i>Mercer County—</i>								
Hopewell,								
Princeton,								
Total,								
<i>Middlesex County—</i>								
East Brunswick,	2		78	\$55	\$35.50	\$7.50	\$7.50	\$30.50
Madison,	5	1	205	235	148.05	74.03	74.02	20.00
Monroe,	1		500	1,000	11.60			15.00
Sayreville,	4	3	59	74	29.90	14.95	14.95	
South Brunswick,	3		170	100	7.00	3.50	3.50	10.00
Spotswood (Boro.),								
Total,	15	4	1,012	\$1,464	\$232.05	\$99.98	\$99.97	\$75.50
<i>Monmouth County—</i>								
Atlantic,	4		85	\$95	\$26.40	\$13.20	\$13.20	
Freehold,	3	1	135	330	61.25	30.62	30.63	
Howell,	19	3	580	1,030	343.90	96.49	96.51	\$351.90
Middletown,								
Ocean,								
Shrewsbury,	3	4	42	224	74.25	24.38	24.37	25.50
Wall,	4		340	245	45.60	19.80	19.80	21.00
Total,	33	8	1,182	\$1,924	\$551.40	\$184.49	\$184.51	\$398.40

FIREWARDEN'S REPORT.

TABLE 6—FOREST FIRES BY COUNTIES AND TOWNSHIPS, CALENDAR YEAR 1919.—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.
<i>Morris County—</i>								
Boonton,								
Chester,	4	3	150	\$440	\$63.10	\$14.55	\$14.55	\$34.00
Denville,	9	3	150	1,691	176.60	76.30	76.30	35.00
Hanover,	11	9	253	343	136.10	25.65	25.65	100.15
Jefferson,	5	2	59	61	84.88	42.44	42.44	10.00
Mendham,	3	.....	68	48	76.25	10.72	10.73	57.80
Montville, .....	.....	2	.....	.....	25.25	12.75	12.75	24.00
Morris,	3	3	32	33	20.60	9.30	9.30	35.00
Mt. Arlington,	2	.....	7	7	21.50	2.25	2.25	17.00
Mt. Olive,	2	.....	17	25	20.00	.....	.....	20.00
Passaic, .....	.....	.....	.....	.....	.....	.....	.....	.....
Pequannock,	3	2	14	25	42.15	10.50	10.50	30.00
Randolph,	5	.....	60	65	80.40	26.70	26.70	27.00
Rockaway,	11	1	268	404	140.15	66.08	66.07	8.00
Roxbury,	6	.....	77	117	19.50	5.25	4.75	19.50
Washington, .....	.....	.....	.....	.....	.....	.....	.....	.....
Total,	64	25	1,155	\$3,259	\$906.48	\$302.49	\$301.99	\$417.45
<i>Ocean County—</i>								
Beachwood (Boro.), ..	.....	.....	.....	.....	.....	.....	.....	.....
Berkeley,	4	1	140	\$285	\$31.00	\$11.50	\$11.50	\$8.00
Brick,	1	2	1,200	5,000	111.20	55.60	55.60	.....
Dover,	5	1	661	1,065	95.75	10.50	10.50	79.75
Eagleswood, .....	.....	.....	.....	.....	.....	.....	.....	.....
Jackson,	5	.....	280	600	69.20	34.60	34.60	10.00
Lacey,	2	16	260	260	120.55	11.87	11.88	96.80
Lakewood,	7	1	199	263	74.00	33.50	33.50	17.00
Little Egg Harbor, ..	.....	.....	.....	.....	.....	.....	.....	5.00
Manchester,	8	3	3,365	5,200	168.65	22.05	22.05	134.55
Ocean,	4	3	37	105	38.50	9.50	9.50	19.50
Ocean Gate, .....	.....	1	.....	.....	9.50	4.75	4.75	.....
Plumstead,	1	.....	50	50	12.00	6.00	6.00	.....
Stafford, .....	.....	.....	.....	.....	.....	.....	.....	.....
Union,	2	.....	110	85	7.20	3.60	3.60	.....
Total,	39	28	6,602	\$12,913	\$737.55	\$203.47	\$203.48	\$370.60
<i>Passaic County—</i>								
Bloom'gdale (Boro.), ..	2	.....	175	\$150	\$62.90	\$31.45	\$31.45	\$5.00
Ringwood (Boro.), ..	7	6	470	1,180	124.40	50.60	50.60	23.20
Wanaque (Boro.), ..	1	.....	15	5	12.50	6.25	6.25	5.00
West Milford,	3	1	80	81	73.30	32.37	32.38	23.55
Total,	13	7	730	\$1,416	\$273.10	\$120.67	\$120.68	\$56.75

110 CONSERVATION AND DEVELOPMENT.

TABLE 6—FOREST FIRES BY COUNTIES AND TOWNSHIPS, CALENDAR YEAR 1919.—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.
<i>Salem County—</i>								
Alloway,								
L. Alloways Cr.,								
Pittsgrove,	2	1	37	\$37	\$20.75	\$0.75	\$0.75	\$25.00
Quinton,								
Upper Pittsgrove,	1		6	6	6.00			10.00
Total,	3	1	43	\$43	\$26.75	\$0.75	\$0.75	\$35.00
<i>Somerset County—</i>								
Bernard,	1	1	6	\$6	\$36.00			\$36.00
Bridgewater,	4	2	25	40	57.00	\$23.00	\$23.00	11.00
Hillsborough,								
Montgomery,								
North Plainfield,	3		130	70	54.80	27.40	27.40	
Warren,	4	1	57	62	77.85	4.12	4.13	75.00
Total,	12	4	218	\$178	\$225.65	\$54.52	\$54.53	\$122.00
<i>Sussex County—</i>								
Andover,								
Byram,	2		50	\$40	\$25.00	\$8.50	\$8.50	\$8.00
Frankford,								
Franklin (Boro.),								
Green,								
Hampton,								
Hardyston,	3	1	350	325	112.80	54.27	54.28	4.25
Hopatcong,	1		25	25	27.70	13.85	13.85	
Montague,								
Ogdensburg (Boro.),								
Sandyston,	2	1	18	84	39.25	17.12	22.13	
Sparta,	2		30	20	43.00	21.50	21.50	
Stillwater,								
Vernon,	2		90	90	18.00	9.00	9.00	
Walpack,		2			7.00			7.00
Wantage,								
Total,	12	4	563	\$584	\$272.75	\$124.24	\$129.26	\$19.25

FIREWARDEN'S REPORT.

TABLE 6—FOREST FIRES BY COUNTIES AND TOWNSHIPS, CALENDAR YEAR 1919.—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.
<i>Union County—</i>								
Mountainside,	2	.....	30	\$60	\$26.50	\$6.25	\$6.25	\$15.00
New Providence,	2	.....	40	25	15.50	6.75	6.75	5.00
Scotch Plains,	1	.....	30	.....	.....	.....	.....	.....
Springfield,	2	.....	72	750	22.10	11.05	11.05	.....
Total,	7	.....	172	\$835	\$64.10	\$24.05	\$24.05	\$20.00
<i>Warren County—</i>								
Allamuchy, .....	.....	.....	.....	.....	.....	.....	.....	.....
Blairstown,	1	.....	6	\$6	\$9.85	\$4.92	\$4.93	.....
Franklin, .....	.....	.....	.....	.....	.....	.....	.....	.....
Frelinghuysen, .....	.....	.....	.....	.....	.....	.....	.....	.....
Hardwick, .....	.....	.....	.....	.....	.....	.....	.....	.....
Harmony,	1	.....	180	720	1.00	.....	.....	\$5.00
Hope, .....	.....	.....	.....	.....	.....	.....	.....	.....
Independence,	1	.....	20	20	20.00	10.00	10.00	.....
Knowlton,	3	5	35	47	29.25	.....	.....	29.25
Mansfield, .....	.....	.....	.....	.....	.....	.....	.....	.....
Pahaquarry, .....	.....	.....	.....	.....	.....	.....	.....	.....
Washington, .....	.....	.....	.....	.....	.....	.....	.....	.....
White, .....	.....	.....	.....	.....	.....	.....	.....	10.00
Total,	6	5	241	\$793	\$60.10	\$14.92	\$14.93	\$44.25
State Total,	*460	164	46,927	63,638	7,766.57	2,694.24	2,800.94	3,185.97

* This total is greater than the actual number (607) because in 7 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.

