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ANNUAL REPORT

OF THE

PASSAIC VALLEY

DISTRICT

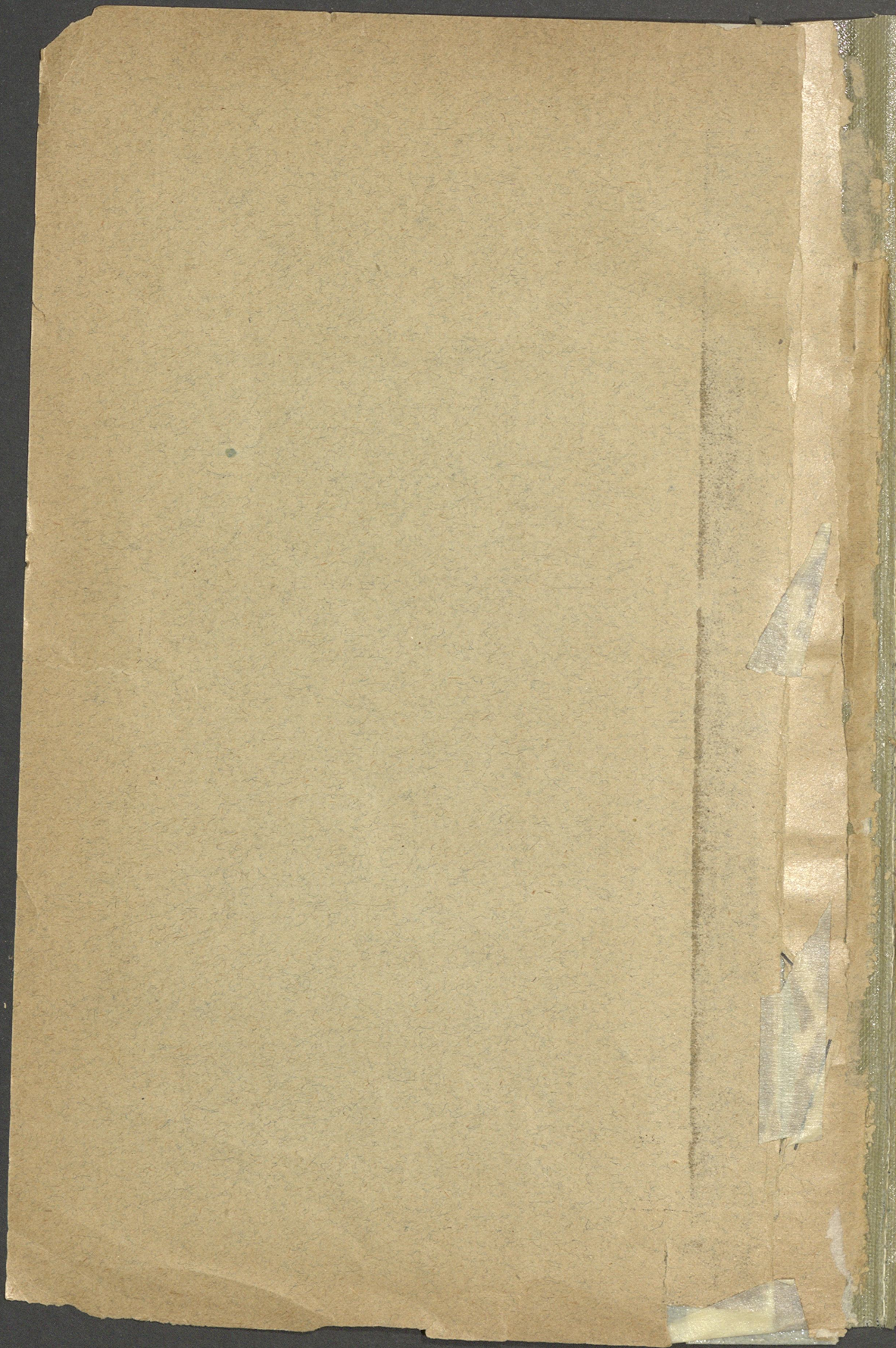
SEWERAGE COMMISSION

TO THE LEGISLATURE,
SESSION OF 1903.

TRENTON, N. J.

MACCRELLISH & QUIGLEY, STATE PRINTERS, OPPOSITE POST OFFICE.

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STATE OF NEW JERSEY,
EXECUTIVE DEPARTMENT,
TRENTON, January 26, 1903. }

To the Senate:

I have the honor to transmit herewith the Annual Report of
the Passaic Valley District Sewerage Commission.

Respectfully,

FRANKLIN MURPHY,
Governor.

ANNUAL REPORT
OF THE
Passaic Valley District Sewerage
Commission.

To the Legislature:

The undersigned Commissioners appointed by the Governor under the provisions of an act of the Legislature approved March 27, 1902, "authorizing the appointment and defining the powers and duties of commissioners in sewerage and drainage districts created for the purpose of relieving the streams and rivers therein from pollution, and to provide a plan for the prevention thereof, and providing for the raising, expenditure and payment of moneys necessary for this purpose," hereby report the result of their investigations, together with their conclusions, as required by the act aforesaid.

The Commissioners met for organization on April 22, 1902, since which time the subject has had their continuous attention, and consideration has been given to every phase of the work imposed upon them by the law, with the purpose of ascertaining the most efficient and economical plan to relieve the streams and rivers of the Passaic Valley District from pollution. To this end careful investigation has been made of the various methods employed by the municipalities of this and other countries for sewage disposal.

Among the first acts of the Commissioners was a conference with the members of the State Sewerage Commission, who had given considerable study to this particular problem, and to whom these Commissioners are indebted for maps and other valuable information pertaining to their work. But the findings herewith presented have been reached by independent investigation, and have not been influenced by the conclusions of former Commissions.

A study of the condition of the Passaic River, and the causes of pollution, demonstrated that the limited flow of the river became insufficient some years ago to assimilate the volume of sewage and factory waste which was being constantly poured into its waters; that this pollution has been increasing in proportion to the rapid growth of population and industries, making the river, especially during the dry seasons, nothing less than an open sewer—a menace to health, a nuisance to the residents in its vicinity, a detriment to manufacturing interests, and an obstacle to the increase of property valuations in large areas which would otherwise be utilized for suburban residences and for factory purposes. The flood which caused an abnormal flow of water in the river last Spring served to lessen these conditions in some degree, but they have since been bad. The investigation in this direction was made that the Commissioners might have knowledge of all the circumstances surrounding the situation, and what remedial measures were necessary.

Soon after organization a visit was made to Massachusetts, where the trunk sewer system of Boston and its Metropolitan district and the chemical disposal plants of Worcester and Providence were examined. Reports and special information relating to the sewerage systems of Manchester, Glasgow, Berlin and other cities were procured and study was made of works published upon the subject of sewage disposal by eminent engineers and chemists. One of the Commissioners, during a visit to Great Britain, also obtained valuable information as to the practical operations of the Glasgow and Manchester systems.

Pending these investigations the Commissioners, in compliance with the law, provided hearings which gave the governing body of each municipality contained wholly or in part within the boundaries of this district an opportunity to be heard in relation to the plan or method to be adopted. At these hearings much was elicited respecting the sewerage and drainage requirements of the different municipalities, and many ideas were advanced as to the proportion of cost each should bear, but while all admitted the necessity for speedy relief, few were ready to submit any definite conclusion as to the methods to be provided for the accomplishment of the work in hand. In nearly all instances the representatives of the municipalities expressed their willingness to abide by the conclusions reached by the Commissioners.

The observations made by the Commissioners as to the various methods employed for the relief of rivers from pollution may be summarized as follows:

CHEMICAL PRECIPITATION.

The method of chemical precipitation, with subsequent filtration, involves the construction of a plant for the chemical treatment of the influent, and of precipitation tanks and works for the purifying, by filtration, of the effluent, which, when so purified, must be discharged into some waterway. There is then left a considerable residue of sludge, for the disposal of which a further plant and machinery is necessary. For the proper treatment of the sewage by this method considerable ground is required, for works and filtration beds, and for the deposit of the sludge extracted, the cost of which, in the vicinity of our populous cities is necessarily great, while the offensive odors arising from such establishments create a nuisance, arouse the opposition of residents of the vicinity, and in some instances has resulted in suits for damages against the communities which have adopted this method. With the growth of population there is a constant necessity for increased acreage and works, increasing the expense in corresponding ratio. If it is attempted to establish such plants at points where land is cheaper, the benefit thus obtained is offset by the cost of carrying the sewage a greater distance.

The cost of chemical treatment is in itself a large item. In Worcester, Mass., a city of 123,000 population, the annual cost of chemical treatment and disposal has arranged from \$43,773.99 to \$84,694.98. In Providence, R. I., a large and costly purification plant of this kind has been constructed, but the officials in charge, while admitting that the cost was large, claimed to be unable as yet to give figures, because the plant had not been long enough in operation.

In none of the chemical treatment plants is it contended that complete purification of the effluent is obtained. It is only claimed that a sufficient degree of purification is reached to prevent serious pollution, thus leaving a doubt whether this partial pollution may not become too great for the limited flow of the Passaic river when the population of this district is doubled or trebled.

The idea which prevails among many, that the sludge obtained from chemical purification possess value for fertilizing purposes, is dispelled by the knowledge that cities which have attempted to dispose of it for such use have found that it possesses little, if any, commercial value. In fact, before it can be handled at all, it needs considerable treatment, both costly and offensive in character, to put it in a condition suitable for ordinary trans-

portation. Worcester and Providence, after such treatment, are each compelled to cart it away to dumping grounds acquired for that purpose, while the cities of London and Manchester carry away each year thousands of tons and deposit it in the depths of the sea.

Whether this method is applied to one plant for the whole district, or to a number of plants (representing one for each municipality, or each group of municipalities), in each instance intercepting sewers and pumping works will be necessary for the conveyance of the sewage to the place of disposal.

SEPTIC TREATMENT.

It is difficult to obtain full knowledge of the value and cost of the method of septic treatment, with subsequent filtration. It is a comparatively new method of treatment, and much is expected of it by its advocates, but no municipality of great population has yet completed a plant of this kind for the disposal of all its sewage. Numbers are giving it a trial by the application of the method to the treatment of a part of their sewage product, while some have abandoned it after an experimental trial.

The same conditions, in regard to the acquirement of land for the location of treatment works and filtration beds, the need of intercepting and trunk sewers and pumping works to convey the sewage to the place of disposal, and the nuisance created in the vicinity of the disposal plant, as prevail in the method of chemical treatment, exist also in respect to septic treatment, and likewise complete purification cannot be expected.

The residue of sludge by this method is not as large as in chemical precipitation, and it is doubtless the case that under favorable conditions, where little else than house sewage is treated, the sludge obtained from the septic treatment has some manurial value; but in a great industrial district like this, where the effluent from factories must be discharged into the sewers if river pollution is to be avoided, the chemicals and deleterious substances so discharged would nullify this value to such an extent that the sludge would practically be useless for fertilizing purposes. The bacteria, the operations of which form the basis of this treatment, might be destroyed by the chemical nature of the effluents from some of the factories, making it necessary to treat such effluents independently, before they enter the sewers.

It is the consensus of expert opinion that many problems connected with this method of disposal have not yet been solved. In

some localities septic treatment has been adopted with the expectation that it will prove the best method practicable under existing conditions, but it is nevertheless considered as still in the experimental stage of its development.

BROAD IRRIGATION.

The system of Broad Irrigation, which has been adopted by some cities, and the best demonstration of which on a large scale, as far as learned, has been made by the city of Berlin, in Germany, is evidently the most effective of the methods named thus far, if conditions are favorable. In the vicinity of Berlin the soil is peculiarly adapted to the purpose, and yet more land is there required for irrigation than the city itself occupies. The acreage required for this treatment depends upon the nature of the soil with regard to its absorbent quality, but it is generally assumed that an acre of land is required for each one hundred of population. To provide for a population of 1,500,000 would necessitate eventually the acquirement of at least 15,000 acres of land. Again, as in the cases of chemical precipitation and septic treatment methods, the sewage must be collected by intercepting sewers, at one or more points, and must then be forced by pumps, through pipes, to and over the large area where the effluent is to be applied to the soil.

Further, a special preparation of the land is necessary that it may properly receive the effluent, and considerable labor is constantly required for its proper distribution. Under the most favorable circumstances only may good results be obtained from the manurial and irrigating properties of the sewage. In places where the soil is not so well adapted for absorption, a still greater area would be necessary, in which case the work and expense involved by the distribution of the effluent over this larger area would be proportionately greater. In addition, great care would have to be exercised to keep from the sewage such factory effluents as would by reason of their chemical composition somewhat destroy the value of the sewage for fertilizing purposes. As the object of river purification would be defeated by any method which would not care for this factory discharge, this condition would have to be met by the separate treatment of the factory effluent before it is admitted to the sewers.

Regarding all the systems heretofore noted, it must be taken into consideration that each one, if it is to be made effective, will require, in addition to the ordinary engineering and incidental

expenses, chemical experts and skilled assistants to be in constant attendance, as processes have to be changed from time to time to meet the changing conditions of the sewage under treatment. Chemical laboratories must be established and maintained, and the utmost diligence observed, to obtain reasonably effective results from their operations.

INTERMITTENT FILTRATION.

This system is regarded by experts as the most effective method of sewage disposal, because it is claimed to effect a perfect purification of the effluent. It is a process by which the sewage is treated upon ground specially prepared for the purpose. The ground is leveled, grooved and sub-drained, and the sewage is poured over it in a raw state. When a section is thus covered the channels are closed, and the sewage upon that section percolates through the soil to the sub-drains, through which the effluent passes away in its purified condition. When the sewage is absorbed the bed is raked over and dried before receiving another installment. Meantime other beds are receiving the sewage for like treatment. It is found, where adopted, that this treatment requires an acre of land for each 1,000 of population, and it must be a sandy soil. A depth of from four to five feet is required, and where the sand has to be brought from a distance the cost, at a low estimate, would be at least \$5,000 per acre. To meet what will eventually be the requirements of this district, when it shall have reached a population of a million and a half, would necessitate the preparation of fifteen hundred acres of land, and in addition would involve all the facilities required in the other systems for pumping and conveying the sewage to the place of disposal.

Intermittent filtration is sometimes used in conjunction with the other systems before described, but is generally considered to be economical only in localities where there is a sandy soil specially adapted to the purpose.

SEA DISPOSAL.

Besides the four methods heretofore described, there remains one other, which may be called the sea disposal plan, by which the sewage is conveyed into large bodies of water, there to be dispersed by the currents. This, of course, is only available for

localities where the sewage does not have to be conveyed beyond a reasonable distance to reach a body of water sufficiently large to dissipate it quickly. The construction required is a main intercepting sewer, to collect and convey the sewage of the entire district to be provided for, to the place of deposit, with one or more pumping plants to meet the requirement of proper gradient in districts where there is only a slight fall from the head of the sewer to its terminus.

In considering these different methods with reference to their adaptability to this particular district, it became apparent that the broad irrigation and the intermittent filtration methods could not be made available. For the former, no sufficient body of land within reach, either in the district or out of it, is obtainable for the purpose. For the latter, while only one-tenth as much land is needed, it is not to be found in sufficient acreage and depth in any of the unbuilt sections of this district, and the cost of making such filtration beds artificially, by bringing here the necessary sand and gravel, at the estimated price of \$5,000 per acre for 1,500 acres, would reach the enormous total of \$7,500,000, and is so great as to practically preclude the adoption of that system.

It then remained to ascertain whether either of the two plans first noted, or a combination of them, might not be more economical.

In the adoption of any method to meet the sewerage needs of this district and relieve its streams from pollution, each feature of the expense of operation and maintenance must be taken into consideration. Economy in the establishment of a plant may be offset by the cost of operation and administration. The methods of chemical precipitation and septic treatment not only involve great expense in the treatment and disposal of sewage, but it is impossible to concentrate their workings under one administration unless a trunk sewer be constructed to bring the sewage of all the municipalities to a common point for treatment. If this were done, it would then be cheaper to empty the mass into the sea than to treat it. If it is not done, separate treatment plants must be established for the various municipalities, and each plant, besides involving the cost of interceptors and trunk main to collect and convey the sewage to the place of treatment, becomes in itself a separate and complete system, requiring an administration of its own for its conduct, and preventing economy of administration by the concentrating of the interests of all under one system of management, to say nothing

of the fact heretofore mentioned that neither secures complete purification.

A careful study of all the foregoing methods was prompted by the fact that an estimate of the cost of a trunk sewer, with deep water outfall, for this district, made by a former Commission, seemed so great that there was created in the minds of the Commissioners a hope that it might be found that some other system would accomplish the desired result at less expense.

The advice of the leading sanitary engineers of the country in regard to the method of sea disposal has been supplemented by a practical investigation of the workings of what is undoubtedly the best system of its kind that has yet been constructed—the system which meets the sewerage needs of Boston and its Metropolitan District. Not only does this system demonstrate in a general way the utility of the trunk-sewer plan; it happens, also, that the conditions there met were similar to those which confront us here. There was a large and populous district, embracing Boston and the neighboring cities and towns, lying upon both sides of the Charles River, and contributing jointly to its pollution until it became a menace to health and a detriment to business. This river, like the Passaic, is subject to tidal influences for a considerable distance. As in the case of the Passaic, the fall of the river is also very slight, involving the same engineering problems that are to be met here.

After the expenditure of a large sum of money in all lines of investigation, the conclusion was reached in the Boston Metropolitan District that no other method would purify the river so efficiently and so economically as the construction of trunk sewers which would intercept the local sewers and convey the whole mass to points in Boston Bay, where it would be dispersed quickly by the currents of the bay. The population being great on both sides of the Charles River, it was found advisable to build two trunk sewers, which would not be necessary in this district, owing to the smaller drainage area and much smaller population on the east side of the Passaic river; it being the judgment of engineers that the needs of the eastern side for many years to come can be fully provided for, and more cheaply, by siphoning the sewage of municipalities on that side across the river to a large trunk sewer on the western side.

The first of the Boston trunk sewers constructed was that on the southern side of the Charles River, which meets the needs of Boston and other municipalities within the drainage area on that side. The sewer terminates at the water front, from which

point the sewage is pumped through a tunnel, below the water, to a great storage tank on Moon Island, in the lower bay. Here, at each ebb tide, or twice a day, the sewage thus stored is emptied upon the surface of the waters of the bay, and although the enormous amount of eighty million gallons is thus disposed of daily, in two discharges, it is quickly dissipated, and does not create a nuisance.

The second of the trunk sewers, which provides disposal for Charlestown and the other municipalities on the north side of the river, is, in the judgment of the Commissioners, an improved method of sea disposal, and one peculiarly adapted to the Passaic Valley District. The sewage is carried under the bay to Deer Island, at which point it is finally pumped and discharged continuously, at the rate of fifty-two million gallons daily, at a depth thirty feet below the surface. The sewage of the entire district is taken while it is still fresh, and before it becomes highly offensive through putrefaction, and quickly disposed of by the undercurrents of the bay. Along the line there is no surface indication of its passage, and no nuisance to be complained of. At the Deer Island Station all refuse that would float upon the surface is screened by a simple device and burned under the boilers. At the outfall the only surface indication is a slight discoloration, which does not extend far beyond the point of discharge, and is not noticeable unless one is directly over it.

The Boston Metropolitan District now contains a population one and a half times as large as that of the Passaic Valley District. In order to meet increasing suburban needs in the southern part of the district, a third trunk sewer is being constructed, which will discharge from another island into the bay.

A careful investigation of the cost of trunk sewer disposal in Boston, compared with the cost of chemical precipitation and septic treatment as practiced in other places, based upon a comparison of population, and the capitalization required for construction and maintenance, leaves no doubt in the minds of the Commissioners that the former is by far the most practical and economical method to adopt for this district, not only for its present, but more so for its future requirements, when the population of the district has largely increased, as the cost of operation and maintenance, by this plan, will not increase proportionately to the increase of population, while in the other methods of disposal the cost of treatment will increase correspondingly with the increased volume of sewage to be treated, to say nothing of a certain amount of nuisance which cannot be avoided. In

the light of these investigations it appeared that this plan, while equally effective here, could be accomplished with less difficulty and expense than the Boston Metropolitan system. A single trunk sewer will supply the need, and fewer pumping stations will be necessary. In addition the proposed outfall in New York Bay will be in considerably greater depth of water than that at Deer Island, in Boston Bay, leading to the belief that there will be no surface indication of the discharge, and, in view of the large dilution, no possible objection on the ground that it will be a nuisance in that vicinity.

For the purpose of acquiring further information as to the feasibility of this plan, and the cost of its execution, and also to ascertain if any other method will provide better or more economical results, the Commissioners engaged the services of Mr. Rudolph Hering, C. E., of New York, as consulting engineer. His selection was influenced mainly by his high standing as a sanitary engineer; his great knowledge of all methods of sewage disposal, gained by practical investigation of the various systems employed in this country and in Europe; his connection with the planning and construction of important works of this character, and his previous investigations looking to the purification of the Passaic river, and the sewerage of this particular district. Mr. Hering was instructed "to investigate, ascertain and report to the Commission the best methods for preventing the pollution of the Passaic river within the Passaic Valley Sewerage and Drainage District; and to report to the Commission the location and course and size and general description, together with the cost of construction, of any sewer, or other works, which may be reported and advised by him for the purpose aforesaid; and to determine and report the apportionment of the capacity of any sewer to be provided for each municipality in the district; and also the cost of the treatment of sewage by any disposal method which may be advised." The engineer entered at once upon the performance of his duties, with a corps of assistants sufficient for the work, which has involved examinations and estimates of cost of the various methods of disposal, which are given in his report. To enable an approximate estimate of the cost of a trunk sewer system in this district, surveys have been made, with land borings along the line of the proposed trunk sewer and soundings for force mains in Newark Bay and an outfall in New York Bay.

As a result of the independent investigations before described, and the report received from the engineer, the Commissioners have reached the conclusion that no other method of sewage

disposal is at once so economical and efficient for this district as the construction of a trunk sewer which will convey the sewage of the entire district to the currents of the sea.

As a matter of fact the Commissioners have been unable to discover that any of the foregoing methods, other than that of sea disposal, has been adopted by communities of considerable population, either in this country or in Europe, where it was permissible for such communities to utilize ocean currents for the disposal of their sewage.

It is but fair to say that the conclusions respecting the comparative values of the various methods of sewage disposal, and the evident superiority of the trunk system on the score of economy, were reached before the report of the engineer was received and before knowledge of his estimates of cost were obtained. As will be seen by his report, which is herewith submitted, he agrees with these conclusions, and enforces them by practical illustrations as to their respective merits, all of which demonstrate the greater utility and economy of the trunk sewer plan.

It was ascertained that an excellent tide-water outfall could be obtained for a trunk sewer terminal into the waters of New York Bay, in a natural channel, and at a point within the jurisdiction of this State, where the depth of water is seventy feet, or more than twice the depth obtained where the Deer Island outfall discharges into Boston Bay.

Investigation was made with reference to the liability of interference with the interests of navigation by reason of the establishment of the outfall at the point proposed. This developed the fact that there would be no obstruction to artificial channels, and no interference with regular currents, the latter being sufficiently strong to dissipate the sewage. Enough was elicited to give reasonable assurance that no objection to this plan by the authorities of the general government in charge of such matters need be anticipated, if certain conditions imposed by the government for such work are complied with. These conditions, which have been clearly defined, are of such character that compliance therewith will not in any way interfere with the work, and apprehension in that direction is removed.

Early in the course of the investigations the conclusion was reached by the Commissioners that no plan of sewage disposal construction would be just to all the municipalities interested unless it included intercepting facilities for all the local sewers which now discharge into the Passaic River. This necessitated the beginning of the main intercepting sewer at the Valley of

the Rocks, near the Great Falls in the city of Paterson, and traversing the entire water front of that city, and also the providing of necessary interceptors for the sewer outlets of all the municipalities on the east side.

The plan submitted by the Engineer is intended to meet the needs of this district until it shall have reached a population of 1,500,000. This need is fully contemplated in all the essentials of the main sewer construction. It is not deemed advisable to construct at the present time pumping machinery, force main pipes under Newark Bay, and outfall pipes into New York Bay, of sufficient capacity to meet the ultimate need of 1,500,000 people.

Additions in these respects may be made from time to time, as needed, until the appliances referred to are brought up to the full capacity of the trunk sewer. The cost of this enlargement will be small when compared with the increase of population and wealth during the years which will elapse before the full capacity is required.

It will be seen by the Engineer's report that his estimate of the entire cost of construction, as at present planned, will approximate \$8,700,000. To this must be added the cost of right of way.

CONSTRUCTION AND MAINTENANCE.

To provide for the cost of constructing and the expense of maintaining this work is one of the most important questions to be considered. The Commissioners have no hesitancy in saying that the State should give financial aid, because the State will be benefited materially by this improvement, which will enhance the value of its holdings as a riparian owner. It should give such aid for the further reason that the Passaic river and many streams which flow into it within this district are so polluted by sewage and other deleterious matter that the health of the people residing in the district is seriously endangered, and relief therefrom should be obtained without delay. The State owns our waterways, controls the use and prevents the misuse of our waters, and there should be no objection to the giving of its aid for their improvement, in the same way that it aids other improvements for the public good, by appropriations for permanent roads, for the protection of oyster beds, for stocking waters with fish and forests with game, etc. The area contained within the boundaries of the Passaic Valley District has a population of more than half a million, with a net taxable valuation of nearly

three hundred million dollars. It comprises, in fact, nearly one-third of the population and wealth of the State and in both respects there should be immediate and substantial increase as the result of the purification of the Passaic River.

As the proposed improvement is to be permanent in its character, and built to serve eventually a population fully three times as large as at present, the Commissioners have reached the conclusion that the payment for cost of the works should be extended in part to the tax-payers of the future, who will enjoy the benefit. This may be done by the issue of long-term bonds for the cost of construction, such bonds to be sold at the lowest rate of interest obtainable, not exceeding four per cent. It is deemed advisable that these bonds should run for a period of fifty years, with an annual sinking fund provision of one per cent., which will be sufficient for their redemption at maturity, and they should be issued in series as the work progresses.

In the matter of the apportionment of the cost of construction, the Commissioners believe it should fall upon the taxable valuations of the district; that is, that the interest and sinking fund charges upon bonds issued for this purpose, shall be apportioned among the respective municipalities and taxing districts lying wholly or in part within the sewerage district, in such proportion as the taxable ratables within so much of the municipalities and taxing districts as is embraced within the sewerage district, bears to the total amount of taxable property within the whole of the district. In this manner the burden will be most fairly equalized. With the increase of wealth the taxable burden for interest and sinking fund charges will become appreciably less each year, and it is only just that those who will reap this benefit should bear a proportion of the initial cost.

There are abundant reasons why the cost of maintenance should be based upon the use made of the sewer by the various municipalities within the district. Some of these municipalities discharge all their surface drainage, house sewage and factory waste into their sewers; others do so in part, and still others have provided separating systems, which will require trunk sewer facilities for the carrying of house sewage only. Some municipalities do not sewer into the river at all, but their future need is apparent, if the river is to be kept pure. The assessment of the cost of maintenance upon municipalities, in proportion to the volume of sewage which each puts into the trunk sewer, meets every requirement of fairness, as each will pay only for the cost it imposes to make provision for its separate need. It also provides a future benefit which cannot be fully estimated at

this time. The various communities interested, knowing they will be charged upon the basis of such use as they make of the sewer, will endeavor to lessen the cost to themselves in every possible way. In time manufacturers will probably be required to separate deleterious substances from factory effluents, and discharge their clean water elsewhere than in the sewer; new sewer construction will doubtless be provided with separating systems to relieve the trunk sewer from surface drainage and harmless effluents from factories and elsewhere; and existing systems will be changed gradually to effect this economy. In this way the proposed plant will probably meet the real needs of this district, without enlargement or addition, for a much longer period than is now contemplated.

TAXABLE VALUATIONS AND COST.

It is impossible to give at this time the exact taxable valuations within the area of the Passaic Valley District, for the reason that some municipalities do not lie wholly within the district lines. This is true of a very small portion of the city of Newark, parts of the boroughs of East Rutherford, Rutherford and North Arlington, part of the township of Union, and part of the town of Kearney. But an estimate of the valuations in such parts of these municipalities as are within the district has been made to enable an apportionment of cost upon the aggregate of valuations which must be very nearly correct. The return of net taxable ratables for the year 1902, with estimated deductions for parts of municipalities outside the district, is as follows:

	Total Valuation Taxable.	Deduction for Area Outside District.	Net Valuation in District.
ESSEX COUNTY:			
City of Newark.....	\$163,303,004	\$500,000	\$162,803,004
City of Orange.....	10,677,716	.....	10,677,716
City of East Orange..	18,225,000	.....	18,225,000
Town of Bloomfield..	5,046,750	.....	5,046,750
Bor. of Glen Ridge...	1,830,000	.....	1,830,000
Town of Montclair...	10,355,300	.....	10,355,300
Township of Belleville,	2,295,605	.....	2,295,605
Town of Nutley.....	1,587,490	.....	1,587,490
PASSAIC COUNTY:			
City of Paterson.....	48,789,850	.....	48,789,850
City of Passaic.....	10,442,370	.....	10,442,370
Twp. of Acquackanonk,	2,153,750	.....	2,153,750

	Total Valuation Taxable.	Deduction for Area Outside District.	Net Valuation in District.
BERGEN COUNTY:			
Borough of Garfield..	\$863,779	.....	\$863,779
Bor. of Wallington...	455,232	.....	455,232
Bor. of E. Rutherford,	1,174,646	\$650,000	524,646
Bor. of Rutherford...	3,591,155	2,000,000	1,591,155
Township of Union..	635,120	290,000	345,120
Bor. of N. Arlington.	274,483	130,000	144,483
HUDSON COUNTY:			
Town of Kearney....	5,369,195	550,000	4,819,195
Town of Harrison...	3,948,610	.....	3,948,610
Bor. of East Newark.	1,951,200	.....	1,951,200
	<u>\$292,970,255</u>	<u>\$4,120,000</u>	<u>\$288,850,255</u>

RECAPITULATION.

Net taxable valuation in Essex County.....	\$212,820,865
“ “ “ “ Passaic “	61,385,970
“ “ “ “ Bergen “	3,924,415
“ “ “ “ Hudson “	10,719,005

Total net valuation in district.....\$288,850,255

The increase of the net taxable valuations of this district in the year 1902 is nearly nine million dollars, and for the purposes of computation it will be safe to assume that the ratables of this district will exceed three hundred million dollars by the time the first interest and sinking fund charges on an issue of bonds would fall due.

Under the proposition that the cost of maintenance will be most justly imposed if apportioned among the municipalities in proportion to the use they make of the sewer, it will be impossible to say exactly to what extent this charge will affect the tax rate of each municipality until such time as the amount of use made by each is ascertained.

The cost of construction and acquirement of right of way being estimated to be somewhat within nine million dollars, if authority is given for the issue of bonds for this purpose, to the amount stated, and to run for a period of fifty years, it should be possible to float them at an annual interest rate of not more than from three and a half to four per cent. An annual sinking fund

of one per cent., continuously invested for forty-seven years, should be abundantly sufficient to pay off the bonds at maturity. It should therefore be possible to omit the sinking fund provision for the first three years, in order to make the burden of taxation as light as possible at the outset. As some years would be required for the construction of the work, it is safe to assume that taxes for maintenance will not be levied before five years hence, and but very little for sinking fund until that time. Only the interest upon such of the bonds as might be issued during the course of construction will need to be provided for. Time will be required to mature plans, receive estimates and make contracts, so that for two or three years the burden of taxation for this work would be hardly appreciable, and its full effect would probably not take place before five years, when the sewer plant as now proposed to be constructed would be completed. The interest and sinking fund charges, and the cost of maintenance, as estimated by the engineer, would then be as follows:

Interest upon \$9,000,000 of bonds at 4 per cent.	\$360,000
Sinking fund account at 1 per cent.	90,000
Cost of pumping stations	112,500
General maintenance, etc.	35,000
Administration and supervision	45,000
	\$642,500

At the present rate of increase of taxable valuations, the aggregate of such in this district should reach about \$350,000,000 five years hence, and if the whole charge were imposed on rates it would amount to about 17 cents upon each \$100 of taxable valuations.

For the reason, however, that under the plan proposed the various municipalities would defray the cost of maintenance in proportion to the volume of sewage which each would discharge into the sewer, this rate would not be uniform to the several municipalities. Therefore, it is likely that the annual fixed charges would make the tax rate a little more than 17 cents per \$100 in some municipalities, and a little less than that sum in others.

It must be remembered that this estimate of annual taxable cost is based upon the contingency that the district will be called upon to meet the whole cost of the work. If State aid is given, as recommended by the Commissioners and requested by the various municipalities, this rate of about 17 cents per \$100 would be reduced in proportion to the amount contributed by

the State. There would also be a further reduction if a less rate of interest than four per cent. is obtained in the sale of the bonds.

The percentage of cost for the first few years succeeding the completion of the plant will be the greatest cost, and, as stated before the constant increase of ratables in the district will gradually decrease the rate of taxation.

In obedience to our instructions we report to the Legislature a bill which, in our opinion, will make effective the work advised by this report, and a copy of which is herewith presented.

All of which is respectfully submitted.

[SEAL.]

J. A. LEBKUECHER,
JNO. HINCHLIFFE,
FRANCIS CHILD,
PETER HAUCK,
WM. MCKENZIE,

Commissioners.

Attest,

JOHN S. GIBSON,
Clerk.

January 23d, 1903.

DECEMBER 13, 1902.

Hon. Julius A. Lebkuecher, Chairman, and Members of the Passaic Valley District Sewerage and Drainage Commission, Newark, N. J.:

GENTLEMEN—Pursuant to our correspondence of August 16 and 18, 1902, by which you appointed me Chief Engineer to your Commission, I beg to present herewith a report upon those engineering matters which are at present required in connection with the proposed purification of the Lower Passaic river.

You request me to consider the question of purification as a new proposition, irrespective of the conclusions reached by previous Commissions.* As these reports are readily accessible, much detail could be and has been omitted from the present report.

There are in chief two methods available for the purification of this river. One, which is here called Project A, involves a trunk or intercepting sewer with all necessary connections and appurtenances to receive and convey all foul and polluting waters,

* Report of the Passaic Valley Sewerage Commission upon the General System of Sewage Disposal for the Valley of the Passaic River, and Prevention of the Pollution thereof, February, 1897.

Report of the State Sewerage Commission, 1901.

now entering the river, from near Great Falls in Paterson to a point of final disposal into the waters of the Upper New York bay, near Robbins's Reef Light, within the State of New Jersey.

The waters of the Hudson river and the tidal flow from the Lower New York bay and the East river, together furnish such a large quantity of water that the proper discharge of sewage into the same from a population of many millions cannot be noticed by the senses.

At present the sewage of nearly four million persons finds its way directly into these waters from Manhattan, Bronx, Brooklyn, Queens, Richmond, Jersey City and Hoboken. The only visible effects herefrom is the floating matter which has resisted the comminuting effects of waves and currents. Such matter will be excluded from the Passaic Valley Sewage, because of its retention by screens before the sewage passes through the pumps. It is not now separated from the sewage of the New York metropolis and adjoining cities of New Jersey. Nor will all the silt and heavy matters brought into the sewers by the rain washing the streets enter the bay from the Passaic valley, because most of it will be held back prior to the pumping at Newark bay. A third advantage of the proposed disposal over that now practised in the metropolitan district, is the discharge of the sewage into the current instead of at the shores, and at least forty feet below the surface instead of immediately at the surface.

The other plan of sewage disposal, which is here called Project B, involves likewise a system of trunk or intercepting sewers, but instead of a dilution of the sewage in the waters of New York bay, it involves its treatment by some process of purification, either in a single plant or in separate plants for each group of communities in the district under consideration.

The present report covers specifically the location, sizes, and grades of a main trunk sewer collecting in the most expeditious way the sewage from every municipality in the district and discussed as Project A. It indicates also the principal connections and necessary pumping stations and other appurtenances along the proposed route of the sewer from Prospect street, Paterson, to the point of discharge in New York bay, and also sets forth the estimates of cost, both of construction and of maintenance of the works considered.

The report is accompanied by a map showing the territory of the several municipalities according to the boundaries furnished by you with the alignment of the entire trunk sewer and location of principal connections, together with cross sections of

the sewer and a profile of the same showing sizes and necessary grades.

As to Project B, the report contains a comprehensive discussion of the practicability of artificial sewage purification, together with approximate estimates of cost and comparisons of the same with cost of Project A.

In order to secure adequate data for the design of the trunk sewer and outfall, a careful survey was made under the immediate supervision of Mr. W. B. Fuller, C. E., of Paterson, extending from the Great Falls to New York bay. He also collected other necessary information for ascertaining the probable cost of the work. The field work included quite an extensive series of soundings and borings, made under contract by Messrs. P. H. & J. Conlan, of Newark, to supplement the information previously available as to geological conditions to be encountered in the construction of the work.

In this office the various data bearing upon the entire subject have been collated and studied, and designs have been prepared for the project. The latter work has been under the immediate charge of our assistant, Mr. Theodore Horton, C. E., of Montclair, and formerly with the Metropolitan Sewerage Commission of Boston. Acknowledgment is hereby made of the efficient services rendered by the above mentioned gentlemen and also of the co-operation of my associate, Mr. G. W. Fuller, especially concerning the questions relating to sewage purification.

In presenting a report of these studies and conclusions as to the best means of purifying the Lower Passaic river, the subject will be discussed under three headings: A, Discharge of the Sewage into New York Bay; B, Local Treatment of the Sewage, and C, Conclusions.

A. TRUNK SEWER DISCHARGING INTO NEW YORK BAY.

The trunk sewer is located on the west side of the Passaic river. In order to intercept the sewage now entering the river from the east side, several auxiliary intercepting or trunk sewers have been located on the map between Paterson and Harrison. At suitable intervals they are carried across the river through inverted siphons below the established waterway, and discharge into the main trunk sewer.

The trunk sewer as now designed should prove adequate until the population within this district reaches somewhat more than 1,500,000 persons, depending upon the careful use of water, the

elimination of its waste, and avoidance of the reception into the sewers of excessive quantities of ground water and of rain water. It will be evident that the length of time during which the trunk sewer can serve the entire valley, will depend partly upon the rapidity of growth of its population, and partly upon the successful exclusion from the sewer of all waters that of themselves would not foul the river.

As is well known, the present sewers of Paterson, Newark, Harrison, Kearney and East Newark are built principally upon the combined plan, admitting sewage, ground water and rain water. The local systems of these municipalities, however, have not been fully developed. For the reasons given below it is assumed in the present design that all of the sewers to be built in the undeveloped portions of these municipalities will be built on the separate plan. With this assumption I have estimated for the present design that about one-third of the present areas of Paterson and Newark, one-half the areas of Harrison and Kearny, and the whole of East Newark, will be covered by the separate system.

The successful exclusion of all waters not causing offensiveness in the river, which would greatly prolong the time when this trunk sewer will serve the district, is a subject that needs emphasis at this place. Such waters are the unnecessary and excessive waste of water by the communities and the entrance into the sewers of excessive amounts of ground water, the unnecessary entrance of rain water into the same sewers which receive the foul water.

This view might also be held, though with less force, with regard to the admission of storm water, which might be excluded more by allowing an increased proportion to overflow into the river. But with such arrangements there would follow simultaneously recurring pollution of the river to a certain degree by such overflows. It therefore seems proper to take steps at the outset gradually to eliminate the entrance of unnecessary amounts or rain water into the trunk sewer. It is respectfully suggested that for this purpose the following proceeding is practicable and eventually a profitable one.

1. That after the authorization of the building of the trunk sewer, no matter what method of treatment is resorted to, all sewers built within the district be designed, so far as practicable, on the separate plan, the foul waters to enter in one set of sewers, which would discharge into the trunk sewer, the street water to enter another set of sewers or drains discharging directly into the river. This change is already partly inaugurated in the city

of Newark. The entire city of Worcester, Mass., is now undergoing a similar change of system on account of the ultimate economy expected thereby. The great distance from Paterson to New York bay makes it unwise, because it is expensive, to carry any rain water, that could as well flow into the river at any point, all the way down to New York bay, not to speak of pumping it. If the annual cost of maintenance is to be paid for by the quantity of sewage delivered by each community, economy will suggest a gradual separation of foul and clean waters by all the cities in your district.

2. That in order to purify Passaic river and to maintain its purity, the rain water sewers or drains discharge their first wash, which contains the foul matter collected on the streets, into the foul water sewers and eventually into the trunk sewer, the subsequent flow being excluded by the usual automatic regulators, and discharging directly into the river. The amount of foul street water thus admitted into the trunk sewer is thus controllable and can be fixed at will.

There can be no doubt that the exclusion of ground water from the local sewers is an important question, demanding attention at the outset. It will be remembered that the construction of this separate system in East Orange demonstrated that with fairly good construction an amount of ground water entered the sewers which filled the outfall about one-third full before any sewage connection had been made. It was this large amount of ground water, over-taxing the purification works, that made the expense of purification so high and the purification unsatisfactory.

The ground water should be discharged directly into the river, and not into the sewers. It is therefore necessary to construct the intercepting sewers with the greatest care, so as to make them water-tight and exclude ground water from along their course. While the separate communities will naturally pay the district for conveying and pumping the ground water unnecessarily collected and delivered by them alone, they should not be required to pay a further share for handling any very excessive amount of ground water entering the proposed trunk and intercepting sewers themselves.

It is considered that to remove the manufacturing wastes from the Lower Passaic river is as essential as to remove the domestic sewage. The proposed works are therefore intended to receive and remove practically all of these wastes.

The accompanying map indicates the general alignment of the trunk sewer with its auxiliaries. It begins near the falls at Paterson on the right bank of the Passaic river, and follows it along

the most practicable routes to the main pumping station, situated in the city of Newark, near Newark bay and north of the Lehigh railroad bridge. The trunk sewer then leaves the district as the collecting sewer, and subsequently crosses the bay by inverted siphons as the outfall sewer, skirts the north side of the Morris and Essex canal as a gravity sewer, then at the eastern shore of Jersey City continues as a pipe beneath tide level to a point in New York bay, where it discharges near Robbin's Reef Light and near the main channel, which has a depth of seventy feet.

At two points it will be necessary to have auxiliary pumping stations to lift the sewage of low areas into the main trunk sewer. To avoid these auxiliary lifts would have required the lowering of the trunk sewer to a depth that would have made its proper construction extremely difficult and expensive. One auxiliary pump is at Wallington, and commands the low territory along the river from Garfield to Rutherford. It will be found economical for many years to bring to this station also the sewage of all the territory draining into Saddle river, even though its point of origin is sufficiently high to bring it to the main trunk sewer by gravity. The second auxiliary pumping station is at Lyndhurst, which may be required in the future, and commands the low territory along the river from Rutherford to North Arlington.

The proposed trunk sewer and its branches will be connected either directly or indirectly with the various sewers now existing in the district and discharging at present into the river, of which twenty-six are situated at Paterson, ten in Passaic, two between Passaic and Second river, and twenty-nine below Second river.

To make the several connections in a proper manner there are required seven branch sewers: One for the collection of the sewage in Paterson on the north side of the river, one at Wallington, collecting the sewage from that section of the district lying east of the river, one on the east side of the river, collecting the sewage from low districts in Rutherford, Union township and North Arlington, one on the east side of the river extending from Arlington through Harrison and Kearney and connecting with the main interceptor in Newark, and three smaller branches on the east side of the river serving the high districts in East Rutherford, Rutherford, Union township, North Arlington and part of Kearney.

For the purpose of proportioning the annual cost of maintenance it will be necessary to provide gauging stations at these and other connections, at least one for every community using the trunk sewer, so as to measure the amount of sewage delivered by each one.

From the data at hand it is estimated that the trunk sewer at the pumping station on the Newark meadows should have a capacity of 326 million gallons per twenty-four hours when running three-quarters full. To indicate the relative capacity of this sewer at several leading points it may be said that in million gallons per twenty-four hours when running three-quarters full, its capacity would be 74 million gallons at the Paterson city line, 110 million gallons at Passaic below the branch from Wallington, 165 million gallons at Second river, and 260 million gallons at Newark above the Harrison branch. The details of these figures regarding quantities of sewage, including ground water and rain water, are given in Appendix A. In passing it may be said that the quantity of sewage allowed in the present design is about twenty per cent. greater than was considered last year by the State Sewerage Commission, due to a more adequate provision now made for storm water, leakage, mill wastes and to the increased area of the district as considered by the present Commission.

The estimate of cost has been based on the proposition to construct the greater portion of the trunk sewer of concrete, as shown on the accompanying sheet of cross sections. In several aspects the concrete sewer is preferable to one lined with brick. While if properly made concrete will be as durable as brick, the special advantages are that it can be given a smoother surface, therefore a greater flowing capacity and cleanliness, and that it can be built at a less cost. It also offers greater security and facility for being made water-tight. An effective ventilating plant is required at a point where the sewage issues from the inverted siphon crossing Newark bay.

In size the diameter would range from four feet at the upper end to thirteen feet on the Newark meadows. The computations were made to let it run three-quarters full when serving a population of about 1,500,000 persons for the above allowance of water. It would not be safe, in my opinion, to reduce these assumptions, and correspondingly the sizes, because the experiences in other quasi metropolitan districts comparable with those in the present case, have indicated a tendency to increase rather than to reduce them. Besides, the interests of the communities eventually would be well served by a possible extension of the term of usefulness for the trunk sewer than now assumed, should this be found practicable.

The gradient of the sewer has been fixed so that the velocities will be very satisfactory throughout the entire sewer, a requirement which in view of its length is important, and the consequent

transformation of the fresh into septic sewage will be minimized.

The total length of the sewer from a point near the Great Falls at Paterson to the pumping station on the meadows is 112,370 feet, or about twenty-one and one-third miles. This length is somewhat shorter than that shown upon earlier plans, due to a more advantageous location of the line of the sewer from the more precise surveys recently made. The grade of the sewer and its sizes at various points are shown upon the accompanying profile.

Three pumping stations are required for discharging the sewage of the district into New York bay. The first of these has a capacity of about twenty million gallons daily, and is located at Wallington at the foot of the branch sewer which conveys the sewage from the upper section on the eastern side of the river, comprising the Saddle river district, to the main trunk sewer. The maximum lift of the sewage at this point is about fifteen feet.

The second pumping station is located in Lyndhurst township and is intended to collect the sewage from a narrow strip of land near the river from the townships of Rutherford, Union and North Arlington, and to discharge it into the main trunk sewer. The capacity of the station would be about one million gallons, and the lift about fifteen feet. This, however, may not be required for some time.

The main pumping station is located on the Newark meadows, as close to Newark bay as practicable. It is conveniently situated for rail and water transportation facilities. For its first installation it should have a capacity of at least 150 million gallons daily. The maximum lift is about forty feet.

At all of these pumping stations provisions should be made for a ready supply of fuel, for pumps and boilers, also for necessary screen and silt catchers to enable the plant to be operated efficiently and inoffensively.

Beginning at the main pumping station on the Newark meadows, the outfall sewer consists of two lines of steel mains operated under pressure, a section of gravity sewer, and then a single line of iron main to the outlet. The two lines of force mains, each six feet in diameter, pass under Newark bay to a point on the west shore of Jersey City at the Morris and Essex canal. The gravity sewer, thirteen feet in diameter, leads from the last named point along the north shore of the canal to a point near the eastern shore of Jersey City, where a single line of steel pipe, eight feet in diameter, leads out into the main channel of New York bay, the point of discharge being within

the State of New Jersey and about three-quarters of a mile north of Robbin's Reef Light and about forty feet below mean low tide.

The force mains under Newark bay and the outfall pipe into New York bay each have an immediate capacity of 120 million gallons per day; while the gravity sewer across the Bayonne peninsula has the same capacity as the thirteen-foot sewer leading to the pumping station in Newark. The length of the outfall sewer from the pumping station to the outlet is 27,700 feet, or about five and one-quarter miles.

Estimates of cost have been prepared of the entire system considered above, based on current prices for materials and labor required for work of this character. A list of unit prices used in making these estimates is presented as Appendix B. No allowances have been made here for real estate nor legal expenses. The construction of the trunk sewer from Prospect street, Paterson, to the pumping station on the Newark meadows together with all branch sewers, auxiliary pumping stations, river crossings, connections and appurtenances, and of the main pumping station, with the force mains and outfall to the point of discharge in New York bay is estimated to cost \$7,760,200. To this sum is added 12 per cent. for contingencies and supervision, making a grand total of \$8,691,400.

The estimate of cost of construction of the trunk sewer project to discharge the sewage into New York bay, as given, is believed to be liberal and the provisions ample for the stated requirements. As stated, however, the pumping station equipment on the Newark meadows, the force mains under Newark bay and the outfall into New York bay as first built are less than required for the full capacity of the trunk sewer. After a term of years, therefore, when the population of the district has materially increased, it will be necessary to add to these portions of the works in order to bring them up to the capacity of the other portions.

Under the conditions of operating the system as now proposed to be constructed during its first years of service, it is assumed that the average daily pumpage at the Wallington station would be ten million gallons, at the Lyndhurst station if now built, about one-half million gallons, and at the Newark station 120 million gallons. On this basis the annual cost of maintenance, including depreciation and repairs, is estimated for the Wallington station \$16,500, equal to about \$4.50 per million gallons, for the Lyndhurst station at \$2,000, equal to about

\$11.00 per million gallons, and for Newark pumping station at \$94,000, equivalent to about \$2.00 per million gallons.

To these sums should be added the cost of cleaning, ventilating and maintaining 37 miles of sewers, connections and appurtenances, taken at \$35,000 annually, and also the cost of administration, supervision and incidental expenses, estimated at \$45,000, making a possible maximum of the total cost of maintenance per annum \$192,000.

With the trunk sewer operating at its full capacity and on the same basis of unit costs, the total maximum annual cost of maintenance might be estimated at \$303,000.

The following table gives a recapitulation of the maximum total annual cost of the trunk sewer project:

TABLE I.

SHOWING MAXIMUM ANNUAL COST OF OPERATION AND MAINTENANCE OF THE TRUNK SEWER PROJECT AS DEFINED.

Interest on investment of say \$8,800,000 at 4 per cent..	\$352,000
Pumping charges, including depreciation and repairs:	
Wallington	16,500
Lyndhurst	2,000
Newark	94,000
General maintenance, including gauging, cleaning, ventilating, etc.	35,000
Administration and supervision.....	45,000
	\$544,500

B. LOCAL SEWAGE TREATMENT WORKS.

The proposition to purify the sewage by some local treatment is here considered with reference to the cities situated in the upper section of this district. Later mention is made of the practicability of this method for the entire district.

In every investigation which has been made thus far for removing the pollution of the lower Passaic river, consideration has been given to the disposal of the sewage of the upper section of the district by separate purification works. This was natural, because the two principal groups of communities are situated near the two extreme ends of the district, and the pos-

sible economy of separate treatment for the upper section would therefore suggest itself at once.

The Passaic Valley Sewerage Commission of 1896, to which Messrs. Fteley and Jacobsen were the engineers, concluded that independent disposal works for the upper section were impracticable, on account of both expense and future undesirable local conditions. This conclusion was concurred in by the State Sewerage Commission in their report of 1901.

It appears that there is still uncertainty on the part of some as to whether separate purification works for this section would not be the cheapest and best solution. This is evidenced by the formation of a citizens' association in Paterson and the engagement of so distinguished a sanitary engineer as Mr. Samuel M. Gray, of Providence, to report to them fully as to the practicability of separate purification works.

In view of this feeling, and although this question was decided in the negative by two preceding commissions, you advise me, for the sake of completeness of the records and reports of your Commission, that this matter should be given a reconsideration so as to form a part of the present report, giving due consideration also to any recent developments which possibly might justify placing the purification projects in a more favorable light than previously reported.

In accordance with your request, therefore, this matter is entered into at some length, and put in as favorable a light as is consistent with present knowledge on the subject of sewage purification.

The upper section of the Lower Passaic valley, made up chiefly of the cities of Paterson and Passaic and neighboring towns, is essentially a manufacturing community, in which textile and dyeing industries occupy important positions. At Paterson the public water-supply at present does not exceed about ten million gallons daily on an average.

The sewers are for the most part designed on the combined plan, but the ordinary flow of domestic sewage, which must be kept out of the river, comprising the spent water supply, seepage of ground water into the sewers, and the first portion of the rain water running off the streets, which must be treated together with the sewage, is estimated at present to average about 150 gallons per capita, or say at a rate of not over eighteen million gallons daily. Our investigations into the volume of mill wastes at those establishments where the water is obtained from wells and other private sources, indicate that the daily volume

approximates an average of twenty million gallons or slightly in excess of the ordinary municipal sewage as above stated.

In Passaic the present water consumption from the public supply averages about three million gallons daily, and investigations show that there are about five million gallons of mill wastes from establishments having private sources of water-supply. The sewers are on the separate system, and practically no allowance need be made for the mixture of storm water with the sewage.

The successful elimination of the pollution of the lower Passaic river, especially at seasons of drought, involves therefore not only the removal of domestic sewage, but also of the great mass of the trade wastes. Accordingly, the purification of sewage and wastes for Paterson and Passaic is a much greater and more difficult project than would appear at first sight, due not only to the large per capita volume to be treated, but chiefly to the complex character of the mill wastes with reference to satisfactory treatment.

As the lower Passaic and Hackensack rivers, into which the treated sewage would naturally flow, are not used as sources of public water-supplies, it is of course necessary, in considering these projects, to secure only such a degree of purification as will give a stable effluent so far as its organic composition is concerned; that is to say, one which would not putrefy after being discharged into the river. In this respect the local purification projects correspond quite closely with those of many of the large English cities, where the sole object is to guard against putrefaction and nuisances, and therefore quite unlike works at a number of places in New England, where the object is to purify the sewage that the effluent may be discharged satisfactorily into streams used for drinking purposes.

At a number of places in Europe, notably at Berlin and Paris, large volumes of municipal sewage are disposed of with considerable success upon relatively large areas of land so situated and of such a character that the sewage is used for irrigating various crops which are raised. Such sewage farms, in order to be successful, must have a suitable soil and be sufficiently large in area so that, at the time of harvesting, the application of sewage will not be at so great a rate as to ruin the crops. At Berlin and Paris the soil conditions are very favorable, but it is found that the success of the farms requires in the neighborhood of one acre of land on an average for each five thousand gallons per day of sewage. The total area of land purchased at Berlin for sewage farms up to 1890 was over 18,000 acres.

The country adjoining Paterson and Passaic has been examined with reference to land treatment, but it is clearly out of question to dispose of the sewage in this way, owing to the clay soil on the land east of the river and above Passaic, which is practically the only place on the uplands physically available for disposing of the sewage.

In view of the foregoing it is obvious that the only means available for the purification of this sewage is to be found in purification works of artificial construction. Of works of this type there are several in use elsewhere, among which may be mentioned chemical precipitation plants, intermittent sand filters, septic tanks and contact beds. The most applicable style of purification works of artificial construction generally depends upon a series of local conditions.

As pointed out by Messrs, Wise, Watson and Ferguson, two sites are physically available for the location of purification works in the upper section. The first of these is situated somewhat less than one mile east of the Dundee dam, in Bergen county, near the site of an old brickyard, from which the effluent water could flow into the Passaic river. This might readily be utilized for Paterson, but not for Passaic or the adjoining communities without resorting to expensive methods of sewage collection and some pumping. The other site is at the so-called Cedar swamp, situated upon the Hackensack meadows, about two miles north of the main line of the Erie Railroad. At about two feet below the surface of the marshes at this point clay is found, satisfactory for foundations, and the effluent water from a plant so situated could be readily disposed of into the Hackensack river. General arrangements for purification projects, with estimates of cost, have been prepared for each of these sites.

The capacity of works located at the brickyard site east of the Dundee dam, for serving the city of Paterson, is taken at fifty million gallons per day.

For a plant located upon the Cedar swamp on the Hackensack meadows, and dealing with the sewage of Paterson, Passaic, Garfield, Rutherford, Wallington, etc., the sizes are fixed for a volume of seventy million gallons per day for the first installation.

Of the several types of artificial works for sewage purification it has been considered impracticable to rely upon chemical precipitation alone, on the ground that in the case before us it would remove only about one-half of the organic matter from the sewage, and that this fraction would be insufficient for protection against secondary putrefaction at time of protracted

droughts. As to intermittent sand filters, such as have been used successfully at a number of places in New England, where sandy areas are readily available the expense of such a project for our purpose makes it out of the question on account of the absence of natural sand beds of sufficient area and depth.

Developments in recent years in Europe, as well as in this country, with the so-called biological method give promise that this method would furnish the cheapest treatment. Accordingly, consideration has been given to the use of septic tanks, in which the larger and heavier suspended matters would be deposited and in which a considerable portion of those of an organic nature would be liquefied. The effluent of these tanks would contain somewhat more suspended matter than the effluent from chemical precipitation works, and the total amount of organic matter would also be somewhat greater. To render the effluent of septic tanks sufficiently free of organic matter, so that the final effluent is non-putrefactive, there seems to be every reason for believing that the most available method is that proposed in the several reports lately made to the State Sewerage Commission, namely, rapid filtration through coarse-grained materials (broken stone), or what is ordinarily known as contact beds. It is thought that by such a procedure the sewage could be treated to a satisfactory degree at a minimum expense as regards the total cost involving construction and maintenance.

Such purification works for the present case, in brief, would involve septic tanks, uncovered, to save expense, and holding twelve hours' flow of sewage under average conditions. The contact beds containing six feet in depth of broken stone would be operated at an average rate of one million gallons per acre per twenty-four hours, and adequate facilities would be provided for the disposal of the sludge and for the settling of the final effluent, when it contains too much suspended matter.

Comparing a purification plant such as outlined above with the evidence bearing upon the subject, as obtained in Europe and in America, it is evident that the project stated places the matter in as favorable a light financially as practicable, and in fact requires that the benefit of the doubt be given to such a plant when the question of its permanent efficiency is considered. It is also to be borne in mind that evidence is very meagre as to the biological treatment of a sewage which, as that coming from Paterson and Passaic, would contain more than fifty per cent. of mill wastes of a very stable and resisting character. It is in fact by no means certain that the septic treatment would prove adequate, even if the sizes of the basins were considerably increased

above that stated, and it is quite possible that after the works were built it might be found necessary to adopt chemical precipitation in the tanks designed for the septic process, in order to prepare the sewage adequately for rapid filtration through contact beds.

In the report of the Consulting Engineers of the State Sewerage Commission of 1901, this matter, as you know, was taken up with care, and it is still believed that the cost of treatment as therein outlined was fair and conservative, and that in the works herein projected, as well as in the estimates of costs, given below, there are many uncertain features involved which are of very serious moment in a project of this magnitude, and that it is to be clearly borne in mind, as above stated, that the benefit of all doubts is given to these disposal works as herein outlined.

In the following tables, marked II and III, estimates of cost are given for the construction and maintenance of purification works in accordance with the description at the head of each table. Thus, Table II relates to those of an average capacity of fifty million gallons daily which would be the first installation for Paterson alone, and located at the brickyard site east of the Dundee dam. Table III refers to the first installation of a plant located upon the Hackensack meadows at Cedar swamp for the entire upper district, and of an average capacity of seventy million gallons daily.

The various items of construction have been placed at low figures, as will be seen from the tables, and the same is true with regard to operating expenses. It is doubtful as to whether the amounts estimated for depreciation and repairs would prove adequate after the first few years of operation, and the same is true as to the cost of labor for attendance. The cost of sludge removal is also placed at a low figure, taken at one-third of the minimum cost of sludge disposal per million gallons of sewage in large English cities so situated that the sludge can be readily carried to sea. According to our figures on the relative amounts of sludge to be expected from the local works if built, as compared with that actually obtained from the English works in question, the estimates in the following tables are quite low, and on the basis that the local disposal of sludge could be carried on as economically as it could in those English cities where large vessels with deep draft can be loaded at the works and proceed to sea under most favorable conditions.

TABLE II.

SHOWING ESTIMATED COST OF SEPARATE SEWAGE PURIFICATION WORKS FOR PATERSON ALONE, WITH A PRESENT CAPACITY OF FIFTY MILLION GALLONS DAILY, AND LOCATED AT BRICKYARD, EAST OF DUNDEE DAM.

Branch sewer from line of trunk sewer to site,	\$100,000
Pumping station complete 40-foot lift with receiving basins and screening plant,	250,000
Settling and septic tanks, uncovered, 25 million gallons capacity, at \$4,000,	100,000
Contact beds, 6 feet deep, complete, 50 acres, at \$20,000,	1,000,000
Basins for storing and settling sludge and effluent after cleaning beds as required, 5 million gallons capacity, at \$4,000,	20,000
Effluent conduit from plant to river,	50,000
Effluent conduit from plant to river,	50,000
Sludge disposal outfit for transportation to deep sea,	300,000
	<u>\$1,820,000</u>
Add 10 per cent. for contingencies and supervision,	182,000
	<u>\$2,002,000</u>
Land,	150,000
Trunk sewer from Prospect street, Paterson, to Clifton avenue,	1,152,200
	<u>1,152,200</u>
Total,	\$3,304,200

ANNUAL COST OF ABOVE PROJECT.

Interest on investment, \$3,304,200, at 4 per cent.,	\$132,170
Depreciation and repairs,	40,000
Pumping charges at \$2 per million gallons,	36,400
Labor at purification works at \$1 per million gallons,	18,250
Sludge disposal at 75 cents per million gallons,	13,700
	<u>13,700</u>
	\$240,520

TABLE III.

SHOWING ESTIMATED COST OF SEWAGE PURIFICATION WORKS FOR THE ENTIRE UPPER SECTION OF THE DISTRICT, AND LOCATED ON THE HACKENSACK MEADOWS, WITH A PRESENT CAPACITY OF SEVENTY MILLION GALLONS DAILY.

Sewer from Passaic river to plant,	\$450,000
Pumping station, complete, 20 feet lift, with all screening requirements,	200,000
Settling and septic tanks, 35 million gallons, at \$4,000,	140,000
Contact beds, 70 acres, at \$20,000,	1,400,000
Tanks and conduits for disposal of effluent,	50,000
Sludge disposal outfit,	400,000
	<hr/>
	\$2,640,000
Add 10 per cent. for contingencies and superintendence,	264,000
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	\$2,904,000
Land,	225,000
Cost of trunk sewer from Prospect street, Paterson, to Lafayette avenue, Passaic, including Wallington branch,	1,769,500
	<hr/>
Total,	\$4,898,500

ANNUAL COST OF ABOVE PROJECT.

Interest on investment, \$4,898,500, at 4 per cent.,...	\$195,940
Depreciation and repairs,	52,800
Pumpage charges at \$1.50 per million gallons,	38,400
Labor and purification works at \$1 per million gallons,	25,600
Sludge disposal at 75 cents per million gallons,	19,200
	<hr/>
	\$331,940

C. CONCLUSIONS.

The foregoing discussion of the engineering questions in connection with the proposed purification of the Lower Passaic river shows that, of the two available projects, the final disposal of the sewage by immediate dilution in New York bay, is simpler, cheaper and more efficient in this district than the local projects requiring purification of the offensive matter.

The annual expense including interest for the project as defined, is estimated to be:

1st, For the disposal of the sewage of the entire district in New York bay,	\$544,500
2d, For the disposal of the sewage of Paterson alone with about one-fifth of the population of the entire district by purification works at the brickyard east of Dundee dam, ..	240,520
3d, For the disposal of the sewage of Paterson, Passaic and the upper section of the district with about three-tenths of the population of the entire district, by purification works on the Hackensack meadows,	331,940

Whatever system may be selected for apportioning the cost of the project, it is clear, whether comparing the respective populations, the amounts of sewage flow or ratable values, that either Paterson alone, or all of the towns of the upper section of the district would be subjected to a much smaller expense by sharing the cost of the common trunk sewer than by establishing independent sewage purification works for themselves alone.

It should not be omitted to call attention to the fact that the estimate of cost presented for the trunk sewer project by the State Sewerage Commission in 1901 and the one now presented are not for the same amount of work. The present estimate includes, besides all that was previously proposed, also about 96,000 feet of intercepting and collecting sewers within the city of Paterson on the west, and within most of the townships on the east side of the river, adding about \$1,350,000 to the State Sewerage Commission's estimate. During the last year prices have risen materially, of which account has been taken, and this explains the remaining difference between the two estimates. It should also be added that the capacities of the sewers have been somewhat increased.

In the light of the above comparisons of cost, the question of providing purification works for the upper section of this district, taken either separately or collectively, to say nothing of the possibilities of future troubles and uncertainties, may be safely said to be almost impracticable.

As to the question of purifying all the sewage of the district on the Newark meadows, as compared with discharging it into New York bay, it is obvious from the information above given that this would be still less economical than purification works for the upper section alone.

Based on the facts and comparisons above given, I recommend to you a trunk sewer for the joint disposal of the sewage of your entire district into New York bay as the most economical and satisfactory project for adoption.

In conclusion, I desire to express my thanks to your honorable commission for the ready assistance rendered in carrying out these investigations, and also to the several engineers in the district, Messrs. Owen, Adam, Wise, Watson and Ferguson, who are familiar with various portions of the projects and who have furnished me with valuable data.

Respectfully presented,
RUDOLPH HERING.

APPENDIX A.

POPULATIONS AND QUANTITIES OF SEWAGE, INCLUDING GROUND WATER, FOR WHICH PROVISION IS MADE.

City or Town.	Population 1900. (Whole Towns).	Population adopted for present study.	Flow of Sewage in Gallons.
Paterson,	105,200	260,000	74,200,000
Passaic,	27,800	130,000	34,700,000
Aquackanonck,	5,350	90,000	15,700,000
Franklin,	3,700	50,000	8,750,000
Belleville,	5,900	40,000	7,000,000
Garfield,	3,500	18,000	3,140,000
Lodi,	1,900	15,000	2,620,000
Hasbrouck Heights,	1,250	4,000	700,000
Woodbridge,	580	6,000	1,050,000
Wallington,	1,810	15,000	2,620,000
Carlstadt,	2,572	5,000	875,000
East Rutherford,	2,640	5,000	875,000
Rutherford,	4,400	20,000	3,500,000
Union township,	1,600	20,000	3,500,000
North Arlington,	300	10,000	1,750,000
Montclair,	13,960	50,000	8,750,000
Glen Ridge,	1,960	10,000	1,750,000
Bloomfield,	9,670	50,000	8,750,000
Orange,	24,100	60,000	10,500,000
East Orange,	21,500	70,000	12,200,000
Kearney,	10,900	60,000	12,000,000
East Newark,	2,500	4,000	900,000
Harrison,	10,600	50,000	10,000,000
Newark,	246,000	575,000	120,000,000
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	509,690	1,617,000	345,830,000

APPENDIX B.

LIST OF UNIT PRICES FOR THE ESTIMATE OF COST.

Concrete, per cubic yard,.....	\$6.50
Brickwork, per cubic yard,.....	15.00
Forms (large sewers), per lineal foot.....	4.00
Lumber, per M. B. M.,.....	40.00
Twisted steel bars (in place), per lb.,.....	0.05
Excavation, per cubic yard,.....	\$0.50 to 2.00
Handling water (in trench) per cubic yard of excavation,	0.00 to 0.50
Rock excavation per cubic yard in trench,..	2.00
Rock excavation per cubic yard in tunnel,..	4.00 to 7.00
Repaving streets, per square yard,.....	1.50
Regrading and resurfacing macadam roads, per mile,	10,000.00
Railroad crossings, each,	\$2,000 to 10,000.00
Sewer pipe, 24 inches, per lineal foot,.....	0.85
18 inches, per lineal foot,.....	0.45
12 inches, per lineal foot,.....	0.25
Cast iron pipe, per ton,.....	30.00
Cast iron specials, per ton,.....	60.00

AN ACT to relieve from pollution the rivers and streams within the Passaic valley sewerage district, established and defined by an act of the legislature entitled "An act to create a sewerage district, to be called the Passaic valley sewerage district," approved March twenty-seventh, one thousand nine hundred and two, and for this purpose establishing therefor a district board of commissioners, defining its powers and duties and providing for the appointment, terms of office, duties and compensation of such commissioners, and further providing for the raising, collecting and expenditure of the necessary moneys.

WHEREAS, The legislature of this state has created and defined a sewerage district, embracing a large number of municipalities and parts of municipalities in the counties of Passaic, Bergen, Hudson and Essex, under the name of the Passaic valley sewerage district; and

WHEREAS, The Passaic river and many streams flowing into it within said sewerage district are polluted by sewage and

other deleterious matter to the extent that the health of the people residing in said district is seriously endangered; and

WHEREAS, Immediate relief therefrom is imperative; and

WHEREAS, The governor of this state by sanction of the legislature has appointed five commissioners for said district with power, among other things, to investigate methods and plans for relieving the streams and rivers within said district from pollution, and for preventing the pollution of the same; and

WHEREAS, Said commissioners have adopted an effectual plan or method for relieving the streams and rivers within said district from pollution and for preventing the pollution of the same, and have reported said plan or method to the legislature; and

WHEREAS, In order to carry into effect such plan or method, with such modifications or additions thereto as shall hereafter be approved by said commissioners, it is necessary that further and greater power be given to said commissioners;

BE IT ENACTED *by the Senate and General Assembly of the State of New Jersey:*

1. The commissioners heretofore appointed by the governor of this state in and for the Passaic valley sewerage district shall continue in their respective offices for the terms for which they were severally appointed, and said terms are hereby extended to the first Tuesday of May succeeding the date when their terms under said appointments would respectively expire; and hereafter one commissioner shall be appointed by the governor in each year for a term of five years, beginning on the first Tuesday of May next following the date of his appointment; any vacancy in the office of commissioner by death, resignation or otherwise shall be filled by the governor, but for the unexpired term only; each of the said commissioners hereafter appointed, before he enters upon the duties of his office, shall take and subscribe an oath that he will faithfully and impartially execute and perform the duties imposed upon him by law, and cause the same to be filed in the office of the secretary of state of this state; the commissioners shall each receive for services under this act an annual salary of twenty-five hundred dollars, payable in equal monthly installments; the governor of this state shall have power to remove any commissioner from office for cause during his term of office, and upon removal to fill the vacancy thus occasioned for the unexpired term; in making appointments, either for full terms or to fill vacancies, regard shall be had by the governor both to ability and fitness, and also to locality, so that each section of the district may be represented as far as practicable.

2. The said commissioners shall, on the first Tuesday in May of each year, at the hour of two o'clock in the afternoon, organize by the choice of one of their members as chairman of the board, and they may elect a treasurer, who may or may not be a member of the board, and a clerk, who may or may not be a member of the board, and may also, from time to time, appoint such other officers, attorneys, agents, employes and servants, and such engineers and assistants as they may deem necessary to carry out the purposes of this act, and may prescribe the duties and fix the compensation of all officers, attorneys, agents, employes, servants, engineers and assistants; and all appointees of said commissioners may be removed at their pleasure; the organization of said board and the appointment of officers, agents, clerks, servants, engineers and assistants heretofore made by the said board shall have the same effect as if made under this act.

3. The said commissioners heretofore appointed and their successors in office are and shall continue to be a body politic and corporate, with perpetual succession under the name of "Passaic valley sewerage commissioners," with power to sue and to be sued, with power to adopt and use a corporate seal, and the right, power and authority to acquire, hold, use and dispose of all such property, real and personal, as may be proper or necessary, and with all other powers proper or necessary to carry out and effectuate the purposes for which said board is created.

4. The board of Passaic valley sewerage commissioners, incorporated as aforesaid, is hereby given full power and authority to make, construct, maintain and operate intercepting, main, trunk and outlet sewers, with the necessary pipes, conduits, pumping works and other appliances for the purpose of taking up within the said Passaic valley sewerage district sewage and other offensive and deleterious matter which would or might otherwise pollute the streams and rivers in said district and convey the same to some proper place or places of deposit, discharge or outfall in the New York bay, within the state of New Jersey, to be selected by the said sewerage commissioners, there to be discharged; and the said sewerage commissioners shall also have power to establish, when necessary, sewage disposal works and works for the treatment, disinfecting and disposal of sewage.

5. It shall be the duty of all persons, corporations and municipalities owning or controlling the sewers or drains within the limits of said sewerage district, which discharge directly or indirectly into the streams or rivers within the said sewerage district any sewage or deleterious matter, to cause the same to be connected with an to be discharged into the sewers constructed by

the said sewerage commissioners when the same shall have been constructed, and at the places which shall have been designated for that purpose by the said sewerage commissioners; all sewers and drains hereafter constructed by any person, corporation or municipality within the said sewerage district conveying or discharging sewage or other deleterious matter, which might otherwise discharge into or be discharged into the streams or rivers within the said sewerage district, directly or indirectly, shall be so constructed that the outfall or discharge therefrom shall be delivered into the drains or sewers provided by the said sewerage commissioners at the points and places designated by the said commissioners; and it shall be the duty of the said sewerage commissioners, in constructing said intercepting or main sewers, to have them so constructed that connection therewith can be made at necessary or proper points, and all such connection therewith can be made at necessary or proper points, and all such connections shall be made in accordance with the rules and regulations from time to time adopted by the said sewerage commissioners in relation thereto, and under the direction and supervision of their officers and agents, and all such connections shall be the property of such sewerage commissioners; the main intercepting or trunk sewer to be constructed by the said sewerage-commissioners shall commence at or near the valley of the rocks in the city of Paterson, and shall extend to the point of discharge or outfall in the New York bay, within the limits of the state of New Jersey.

6. The said sewerage commissioners shall have power and authority to purchase and acquire lands and rights or interests in lands within and without the said sewerage district which may be deemed necessary for the construction of sewers, drains, disposal, pumping or other works authorized by this act; and if in any case the said sewerage commissioners shall be unable to agree with the owner or owners of any land or rights or interests in lands deemed necessary by said sewerage commissioners in the construction and prosecution of the work hereby authorized, or when by reason of legal incapacity or absence of such owner or owners no agreement can be made for the purchase thereof, the lands or rights or interests in lands so deemed necessary for the purposes of this act shall be acquired by condemnation by the said sewerage commissioners in the manner provided by the general laws of this state relating to the condemnation of lands for public uses; *provided*, that no private property shall be taken for the purposes of this act without compensation therefor shall have first been made or tendered to the owner or owners thereof,

or in lieu thereof paid to the clerk of the county in which the lands taken are located, for the use of the person or persons entitled to receive the same; and in case such payment or tender to the owner or owners, or payment into court, is made by the said sewerage commissioners upon the award of commissioners, the said sewerage commissioners shall be entitled to take immediate possession of the property so condemned notwithstanding any appeal; and the acceptance by the owner or owners of the lands or rights so condemned of any award of commissioners shall not interfere with or prevent the taking of any appeal provided by law.

7. The said board of sewerage commissioners shall have power to construct any sewer or drain by it to be made or constructed under or over any water course, under or over or across or along any street, turnpike, railway, canal, highway or other way, and in or upon private or public lands, and in or upon lands of this state and under waters of this state, in such manner, however, as not unnecessarily to obstruct or impede travel or navigation, and may enter upon and dig up any street, road, highway or private or public lands either within or without the said sewerage district for the purpose of constructing or laying sewers or drains upon or beneath the surface thereof, and for maintaining and operating the same, and in general may do all other acts or things necessary, convenient and proper to carry out the purposes of this act; and the said board of sewerage commissioners shall have power for the purpose of carrying such sewage or other matter to the place of deposit or discharge in New York bay, to construct sewers and other works within territory outside of the said sewerage district, and with its sewers, pipes and drains to pass through or partly through the territory of municipalities outside of said sewerage district; and whenever the said board shall dig up any road, street or highway as aforesaid, it shall, as far as possible, restore the same to as good condition and order as the same was when such digging commenced; *provided, however,* that when such streets, roads or highways lie outside of such sewerage district the laying down of sewers or drains under or across said streets, roads or highways shall be subject to such police regulations of the governing bodies of such municipalities as are applicable and enforceable in the construction of sewers or drains for such municipality.

8. The said sewerage commissioners shall have power and authority to alter or change the course or direction of any water-course, and with the consent of the township committee of any township, and of the board or body having control of the streets

or highways in any city, town or other municipality, to alter or change the grade or location of any highway, public street or way crossed by any sewer or drain to be constructed under the provisions of this act.

9. The said board of sewerage commissioners may, by its officers, agents, servants and employees, enter at all times upon any lands or waters within or without the said sewerage district for the purpose of exploring, surveying, leveling and laying out the route of any drain or sewer, locating any disposal, pumping or other works, establishing grades and doing all necessary preliminary work; doing, however, no unnecessary damage or injury to private property.

10. The said board of sewerage commissioners shall at all times keep full and accurate accounts of its receipts, expenditures, disbursements and liabilities, and shall annually cause a detailed statement thereof to be published and a copy thereof mailed to the secretary of state of this state and to the clerk of each of the municipalities in the district; the fiscal year of said sewerage commissioners shall end on the first Tuesday of May in each year, and said report so to be published shall be a report for the previous fiscal year and shall be made as soon after the end of each fiscal year as conveniently may be.

11. To provide for the payment of costs and expenses incurred or to be incurred by the said sewerage commissioners for the purchase of lands, rights or interests in lands, or other property or rights, and in the construction of disposal works, pumping stations, sewers, drains and all other works by them to be constructed, and for engineering, administrative and other expenses connected therewith, including interest during construction, said board of sewerage commissioners shall have power from time to time to issue its corporate bonds in an amount not to exceed

dollars, and not to exceed the total estimated cost and expenses of the whole work; such bonds shall be in the form and payable at a time not exceeding fifty years from the date thereof, and at such places and either in currency or coin as the said sewerage commissioners may determine; such bonds shall bear interest at a rate not exceeding four per centum per annum, payable semi-annually; all such bonds shall be signed by the chairman of the said board of sewerage commissioners and countersigned by the treasurer, and shall be sealed by its corporate seal, attested by the clerk; in issuing such bonds the board of sewerage commissioners may in its discretion make the same or any part thereof fall due at stated periods less than fifty years from the date of issue, and may reserve in said

bonds an option to redeem or pay the same or any part thereof at stated periods at any time between the date thereof and the date at which they would otherwise fall due; the said bonds may be either coupon or registered bonds, or partly coupon and partly registered bonds, and all such bonds may be negotiated, sold and disposed of at not less than their par value, and the same or the proceeds thereof may be used by the said sewerage commissioners for the purposes aforesaid; the said board of sewerage commissioners shall keep the cost and expenses of the construction of its plant—in which shall be included the cost of lands, rights or interests in lands, and the cost of all other property and rights, and the cost of construction of all works, including engineering expenses, administrative expenses and legal expenses, and including interest during the course of construction—separate from the cost and expenses of maintenance, operation and repairs.

12. The said board of sewerage commissioners may in anticipation of the issuing of bonds, and from time to time as it may need money, borrow such sum or sums of money, not exceeding at any one time one-fifth of the estimated cost of the whole work, and may issue its certificates of indebtedness, promissory notes or other obligations therefor, retiring the same from time to time as the bonds hereinbefore authorized to be issued are sold; in order that the said bonds issued for the purchase of land, rights in land, and for the construction of the works, plant and extensions, betterments and improvements thereof may be paid and retired at maturity, the sewerage commissioners shall provide a proper and suitable sinking fund, not exceeding in amount to be raised in any one year one per centum of the face value of the bonds issued, which sum shall be raised annually, beginning with the third year after the issuing of said bonds, at the time and in the manner herein provided for the raising of the moneys necessary to pay the interest on said bonds; the money so raised for sinking fund purposes shall be kept in a separate account by the treasurer of the board of sewerage commissioners, and shall under its direction be used or invested from time to time in the purchase or retirement of its own bonds, or in the purchase of securities in which savings banks and savings institutions of this state are authorized to invest.

13. All indebtedness of the said board of sewerage commissioners incurred for the purchase of lands, rights or interests in land or other property, and in the construction of its works or plant, or otherwise lawfully incurred, pursuant to the provisions of this act, whether such indebtedness is represented by bonds, certificates of indebtedness, promissory notes or other form of

indebtedness, with interest accrued or to accrue thereon, shall be a charge upon all persons and property in the municipal taxing districts lying in whole or in part within said sewerage district as fully as the legislature of this state shall have power to authorize the same, and full faith and credit of said municipalities and taxing districts shall in like manner be pledged to the payment of the same; and all bonds, certificates of indebtedness, promissory notes and other obligations issued by the said board of sewerage commissioners shall be free from all state, county, municipal and other taxes, and the property, real and personal, of the said board of sewerage commissioners, held by it under the authority of this act, wherever situated, shall in like manner be free from taxation.

14. The said sewerage commissioners shall on or before the fifteenth day of June in each year ascertain and determine the amount of money necessary to be raised for the payment of interest upon bonds and other indebtedness, and for sinking fund charges for the current fiscal year, and shall apportion the same among the respective municipalities and taxing districts lying in whole or in part within said sewerage district, in such proportion as the taxable ratables within so much of said municipality or taxing district as is embraced within said sewerage district bears to the total amount of taxable ratables within the whole of said sewerage district, as returned and certified by the respective taxing boards and taxing officers of the said municipalities or taxing districts for the preceding year; and it shall be the duty of each assessor, taxing board or taxing officer for the several municipalities and taxing districts lying in whole or in part within said sewerage district for this purpose to examine, compute, determine and certify to the said sewerage board annually and by the first day of April of each year the amount of taxable property or ratables assessed in the last preceding year to or upon persons and property within so much of the several municipalities and taxing districts as lie within the said sewerage district, and the books of each of the said assessors, taxing boards and taxing officers shall at all times be open for examination by the board of sewerage commissioners, its officers and agents, for the purpose of examining, checking, and if necessary, correcting said certificates.

15. The said board of sewerage commissioners shall on or before the fifteenth day of June in each year ascertain and determine as near as may be the amount of money necessary to be raised for operating, maintaining and repairing its works and plant for the current fiscal year, and shall apportion the money

so estimated to be necessary among the several municipalities or taxing districts lying in whole or in part within said sewerage district, according to the amount of sewage by them respectively delivered to or discharged into any sewers or other receptacles provided or constructed by the said sewerage commissioners for the reception thereof; before such apportionment is finally made and adopted by the sewerage commissioners for any year and on the fourth Tuesday of May, at two o'clock in the afternoon, the said sewerage commission shall sit at its principal office for the purpose of hearing such municipalities as desire to be heard upon the apportionment of the estimated amount of money required for the operation, maintenance and repair of said works and plant, but the apportionment when made by the said sewerage commissioners shall be final and conclusive; in case, however, the estimate of moneys necessary to be raised in any year for operating, maintaining and repairing the works and plant of the sewerage commissioners, shall, at the end of the year, be found to have been too low, the deficiency shall be made good by adding the same to the estimated amount required for operating, maintaining and repairing the said works for the next succeeding year; and if said estimate shall be found to have been excessive, then such excess shall be deducted from the estimate for the next succeeding year.

16. The said board of sewerage commissioners shall on or before the twentieth day of June in each year, order and cause a tax to be levied and assessed upon all persons and property within each of the municipal and taxing districts lying in whole or in part within said sewerage district for the purpose of raising the money necessary to pay interest upon its bonds and other indebtedness and necessary sinking fund charges, and for the sum of sums of money estimated as necessary to provide for the proper maintenance and operation of its works and plant, and for all the other expenses of the said sewerage commissioners, and to this end, it shall, on or before the twentieth day of June in each year, certify to the tax assessor, taxing board or taxing officer of each of said municipalities or taxing districts lying in whole or in part within said sewerage district the amount of tax required to be levied, assessed and raised in each of their respective municipalities and taxing districts for said purposes; and the said assessors, taxing boards and taxing officers shall assess said sums so directed to be assessed (and certified to them) upon all the persons and property within their respective municipalities or taxing districts; liable to be assessed for state or county taxes, and the said tax shall be levied, assessed and collected

by the same officers, at the same time and in the same manner and with the same effect as state or county taxes are required to be levied, assessed and collected within said municipalities or taxing districts; and the taxes so levied upon real estate in said municipalities and taxing districts shall be and remain a first and paramount lien thereon until paid.

17. Out of the first moneys collected in any year in any municipality or taxing district, and not required by law to be paid to the county collector for state or county purposes, it shall be the duty of the disbursing officer or officers of such municipality or taxing district to pay to the treasurer of the sewerage commissioners the sum or sums of money directed by said sewerage commissioners to be assessed, levied and collected in such municipality or taxing district.

18. The said board of sewerage commissioners may from time to time in anticipation of the collection of moneys directed by it to be assessed, levied and collected within the municipalities or taxing districts lying in whole or in part within its sewerage district, borrow such sum or sums of money as may be necessary for the payment of interest upon bonds or other indebtedness, and for the payment of sinking fund charges and for the payment of its officers, agents, employees, and for all other necessary or proper expenses in maintaining and operating its works and plant, and the payment of the moneys so borrowed shall be secured by a lien upon said taxes as levied and assessed or so directed to be levied and assessed, and said taxes when collected shall be applied to the payment of the moneys so borrowed.

19. If, in any case, the streams and rivers within said sewerage district are or may be polluted by sewage or other deleterious matter discharged therein directly or indirectly from any municipality or any part of a municipality lying without the said sewerage district, it shall and may be lawful for the said board of commissioners to enter into contract with such municipality for the disposal of all such sewage and deleterious matter, and every such municipality is hereby authorized to enter into such contract with the said board, and the said board may, in the constructions made by it under the authority of this act, make provision for such disposal; such contracts may be made upon such terms and for such lengths of time and for such annual or semi-annual payments as shall be mutually agreed upon, and the municipalities and taxing districts so contracting shall have the power to raise annually by taxation the moneys necessary to make the payments required to be made under such contracts, or to use for this purpose any moneys not otherwise appro-

riated; and the moneys received by the said commissioners under such contracts shall be applied by them as follows: two-thirds thereof to the payment of interest upon bonds issued by the said board, and one-third thereof to the payment of the expenses of operation, maintenance and repair of work.

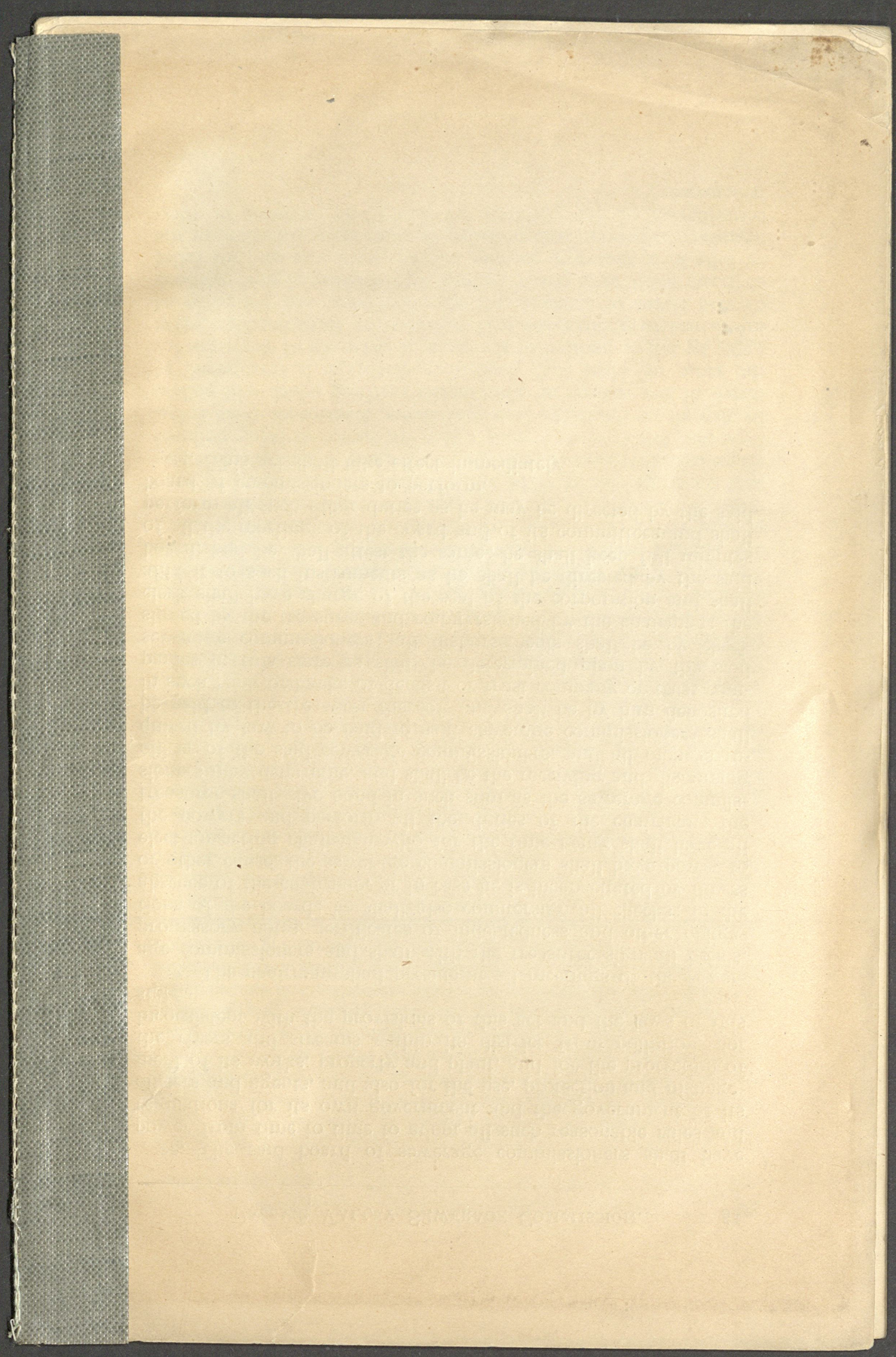
20. In case the legislature of the state of New Jersey shall for the purpose of paying its fair and equitable proportion of the cost of the construction, or of the operation and maintenance of the said works, or for relieving from pollution the lands of the state under the Passaic river, and the riparian rights thereon still owned by the state, appropriate yearly or in any year to the Passaic Valley sewage commissioners any sum or sums of money, the same shall be used for such purpose as shall be designated in the act or acts appropriating said money; and in case no such designation is made in said acts the same shall be used and applied by the said sewerage commissioners at their discretion to reduce the amount otherwise necessary to be raised by taxation for the maintenance of the said work and the payment of the interest and sinking fund charges upon bonds theretofore issued by the sewerage commissioners.

21. The said sewerage commissioners shall have within said sewerage district powers exclusive of all other boards to protect the rivers and streams thereof from pollution and to prevent the pollution of the same, and to this end the said sewerage commissioners may prohibit the deposit or discharge into the rivers or streams within said sewerage district of any sewage or other matter or thing which may pollute the same; they may also in like manner prohibit or prevent the emptying into any tributary of said rivers or streams any sewage or other matter or thing which will directly or indirectly cause the rivers or streams within said sewerage district to be polluted; and the said board of sewerage commissioners may at any time when it has reason to believe that any river or stream within its district is being polluted by deposit or discharge into said rivers, streams or their tributaries, of any sewage or other matter or thing which will pollute the same, or when such deposit or discharge is threatened, to apply by bill or petition to the court of chancery of this state for injunction to prevent the said pollution or threatened pollution of said rivers or streams or their tributaries, and the court of chancery shall have power to hear and dispose of said petitions or bills in a summary manner and to grant any and all relief necessary to prevent said pollution or threatened pollution, or the continuation of any pollution of said rivers, streams or their tributaries.

22. The said board of sewerage commissioners shall have power from time to time to adopt all such reasonable rules and regulations for its own government and the government of its officers and agents, and also for the use, protection and management of its works, property and plant, and for the protection of the rivers and streams within its district from pollution, not inconsistent with the provisions of this act and the laws of this state.

23. The chairman shall preside at all meetings of the sewerage commissioners and shall with the treasurer sign all bonds, promissory notes, certificates of indebtedness and other obligations of the board; he shall also countersign all checks; in the absence of the chairman, or in case he is incapacitated by illness or other cause, the sewerage commissioners shall have power to elect an acting chairman who for the time being shall have all the powers and perform all the duties of the chairman; the treasurer shall give bond in such sum as the sewerage commissioners may determine, and shall be the receiving and disbursing officer of the said sewerage commissioners, and all moneys required by law to be paid to said sewerage commissioners shall be paid to the treasurer thereof, and shall be by him deposited in such bank or banks of deposit or trust company or trust companies in this state as shall be determined upon by the said sewerage commissioners; all disbursements shall be by check signed by the treasurer and countersigned by the chairman; the clerk shall have charge of the seal of the corporation and shall affix it to such instruments as he shall be directed by the said board, and he shall attest the same; he shall keep full minutes of all the meetings of the board and of its committees and shall perform all such other duties as he may be directed by the said board of commissioners to perform.

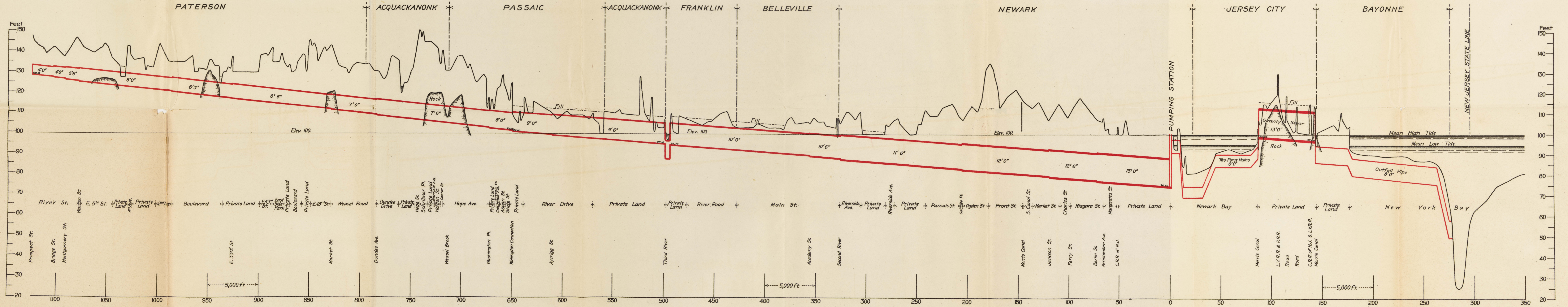
24. This act shall take effect immediately.



PASSAIC VALLEY DISTRICT
SEWERAGE AND DRAINAGE COMMISSION
PROFILE OF
MAIN TRUNK SEWER
AND
OUTFALL INTO NEW YORK BAY

Dec. 1902

Rudolph Herwig Chief Eng.



SEWAGE DISPOSAL PLAN
FOR
LOWER PASSAIC VALLEY.

RECOMMENDED BY THE
PASSAIC VALLEY DISTRICT SEWERAGE AND DRAINAGE COMMISSIONERS

Rudolph Hering, Engineer.

- Heavy black line shows boundary of district
- Heavy red line shows location of main trunk sewer
- - - Broken red lines show pipes under water
- Small red lines show auxiliary collecting gravity sewers
- Green lines show low level auxiliary sewers

