REPORT

OF THE

STATE SEWERAGE COMMISSION

TO THE

Legislature, Session of 1903.

TRENTON, N. J.:
THE JOHN L. MURPHY PUBLISHING CO., PRINTERS.
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REPORT.

To the Legislature:

The State Sewerage Commission herewith presents its annual report, covering operations for the year ending October 31st, 1902. The report of the Treasurer appended includes expenses which were incurred in the previous fiscal year, for part of the engineering investigation of the Passaic river pollution, bills for which were not rendered until after the expiration of the fiscal year. The Commission has kept well within the amount appropriated, as heretofore.

It is highly desirable that the system of inspection should be more complete, and for this purpose the amounts heretofore appropriated may prove sufficient, if the Passaic river case is in charge of another commission, as at present.

The appointment of Hon. John Hinchliffe, a member of this Commission, to serve on the Passaic River District Commission, made the selection of a new Treasurer necessary, and Dr. D. L. Wallace was chosen to succeed him. Commissioner Hinchliffe did not qualify for his new term in this Board, and consequently there has been a vacancy in the Commission since the 7th day of May.

The Secretary's report, which accompanies this report, gives the transactions of the Commission in detail.

THE COMMISSION'S WORK.

The work of the Commission during the last year has covered a wide territory and a large variety of subjects appertaining to sewerage and water-supply. The general plan of the State in creating this Commission has been proven beneficial. The necessity of State supervision of the sewerage of municipalities is amply

demonstrated. It is obvious that a drainage system must follow physical lines; the fall of the land and considerations which define the boundaries of towns where the population is crowded, rarely include drainage. It is almost inevitable that the discharge of sewage must be into the territory of another town, and there instantly arises a conflict of interests which only State authority can regulate. To do justice to both is a task which requires delicacy and knowledge, and in such a State as New Jersey, with crowded population, the difficulties are greatly increased. Although the ocean offers means of disposal for the greater communities, its estuaries and tidal streams offer new obstacles to complete disposal, since the sewage is returned to the point of discharge with recurrent tides.

To adopt a general system of sewerage which would offer equal advantage to all communities might be feasible, but established systems forbid changes, and financial considerations frequently prevent the local governments from adopting systems which would prove to their ultimate benefit.

WATER-SUPPLY AND SEWERAGE.

The relations of water-supply to sewerage are intimate and complex. It is a fair general rule that the introduction of a system of water-supply should be accompanied, or closely followed by, a system of sewerage. The vast increase in the use of water, resulting from a public supply, makes ineffective the ordinary means of house disposal by cesspools. To provide a perpetual spring for every household requires a permanent and adequate outlet. Suburban communities which prevail throughout New Jersey, demand facilities which are found in cities, yet there is neither the taxable valuation upon which to assess the cost of improvements, nor the unused territory to make cheap disposal of sewage practicable. Experience in Europe and in this country affords little instruction, for each problem differs in itself, and New Jersey is unique in many of its natural conditions and public requirements.

PROTECTION OF WATER-SUPPLIES.

This Commission has been called upon frequently to protect the water-supplies of towns from the sewage-discharge of adjacent communities, and the task is one of great difficulty. While it is impossible to establish a general principle which will meet all cases, it may be said that there is no practicable means of perfectly protecting a water-supply which is drawn from streams flowing through a thickly-populated territory. If such a stream can be kept clean in appearance, free from offense to sight and smell, nearly all that modern sanitation can hope to effect is accomplished. Even without any direct discharge of sewage into the stream, the inevitable accidents of pollution in a crowded community will so contaminate the stream as to make it unfit for drinking water. The question, as will be seen, has two branches, and while this Commission will enforce the law for the preservation of streams from pollution, it is compelled to advise some municipalities to seek new and safer sources of water-supply, to secure immunity from disease.

The close relation of the problems of introducing pure water and caring for it when it has been contaminated by household use is obvious, and suggests an extension of the Commission's control over water-supplies.

PROTECTION OF FISHERIES.

Similar to the matter of water-supply and sewerage are the relations of sewage to oyster beds, clam beds and fisheries. Their protection is necessary, yet there must be a limit placed upon such protection, where the necessities of large communities for relief from sewage are greater than the interests of these important industries.

SAFETY OF SUMMER RESORTS.

A large interest in New Jersey is that of the summer resort, often dependent for its attractions upon the water facilities. To permit a lake, stream or the ocean itself to become so befouled with sewage that, instead of being an attraction to summer dwellers, it becomes a nuisance, is a wrong which should not be tolerated. The systems of sewerage along the coast are not infrequently subject to severe criticism, the discharge from the resort towns threatening to destroy the very features which made them attractive and caused their growth. Compulsory measures by the State to require sewerage are distasteful, yet it has been the experience of this Commission that upon proper representation, the individual and the community consent to remedial measures where wrong-doing is clearly shown. Indeed, the public support for the measures adopted has been altogether most gratifying.

The whole subject is one of the greatest sanitary importance, and touches so many different sides—medical, engineering, financial and public policy—that the necessity of liberally maintaining a Commission charged with this great branch of public work is obvious.

THE PASSAIC RIVER.

The Legislature at its last session provided for the appointment of a District Sewerage Commission, to take special charge of the measures for the relief of the Passaic river from pollution. The District Commission was duly appointed and organized with Hon. Julius A. Lebkuecher, of Newark, as Chairman, and John S. Gibson as Secretary, and established offices in Newark. An appropriation of $25,000 from the State funds and authority to raise a further sum of $25,000 by assessment upon the towns affected, provided means for the prosecution of the District Commission's work. The State Commission met with the members of the District Commission, and held an extended conference with that body. Important reports, surveys, maps and other material bearing upon the Passaic river problem were turned over to the

District Commission, and the facilities of the State Commission were placed at its disposal. Unfortunately, the power of the District Commission was limited to further inquiry, and no definite or final action could be taken. The report of the District Commission will be presented to the Legislature and will set forth the conclusions reached. While the State Commission, by the act creating the District Commission, is relieved of further consideration of this great problem of the Passaic, it is deemed part of this Commission's duty to call attention again to the need of early and decisive action. The conditions are steadily growing worse, despite temporary relief from unusual rainfalls, and the nuisance from the pollution causes incessant complaint from property-owners. The investigation, which began in 1896 and has been continued with occasional intervals ever since, culminating in a final report upon the whole subject by this Commission a year ago, has shown clearly that adequate remedies are practicable, that the cost is well ascertained and not excessive, and that no insurmountable difficulties in engineering or in legislation exist. There appears to be willingness on the part of most of the communities to bear the necessary expense. It has been proposed to have the State bear some share of this cost, in which case some supervision of plans and expenditures by State authority would seem desirable.

The State Commission renews its urgent recommendation for final action for the relief of the Passaic. Under the authority of Chapter 72, P. L. of 1900, this Commission served notice upon the municipalities now sewering into the Passaic river to cease polluting prior to June 1st, 1904, withholding notices to manufacturers until the action of the municipality should be foreshadowed. Should the next Legislature fail to confer authority upon the District Commission to proceed with the execution of some plan, Section 10, Chapter 49, P. L. of 1902, should be repealed, so that this Commission should proceed with the work of restraining pollutors other than municipal. The wisdom of the precedent of exempting individual cases from the supervision required under the general law may be questioned.

DRAINAGE AREAS VS. POLITICAL BOUNDARIES.

In defining the boundaries of the Passaic river district, the Legislature followed the drainage district, also as far as practicable heeding the political boundaries. This is in accordance with the recommendations of this Commission, and should be maintained as a general policy of the State. The feasibility of making the drainage district also the taxing district for purposes of sewerage work, needs some further practical demonstration, but it is believed it will operate successfully. The courts have repeatedly declared in favor of such natural divisions in assessments for taxes, and it would certainly appear to be the normal method of reaching justice, that the person benefited should pay the cost. While this means practically the creation of another form of municipal government, its operation is so simple and direct that no legitimate obstacle to its adoption appears.

Attempts to evade this natural method are likely to be made, to meet special needs, or save expense, or to evade the requirements of a more effective system, but the rule should be maintained wherever practicable, and the effect will assuredly be advantageous in the end.

THE SUBURBAN JOINT SEWER.

Somewhat different from the plan in partial operation for the Passaic river district is the work of the Joint Sewer Commission, by which sewerage is being provided for several suburban towns, including West Orange, South Orange, Millburn, a part of Newark and Irvington, Essex county, and Summit, in Union county. These communities were able to reach a common agreement for local sewerage and for an outlet sewer extending through Essex and Union counties, to discharge in Arthur Kill. Their plans were approved by the State Board, but the details are in the hands of a joint committee, appointed by the several cities and towns concerned. The district is, however, established with general regard to the natural drainage, covering the streams tributary to the Rahway river as far south as Millburn and Irvington. Instead of assessing the total cost of the work upon the property

benefited after its cost is ascertained, the expense has been apportioned among the several municipalities, according to the discharge of sewage expected from each. While this may cause some embarrassment in the future, it will probably not be of a serious nature. The work is already well advanced, and it is being hastened to completion.

SEWAGE CAPACITY OF ARTHUR KILL.

It is the opinion of this Commission that when this work is completed and with such additions as will come from the natural drainage district, the capacity of Arthur Kill for absorbing crude sewage will have reached its limit, and no increase in the quantity should be permitted. The interests of Elizabeth, Perth Amboy, and the adjacent towns, as well as the free navigation of the Kill and the sanitary conditions of its shores, all forbid it. The State Commission has not power under the present law to limit the discharge into waters between States—an unfortunate limitation which should be removed.

MORRISTOWN TRUNK SEWER PROPOSITION.

This subject is now before the public for consideration, by reason of the proposition before the Joint Sewer Board of the Rahway district, to add the city of Morristown and the borough of Madison to the communities contributing to the joint sewer. Accompanying this report are statements of the intentions and wishes of the Morristown authorities, who were authorized at the last session of the Legislature to consider the subject of sewerage.

To join the joint sewer, it would be necessary for Morristown and Madison to construct a sewer through Chatham to Summit, with a tunnel through Second Mountain. Such a work would involve a very heavy expense. Should the Joint Sewer Commission be willing to grant permission to these municipalities to join in the outlet, and should the cost be not prohibitive, and should further obstacles be removed, it would still appear extremely unwise to add so largely to the quantity of sewage discharged into

Arthur Kill. Such discharge would also be in clear violation of the principle set forth above as the only practicable means of conducting sewerage enterprise, viz., it would take the sewage of one drainage district and discharge it into another, to the injury of the latter.

Nor is there any sufficient reason why such a course should be taken. There is adequate means of caring for the sewage of both Morristown and Madison within their own immediate vicinity, and at a reasonable cost. The purification of the sewage would be necessary, to protect the streams of the Upper Passaic, but this could be accomplished by properly constructed disposal plants. The borough of Madison has, indeed, taken action in this direction, but has been delayed, pending a decision as to the project of entering the joint sewer. It seems probable that all of the work of both the district of the Upper Rahway and of Morris county may be seriously delayed, if this unfortunate project be not abandoned.

THE RAHWAY RIVER POLLUTION.

While the joint sewer referred to above should relieve the Rahway river of much pollution, there are several sources of injury to the river which will not be reached, and which have occupied a considerable share of the Commission's attention during the last year. The Rahway river in its upper reaches is split into a number of small brooks, and each of these contributes some pollution to the stream. Complaint was made by the city of Rahway, which draws its water supply from the river, and by citizens of Cranford, who use it for pleasure purposes, and by business interests along the river. This stream appears to come under the head of those referred to above, as being objectionable as sources of water-supply by reason of the crowded population above the point of intake, and it will be a matter of extreme difficulty to keep this stream sufficiently pure to warrant the use of the water for domestic purposes. Much of the pollution, however, is clearly of a character to warrant interference, regardless of the use of the water by Rahway, and the Commission has taken decisive measures to secure improvement. A number of inspections were made and several hearings given at the

Commission's offices, to citizens and the Rahway authorities and to the mill-owners. An investigation by the Commission developed that a grave offense by pollution came from a sewer in Orange. While the greater part of the sewage of Orange enters a joint sewer, which is discharged into the Passaic river, one or more of the hat shops discharge into an old city sewer which enters a brook forming one of the tributaries of the Rahway. As the sewage of a large part of the same district of Orange is pumped over the divide near this point, the exception in this case seemed without reason, and so far as could be learned appeared to be due to municipal neglect rather than deliberate intent. Formal notification was served upon the city, calling attention to the wrong, but no response having been received, an order was issued directing the city to remove the nuisance. Action was then promised, but has been delayed, and should remedy not be applied, legal measures will proceed forthwith. The refuse of the hat shops is especially offensive to the eye, and as the brook which is polluted extends through South Orange and Maplewood before it joins the main stream, its condition is a nuisance to a thickly-populated district.

In this, as in other cases, the disposition of private owners to comply with the reasonable requirements of the Commission was more prompt and willing than that of the municipalities.

PLAINFIELD ANALYSES.

The extensive improvements effected at the instance of this Commission in the sewage disposal works at Plainfield, at heavy cost to the city, have been successful in operation. The Commission caused chemical and bacteriological examinations to be made, which show remarkable efficiency for the septic tank and single-contact beds installed. Eighty-seven per cent. of the bacteria were removed and the putrescible matter completely disappeared. There seems no reason why, with proper care, this system should not continue to operate with success. The results obtained confirm the experience in other places that, with a septic tank and single contact beds, properly constructed and operated, an effluent may be obtained which will be free from objection, if discharged into a stream of moderately-abundant

flow. The use of the water of the stream for potable purposes cannot, however, be permitted with safety. Sand filtration might achieve this, but the use for drinking purposes of water once contaminated should be permitted only with great caution and reserve.

NOT UNDULY EXPENSIVE.

The cost of a plant of the kind which has proved effective at Plainfield need not be prohibitory. The cost of the Plainfield plant was $38,755.59, to which ten per cent. may be added for engineering, &c. This purifies about 650,000 gallons of sewage each day (separate system), that being the discharge from 1,575 house connections. The cost of operation appears to be slightly more than $100 a month, although this figure might be increased, to remove sludge. The city owned the land upon which the works were constructed, and the sewers had been previously constructed to the works.

As a fair example of what may be done for a city of Plainfield's size, the case is illustrative. To attempt to apply it to communities of greater size, with far heavier flow of sewage, with intercepting sewers to be built and land for disposal works to be purchased, might make the cost so high that other measures would have to be adopted.

It is also true that had Plainfield originally provided more land for its works, at a greater distance from population, it would have been able to economize somewhat in its methods, and escape some opposition from other communities. The failure to provide adequate space for the development of disposal plants is a common error, which sometimes proves disastrous and always costly in the end.

RED BANK.

A disposal plant similar to that at Plainfield was installed at Red Bank, under the direction of the Commission, and has been in successful operation since June, 1902. A grit basin, to intercept the heavy matter before it enters the small septic tank, has proved efficient. With this work, and the installation of private disposal beds along the river, the pollution of the Shrewsbury river,

which threatened to seriously injure the fame of the region as a summer resort, has been checked, and with proper supervision continued, there will be no further difficulty, it is hoped. The necessity of sewerage regulations on the long branch of the river, extending south to the borough of North Long Branch, has been brought to the Commission's attention, and measures to require either a public system for Seabright, Monmouth Beach and North Long Branch, or else rigorous house to house inspection, are evidently necessary.

The summer resort problem is one of the most serious which confronts this Commission. The crowding of population for three months in a year may entail an expense which would prove a serious burden, yet a laxity in health regulations may prove the quick ruin of a prosperous resort. There is an indisposition to agitate these matters, for fear of arousing public prejudice, and the Commission is compelled in these cases to proceed of its own motion, without the support of a public demand.

LONG BRANCH WATER.

The attention of the Commission has been called to the failure of the Long Branch Water Company to protect its supply from the surface wash at Hollywood and Elberon. The company should place its reservoirs at a greater distance from the thickly-settled part of the shore community, and should have adequate filtration for all of its supply in the months of heaviest draft.

WANAQUE RIVER.

Measures have been taken to remove the acid from the discharge from the powder works on the Wanaque river, and the use of limestone beds appears to be effective and worthy of recommendation.

BORDENTOWN.

A member of the Commission investigated a complaint made by the Bordentown Reservoir and Water Company that the water supply of the city of Bordentown was being polluted by the city and by private parties. It was found that a private sewer, built under authority from the city, was discharging into Thorntown creek, a tributary of Crosswicks creek, from which the water-supply is taken. The outlet of the Delaware and Raritan canal, the water of which is more or less contaminated by drainage from the city of Trenton, is near the intake, and it is also probable that sewage from Trenton reaches the intake through the tidal flow from the Delaware river. These conditions indicate that the more efficient remedy would be an extension of the intake to a point above these sources of pollution.

It was found by the Commission that negotiations were pending between the water company and the city of Bordentown for the purchase of the water works, and the city also had under consideration the building of new works. Upon the assurance of the city government that prompt measures would be taken to bring the matter to a final settlement, it was deemed unwise for the Commission to take any action while the negotiations were pending.

RIDGEWOOD.

The authorities of the Village of Ridgewood have suggested that the Commission should adopt a standard of purity to be required for the streams of the State, to guide the construction of sewage disposal works. The Commission has not found it practicable to adopt any arbitrary standard, but considers each case according to its special requirements. In all these matters it is necessary to proceed slowly and with regard to the conditions prevailing in each community. To make severe requirements may prevent sewerage improvements which are of great importance, and the Commission has sought to serve the good of the greatest number.

OTHER WORK.

The Commission refers your honorable body to its Secretary's report for other details of its work during the year. The number of inquiries, applications for advice in special cases, and instructions appears to increase, and as the system of the Commission's operations is made more perfect, it is practicable to give better satisfaction to those who make use of its facilities, as well as to meet the public demands more efficiently.

THE ROYAL COMMISSION.

Reference has been made in previous reports to the work of the Royal Commission of Great Britain, appointed in 1898, to "inquire and report what methods of treating and disposing of sewage (including any liquid from any factory or manufacturing process) may properly be adopted." The first report was published a year ago and gave some general conclusions and recommendations of inconsiderable interest in this country. The Commission's second report has now been issued, and comprises ten reports of officers appointed to conduct special investigations. While these are of a technical character, they will form the basis of general conclusions to be deduced after further investigation. It is hoped that the Commission will eventually be able to establish its facts so absolutely as to lay down general rules for the treatment of sewage under all conditions, but this is confessedly a task of the remote future. The reports of the curent year deal chiefly with the bacterial phases of sewage, especially as regards pathogenic germs—a subject which remains very greatly in doubt, despite the confident assertions of enthusiasts.

The conclusions reached by Dr. A. C. Houston upon standards for sewage effluents are especially interesting. They are:

(1) That both bacteria bed processes and land processes can yield effluents seemingly non-putrescible.

(2) That in general the effluents from bacteria beds and from land are not to be thought of as safe in the case of drinking streams.

(3) That chemical standards are essential in the case of potable and non-potable rivers.

(4) That a bacteriological standard is most certainly indicated in the case of drinking streams, and is of more importance than the chemical one.

(5) That a bacteriological standard is of secondary importance in the case of non-drinking streams, but may prove useful as an adjunct to the chemical standard.

The same high authority notes the danger to oysters and other shell-fish life which are eaten raw, from sewage pollution, where the purification is not perfect. This is a peril not uncommon on our own coast, and it has an important bearing upon sewage disposal work in this State.

The reports of the Royal Commission, while in reference to work technical and experimental in character so far, will be found of material assistance to engineers and chemists and should be consulted by them. The important conclusions to be reached later will be made public by this Commission when they appear.

All of which is respectfully submitted,

CHAS. F. HARRINGTON,
WILLIAM T. HUNT,
CHARLES W. FULLER,
DAVID L. WALLACE.

Report of the Treasurer.

To the State Sewerage Commission:

I respectfully submit the following report of the receipts, disbursements and expenditures of the State Sewerage Commission for the fiscal year beginning November 1st, 1901, and ending October 31st, 1902:

The Treasurer has received from the State Treasurer and expended, with the approval of the Governor and the State Sewerage Commission, $1,345.99 from the fund of $2,500 appropriated by the Legislature of 1901, for rent and necessary expenses of the Commissioners, leaving a balance of $1,154.01, which returned to the State Treasurer on November 1st, 1902.

The Treasurer has on file vouchers for these moneys expended.

RECEIPTS.

Received from State Treasurer from appropriations:	
1901.	
November	$253 85
December	411 79
1902.	
January	73 25
March	152 13
April	50 47
May	44 54
June	42 40
July	197 50
September	120 06
Total receipts	$1,345 99

EXPENDITURES.

Nov. 25.	To moneys disbursed—		
	For rent to December 31st, 1901	$70 00	
	For reports on septic tanks and contact filters from H. W. Clarke	150 00	
	For expenses of engineers inspecting Passaic river	31 05	
	For telephone	1 70	
	For postage	1 10	
			$253 85
Dec. 30.	To moneys disbursed—		
	For rent to January 31st, 1902	$35 00	
	For engineering expenses	317 95	
	For typewriting	45 24	
	For copy of Engineer's map	5 00	
	For express	45	
	For telephone	1 50	
	For postage	1 00	
	For railroad expenses	5 65	
			411 79
1902.			
Jan. 27.	To moneys disbursed—		
	For rent February 1st to February 28th, 1902	$35 00	
	For typewriting	24 58	
	For electric wiring	7 17	
	For cleaning carpet	3 17	
	For postage	1 00	
	For telegraph	78	
	For telephone	1 55	
			73 25
Mar. 31.	To moneys disbursed—		
	For rent to April 30th, 1902	$70 00	
	For advertising	23 80	
	For typewriting	22 63	
	For postage	6 00	
	For telephone	4 20	
	For railroad expenses	25 50	
			152 13
April 28.	To moneys disbursed—		
	For rent to May 31st, 1902	$35 00	
	For typewriting	1 67	
	For analyses	10 00	
	For express	80	
	For postage	3 00	
			50 47
May 26.	To moneys disbursed—		
	For rent to June 30th, 1902	$35 00	
	For typewriting	1 25	
	For electric light	1 04	
	For express	25	
	For postage	2 00	
	For railroad expenses, &c.	5 00	
			44 54

June 30.	To moneys disbursed—		
	For rent to July 31st, 1902	$35 00	
	For typewriting	1 65	
	For postage	1 00	
	For telephone	60	
	For railroad expenses, &c.	4 15	
			42 40
July 21.	To moneys disbursed—		
	For rent to August 31st, 1902	$35 00	
	For analyses	150 00	
	For Treasurer's check book	12 50	
			197 50
Sept. 29.	To moneys disbursed—		
	For rent to October 31st, 1902	$70 00	
	For stationery	31 30	
	For typewriting	6 30	
	For electric light	46	
	For subscription to Municipal Journal and Engineer for one year	3 00	
	For subscription to Engineering News for one year	5 00	
	For postage	4 00	
			120 06
			$1,345 99

Respectfully submitted,

DAVID L. WALLACE,

Treasurer.

Report of Secretary.

To the State Sewerage Commission:

I have the honor to submit the following report of the work of the State Sewerage Commission during the year ending November 1st, 1902:

The Commission continued under the organization of the year 1901 with Charles F. Harrington as Chairman and John Hinchliffe as Treasurer until the first Monday in May, 1902. It then reorganized by re-electing Mr. Harrington to be Chairman for one year and electing David L. Wallace to be Treasurer for one year. At this meeting the term of office of John Hinchliffe expired. He had been appointed for a full term to begin at this meeting and had been confirmed, but had filed his resignation with the Governor. This left a vacancy in the Commission which has not yet been filled.

The Commission has followed its custom of meeting each Monday afternoon during the year, at is office in Jersey City, and has held special meetings when they were required by its work.

PASSAIC RIVER.

The Commission has taken no action in regard to the Passaic river subsequent to the creation of the Passaic Valley Sewerage and Drainage District by the Legislature of 1902. The Commission, at a meeting held April 21st, 1902, unanimously adopted the following resolution:

Resolved, That the State Sewerage Commission offer to the Passaic Valley Sewerage and Drainage District Commission the service of its members and officers and of its records.

On May 5th, 1902, the Commission held a joint meeting with the Passaic Valley Sewerage and Drainage District Commission and discussed the work in the Passaic Valley District. The Commission has furnished the District Commission from time to time with copies of its maps and records and with such information as has been requested by the District Commission in relation to its work.

RAHWAY RIVER.

The Commission has devoted considerable time during the year to consideration of complaints of pollution of the Rahway river. During July, 1901, the Commission had notified the owners of a number of mills and factories to stop polluting this river with waste water. Renewed complaints were received during the winter that this pollution was continued, and the Commission continued its investigations as to the condition of the river. During January, 1902, reports were received from various factories, stating that action had been taken to stop the pollution by waste water or promising that action would be taken. In April continued complaints were made of this pollution and the Chairman of the Commission investigated the complaints, particularly against the American Copper Extraction Company plant at Garwood. On April 7th, 1902, the Commission held a hearing at which complaints were made against this company, and samples of the waste water discharged into the river from its works were submitted to the Commission and other samples were taken by the Commission. These samples of waste water the Commission subsequently had analyzed by Thomas LeClear, chemist, whose reports follow:

WATER ANALYSIS, APRIL 4TH, 1902.—NO. 874.

Specimen.—About eight ounces of waste water from American Copper Extraction Co. Works, at Garwood, N. J.

Examination.—The specimen is practically colorless and is slightly turbid. It is found to contain a large quantity of solids in solution, there being 7,512 grains (a little over one pound) in each U. S. gallon. This consists chiefly of the sulphates and chlorides of sodium and iron. The amount of iron is very great, corresponding to 542 grains (over an ounce) of metallic iron in each U. S. gallon. In order to reduce this amount to a quantity that is generally accepted as the allowable limit for a potable water, one part of this waste water

must be diluted with 3,000 parts of iron free water, and if the diluting water itself contains some iron, the quantity required to reduce the iron in the waste water will be correspondingly greater. Copper is not present in appreciable quantity. The waste water is slightly acid, containing 9.7 grains of free acid (expressed as HCL) in a U. S. gallon. The dilution made necessary by the presence of iron is sufficient to render the acidity unobjectionable.

Respectfully,
THOMAS LeCLEAR.

WATER ANALYSIS, APRIL 9TH, 1902.—NO. 895.

Specimen.—Sample of water from American Copper Extraction Co. Works, at Garwood, taken from gutter of South avenue, about 125 feet east of works. Monday, March 10th, 1902, about 4 P. M.

Examination.—The specimen is very turbid, having in suspension a considerable amount of solid material of a reddish-brown color. When the water stands this sediment deposits to the bottom of the receptable, leaving a clear and practically colorless supernatant liquid. The amount of the sediment is found to be 175.9 grains for each U. S. gallon, and it is found to consist largely of silt, colored by adhering oxide of iron. The clear liquid contains 6,525 grains of solids in each U. S. gallon, making a total of 6,700.9 grains of dissolved and suspended solids. The material in solution, as in specimen 874, consists chiefly of sulphates and chlorides of sodium and iron, the amount of iron corresponding to 478 grains (about an ounce) of metallic iron in each U. S. gallon. Copper is not found in appreciable quantity. The free acidity is equivalent to 11.4 grains (expressed as HCL) per U. S. gallon, being slightly greater than in specimen 874.

Practically the same dilution of this specimen of waste is required to bring it within the limits of allowable potable waters, as was described for specimen 874.

Respectfully,
THOMAS LeCLEAR.

The works of the American Copper Extraction Company were subsequently destroyed by fire and no action on the complaints received against it was taken by the Commission. Subsequent investigation as to the action taken in compliance with the notices to cease pollution served by the Commission was reported to the Commission by the Chairman at the meeting held April 21, 1902, which showed that at the plants of the Diamond Mills Paper Company and Ernest Lighthipe and Company at Millburn, the pollution continued the same during April, and that at the Fandango Mills at Millburn purification tanks had been built but were not yet in operation. The Commission, however, received promises that the pollution from these sources would be prevented. The Commission examined the Rahway river on May 8th, 1902, and found that the upper part of the river

was polluted by dye stuffs, waste water from hat factories and sewage discharged into the river from a sewer in the city of Orange. The Commission decided at its next meeting, May 12th, 1902, to notify the city of Orange to show cause why the Commission should not notify it to cease polluting the Rahway river. The matter was adjourned until June 2d, 1902, when the city of Orange, having shown no cause to the contrary, the following resolution was adopted by the Commission:

WHEREAS, The State Sewerage Commission has found that the city of Orange is polluting the waters of the Rahway river to the injury of inhabitants of this State in their health, comfort and property,

Resolved, That this Commission notify the city of Orange to cease polluting the waters of the Rahway river prior to the 1st day of September, 1902, and make such disposition of its sewage and other polluting matter as shall be approved by the State Sewerage Commission.

This notice was duly served on the authorities of the city of Orange. At the following meeting, held June 9th, 1902, a communication was received from Thomas A. Davis, counsel of the city of Orange, stating that the pollution of the river was caused by a leak into the storm water sewer, which would be remedied.

At a meeting held September 15th, 1902, the Commission received a complaint that a branch of the Rahway river was being polluted in South Orange. The Commission notified the Board of Health of South Orange of the receipt of the complaint and the matter was taken care of by that Board.

PLAINFIELD.

At a meeting held June 2d, 1902, the Commission authorized the Chairman to have made chemical and bacteriological analyses of the effluent of the sewage disposal works of the city of Plainfield, the plans for which were approved by the Commission December 24th, 1900. During the entire month of June analyses were made by Thomas LeClear, chemist, and his report was submitted to the Commission July 21st, 1902. This report is as follows:

LABORATORY,

20 East Twenty-ninth Street, New York.

Report to the Sewerage Commission of the State of New Jersey on the bacteriological and chemical examinations of specimens from the Plainfield Sewage Disposal Plant, taken during the month of June, 1902:

GENTLEMEN—During the month of June, 1902, acting under the direction of your chairman, Hon. Chas. F. Harrington, I have taken from the Plainfield Sewage Disposal Plant specimens of crude sewage, specimens of effluent from a septic tank and specimens of effluent from the contact beds, which I have subjected to certain bacteriological and chemical examinations, the results of which are herein submitted to you.

The introduction of crude sewage into rivers, and particularly into small streams, renders their waters unpotable, but more than this, it renders them filthy by reason of the changes which the organic matter of the sewage is undergoing, such changes being of the nature of putrefaction of the organic matter, with the resulting production of odors and gases, harmful and offensive to those that dwell or are otherwise brought near to the stream, and the production as well of toxic substances, destructive to many forms of life natural to its waters. The purpose of such treatment as that to which the sewage is subjected at the Plainfield plant, is to so change the sewage that its introduction in this modified condition into natural streams, will not be accompanied with the objectionable consequences, or at least not to the same degree that attends the introduction of crude sewage.

The efficiency of such a sewage disposal plant is determined by the extent to which the final effluent is rendered unobjectionable for disposal in natural streams, the rapidity with which this change is brought about and the expense attending its operation. The following examinations have to do with the first mentioned of these requisites, viz., the character and efficiency of the changes produced in the crude sewage by the treatment to which it is subjected.

Observations regarding the number of bacteria present in the crude sewage, effluent from a septic tank and effluent from contact beds, are presented in the following table:

NUMBER OF BACTERIA IN A CUBIC CENTIMETER OF THE CRUDE SEWAGE, EFFLUENT FROM THE SEPTIC TANK AND EFFLUENT FROM THE CONTACT BEDS IN JUNE, 1902.

Date	*Time.*	*Crude Sewage.*	*Effluent from Septic Tank.*	*Effluent from Contact Beds.*
June 6	10:00 A. M.	996,000	.....	183,000
June 7	10:00 A. M.	1,550,000	.....	70,500
June 9	10:00 A. M.	2,000,000	.....	158,000
June 10	10:00 A. M.	1,529,000	.....	184,500
June 11	9:30 A. M.	1,008,000	553,000	183,000
June 12	9:30 A. M.	1,395,000	*621,000	†6,000
June 13	9:30 A. M.	2,130,000	685,000	124,300
June 14	9:30 A. M.	845,000	524,000	248,500
June 16	9:30 A. M.	736,000	328,000	51,500
June 17	10:00 A. M.	1,380,000	373,000	71,300
June 18	10:00 A. M.	1,592,000	205,800	216,500
June 19	9:30 A. M.	1,595,000	539,000	100,000
June 20	9:30 A. M.	676,000	414,000	143,250
June 21	10:00 A. M.	438,000	263,000	65,000
June 23	10:00 A. M.	2,470,000	298,000	240,000
June 24	9:30 A. M.	880,000	1,865,000	429,000
June 24	10:40 A. M.	.....	.....	75,800
June 25	9:30 A. M.	2,245,000	1,220,000	524,000
June 26	9:30 A. M.	1,600,000	240,000	445,000
June 26	10:40 A. M.	.....	.....	57,000
June 30	3:40 P. M.	35,000	224,000	50,000
	Average	1,321,000	556,800	171,500

* West septic tank emptied on the 11th and out of use fourteen hours. This sample from east septic tank, out of use two hours.

† First effluent from contact beds that came out of west septic tank after being emptied.

From these results it is seen that in the septic tank the crude sewage lost 58 per cent. of the bacteria present and on the contact beds, there was a further loss of 29 per cent., so that the final effluent contained 13 per cent. of the number of bacteria in the original crude sewage. Does this reduction in the number of bacteria remove the danger that the sewage will pollute the stream into which it is allowed to flow?

Since pollution from a bacteriological point of view consists in the introduction of harmful bacteria into potable water, this question resolves itself into the further question: Does the reduction in the number of bacteria which we find in the effluent rid it of the various pathogenic bacteria present or liable to be present in crude sewage? In investigating this point I have observed the fate of the intestinal bacteria in the crude sewage. If the bacteria characteristic of alvine discharges are destroyed by the sewage treatment it is fair to look for the destruction of other pathogenic bacteria, while if the intestinal bacteria persist and appear in the final effluent, the treatment does not render the sewage bacteriologically safe for introduction into drinking water.

The following are the results obtained:

NUMBER OF INTESTINAL BACTERIA (COLON BACILLI AND CLOSELY ALLIED FORMS) IN A CUBIC CENTIMETER.

Date.	*Time.*	*Crude Sewage.*	*Effluent from Contact Beds.*
June 19—	9:30 A. M.	.....	Present.
June 20—	9:30 A. M.	.....	Present.
June 21—	10:00 A. M.	.....	Present.
June 23—	9:30 A. M.	.....	Present.
June 24—	10:40 A. M.	Present.	Present.
June 25—	9:30 A. M.	.....	12,725
June 26—	9:30 A. M.	Present.	Present.
June 27—	9:30 A. M.	.....	10,000

It is thus seen that the intestinal bacteria are not destroyed by the sewage treatment. The conclusion is therefore reached that water, into which this sewage effluent is allowed to flow, is not suitable for drinking and general domestic use.

I have already stated that the introduction of crude sewage into rivers and streams not only renders their waters unpotable, but that it renders them filthy owing to the organic matter of the sewage. It now remains to observe what changes, if any, the organic matter of the crude sewage undergoes in the treatment at the Plainfield plant and to what extent such changes remove the second objection to the introduction of crude sewage into natural streams, namely, the resulting condition of filth from the putrefying organic matter.

The underlying principle of the treatment at this plant is to first bring the organic matter of the crude sewage into solution and subsequently to oxidize the dissolved organic matter. This is accompanied by the aid of the bacteria, which we have seen are present in great numbers in crude sewage. The crude sewage is first allowed to stand in septic tanks, where the bacterial activity accomplishes the solution of the considerable amount of undissolved organic matter. The effluent from the septic tanks is then left in contact beds, where the oxidation of the dissolved organic matter is chiefly accomplished. There results an effluent in which the organic matter has been largely replaced by products of oxidation. The extent of these changes is indicated by the following chemical analyses of various samples taken from the plant while in operation:

CHEMICAL ANALYSES OF SPECIMENS OF CRUDE SEWAGE, EFFLUENT FROM SEPTIC TANK AND EFFLUENT FROM CONTACT BEDS (RESULTS EXPRESSED AS PARTS PER MILLION).

	Crude Sewage.	*Effluent Septic Tank.*	*Effluent Contact Bed.*
June 18th—10 A. M.			
Oxygen consumed in 10 minutes at 100°C.....	52.75	47.75	14.0
June 19th—10 A. M.			
Oxygen consumed in 10 minutes at 100°C.....	61.50	40.50	11.5
Nitrogen of free and saline ammonia.....	27.40	31.00	9.60
Nitrogen of albuminoid ammonia.....	14.60	13.00	8.40
Nitrogen of nitrites.....	Absent.	Absent.	0.24
Nitrogen of nitrates.....	Trace.	Trace,	6.25
Chlorides	105.0	112.5	111.0
Solids in solution.....	388.0	424.0	416.0
Loss on ignition.....	36.0	44.0	16.0
Total solids	520.0	488.0	460.0
Loss on ignition.....	132.0	88.0	44.0
June 26th—10 A. M.			
Oxygen consumed in 10 minutes at 100°C.....	55.0	39.25	12.0
Nitrogen of free and saline ammonia.....	36.00	32.00	14.00
Nitrogen of albuminoid ammonia.....	11.00	4.00	3.00
Nitrogen of nitrites.....	Absent.	0.002	0.20
Nitrogen of nitrates.....	Trace.	Trace.	7.28
Chlorides	59.5	92.5	95.5
Solids in solution.....	360.0	416.0	412.0
Loss on ignition.....	44.0	72.0	36.0
Total solids	540.0	472.0	432.0
Loss on ignition.....	176.0	108.0	52.0
June 30th—3:40 P. M.			
Oxygen consumed in 10 minutes, 100°C.....	124.75	37.50	11.0

Perhaps the most striking indication of the change the organic matter has undergone is seen in the very much less oxygen required to oxidize the organic matter of the final effluent from the contact beds as compared with the amount required to oxidize the organic matter of the crude sewage and of the effluent from the septic tank. It will be seen that this varied, in the four observations made, from about one-eleventh to approximately two-sevenths in the case of final effluent. Even the consumption of this relatively small amount of oxygen is referable in part to changes it produced in the inorganic products, as in changing nitrites to nitrates.

This oxidized condition of the organic matter of the final effluent is further shown by the condition of the nitrogen. In the crude sewage there was the usual large amount of nitrogen of the ammonias. In the effluent from the contact beds this was greatly reduced in amount, and in its place we find a large quantity of nitrogen in an oxidized condition, that of nitrate, with considerable nitrogen in an intermediate stage of oxidation, that of nitrite.

As already stated, the change accomplished in the septic tank is chiefly the solution of the undissolved organic matter of the crude sewage. This is shown by the figures for the undissolved solids calculated from the results of the analyses. These show that 25 per cent. and 33 per cent. of the solids were

undissolved in the crude sewage, while only 12 per cent. and 13 per cent. were undissolved in the effluent from the septic tank.

Do these chemical changes, induced by bacteria in the treatment of the sewage at the plant, render the sewage less likly to undergo putrefactive changes which we at the outset recognized as the cause of the condition of filth produced by the crude sewage? In other words, is the final effluent obtained in this treatment less putrescible than the crude sewage?

The changed chemical composition noted above shows that the final effluent was certainly less putrescible; this fact has also been demonstrated by actual tests of putrescibility reported in the following table:

TESTS FOR PUTRESCIBLE MATTER.

	Crude Sewage.	*Effluent from Septic Tank.*	*Effluent from Contact Beds.*
June 20	Positive.	Positive.	Negative.
June 23	Positive.	Positive.	Negative.
June 27	Positive.	Positive.	Negative.

The results of these tests fully affirm the conclusions reached from the consideration of the composition as shown by chemical analyses, namely, that the sewage modified by treatment is so changed as to render it less putrescible and so less objectionable for introduction into natural streams.

The results of the observations here presented may be briefly summarized as follows:

(1) The treatment accomplished a reduction of 87 per cent. in the number of bacteria.

(2) This reduction was not accompanied by a complete removal of the objectionable bacteria, at least 10,000 intestinal bacteria being still present in a cubic centimeter of the final product.

From (1) and (2) it follows that the resulting product was unsafe for introduction into water that is subsequently to be drunk.

(3) That in the septic tank much of the organic matter of the crude sewage was brought into solution.

(4) That in the contact beds much of the organic matter of the crude sewage was oxidized.

(5) That owing to these changes the organic matter in the final product was no longer putrescible under the conditions that existed in the sewage.

From (3), (4) and (5) it follows that the product resulting from the treatment is free, at least to a very large degree, from the objection that is associated with crude sewage, and that its introduction into natural waters will not result in the production of the great degree of filth that results from the introduction of crude sewage.

Respectfully,

(Signed), THOMAS LECLEAR.

RED BANK.

The Commission decided on October 22d, 1900, to notify the town of Red Bank to cease polluting the waters of the Navesink river prior to the first day of October, 1901. This time was extended, at the request of the officials of the town of Red Bank, owing to the failure of the town authorities to select a system of sewage purification, until December 30th, 1901.

At a meeting held January 6th, 1902, a communication was received from A. C. Harrison, Clerk of the town of Red Bank, enclosing an outline of a plan for purification of the sewage of the town of Red Bank by electricity and a resolution of the Town Commissioners of Red Bank adopting the plan outlined and submitting it to the Commission for approval. At the same meeting the Commission disapproved of the plan submitted for the disposal of the sewage of Red Bank and notified the Commissioners of the town of Red Bank that the Commission required them to submit other plans for the disposal of the sewage of Red Bank.

At a meeting held January 27th, 1902, T. H. Grant, C.E., of Red Bank, submitted to the Commission plans for the purification of the sewage of the town and a certified copy of the minutes of the Town Board of Commissioners, authorizing the submission of the plans of the Commission. These plans provide for a grit basin for the precipitation of silt and sand and a filtering tank.

At the same meeting the Commission adopted the following resolution:

Resolved, **That the plans for the purification of the sewage of the town of Red Bank, prepared by T. H. Grant, C.E., and submitted to this Commission by the Town Commission of Red Bank, be approved, subject to such conditions of operation as this Commission may, from time to time, require; *provided,* the grit tank shown in such plans be doubled in size with duplicate chambers and that the filtering tank be duplicated by the addition of another filter of the same size.**

At a meeting held June 2d, 1902, the Commission was notified that the disposal plant of the town of Red Bank had been completed and placed in operation.

NEWARK.

At a meeting held February 10th, 1902, the Commission received an application from the Board of Street and Water Commissioners of the city of Newark for permission for the construction of a new sewer to discharge into the Passaic river at Polk street, Newark. The Commission adopted the following resolution:

Resolved, That permission be granted by this Commission to the city of Newark to construct a sewer to discharge into the Passaic river, at Polk street, Newark, to relieve the present sewer at Jackson street of storm water, according to the application made by the Board of Street and Water Commissioners of the city of Newark, dated February 7th, 1902, and the accompanying papers and map, subject to the conditions of the notice given June 4th, 1901, by this Commission to the city of Newark to cease polluting the waters of the Passaic river.

The Commission also notified the Board of Street and Water Commissioners of the city of Newark that in granting permission for the construction of a sewer in Polk street, the Commission suggested the desirability of providing for a storm water overflow for the said sewer when the Passaic Valley intercepting sewer should be constructed, and that the work be carefully constructed with a view to saving the city expense when connections with existing sewer are made.

ANGLESEA.

In November, 1901, the Commission was consulted in relation to a system of sewerage for the borough of Anglesea. At a meeting held March 10th, 1902, the Commission received an application from William H. Boardman for the approval of plans submitted by the Borough Council of the borough of Anglesea for a sewerage system to discharge into Beach creek. The Commission at the same meeting approved of the plans submitted by the Borough Council, subject to such conditions of operation as the Commission might from time to time require.

CROSSWICKS CREEK.

At a meeting held June 2d, 1902, the Commission received a complaint of pollution of Crosswicks creek and Thorntown creek, made by the Bordentown Reservoir and Water Company. The complaint alleged that the water-supply of the city of Bordentown was injured by the pollution. This complaint was investigated by the Chairman of the Commission, and it was found that while there was pollution there was difficulty between the water company and the city of Bordentown and a number of private individuals over a proposed new water-supply for the city of Bordentown, and that suits were pending in connection with the alleged pollution. On June 16th, 1902, the Commission decided that it would be inadvisable for it to act in the matter at that time.

WANAQUE RIVER.

At a meeting of the Commission held December 23d, 1901, the Commission received a complaint from George Riley, State Fish and Game Protector, of pollution of the Wanaque river, near Pompton, by refuse from powder mills. This complaint was investigated by the Chairman of the Commission, who reported at a meeting held May 26th, 1902, that he found that acid wastes were discharged from the mills and were neutralized by passing over beds of lime; that he found no cause for action by the Commission.

MADISON.

At a meeting held June 9th, 1902, plans for a system of sewerage for the borough of Madison were received from Wise & Watson, engineers, and placed on file. The Commission had approved of plans for the purification of the sewage of the borough at a meeting held September 30th, 1901.

TOMS RIVER.

At a meeting held April 21st, 1902, the Commission received an application from William A. Torrey, of Lakehurst, requesting approval of plans submitted for a sewer to discharge into Manapaqua branch of Toms river. The Commission disapproved of the plan to discharge sewage into Manapaqua branch without purification.

MILLVILLE.

At a meeting held June 9th, 1902, plans for a system of sewers for the city of Millville to discharge into the Maurice river were submitted to the Commission for its approval by William H. Boardman, C.E., of Philadelphia. The Commission notified Mr. Boardman that the application for the approval of plans should be made by the authorities of the municipality. The plans were returned in order that the application should be made in proper form.

PERTH AMBOY.

At a meeting held December 16th, 1901, the Commission received a complaint of lack of proper sewerage in Commerce street, Perth Amboy. No action was taken by the Commission, as this matter did not come within its jurisdiction.

TIMBER CREEK.

At a meeting held November 25th, 1901, the Commission notified the Board of Health of Camden county that a complaint of the pollution of Timber creek had been received and that this Commission wished to suggest that it take action to prevent danger to health from the use of ice cut from the creek. On September 16th, 1902, the Commission had notified the Board of Chosen Freeholders of Camden county to stop pollution of Timber creek by sewerage of the Camden county institution prior to the first day of April, 1902.

ASBURY PARK.

At a meeting of the Commission held January 13th, 1902, the Commission was consulted in relation to the sewerage of Asbury Park. No action was taken by the Commission, as it did not come within its jurisdiction.

RIDGEWOOD.

At a meeting held July 14th, 1902, the Commission was consulted in relation to the sewerage for the town of Ridgewood, and suggestions were asked by M. T. Richardson, Chairman of the Sewer Committee of the town, as to the amount of purification required for its sewage. The Commission notified Mr. Richardson that all putrescible matter should be removed from the sewage.

The Commission has received the following reports from municipalities which have put in sewerage systems or disposal works:

MORRISTOWN.

W. W. Cutler, Counsel of the Board of Sewerage of the city of Morristown, made the following report of sewerage work in that city:

OCTOBER 17th, 1902.

An application was made under Chapter 124 of the laws of 1902 for the appointment of a Board of Sewerage, and a Board consisting of Robert D. Foote, Charles W. Ennis, William B. Skidmore, Thomas W. Cauldwell, was appointed by Judge Garretson. Mr. Foote is Chairman of the Board and Mr. Ennis, Secretary.

The Board has spent several months in investigating the various systems of sewage disposal and has reached the conclusion that it would be advisable for Morristown to join the trunk sewer at Summit, if permission can be obtained from the Joint Sewer Commission, and provided the costs of so doing would not exceed the amount they are authorized to expend, which is about $410,000.

The Board is now obtaining estimates of the cost of the system and are also in communication with the officials of the trunk line and will soon be able to come to a definite conclusion. It is now suggested that Morristown should

take a daily capacity of 1,500,000 gallons in the trunk sewer and Madison 500,000. The line had been surveyed from Morristown to Summit, to connect with the trunk sewer on the east side by a tunnel.

The Morristown Board has also investigated the question whether the discharge of the sewage into the Arthur Kill, through the trunk sewer, including the additional sewage from Morristown and Madison, would be a nuisance, and have the opinion of Mr. Rudolph Hering that the flow of water from the Kill is sufficient to dilute the sewage discharged so as to inoffensively dispose of all the sewage which is likely to be discharged by the sewer for a generation to come.

At present there is no sewer system in Morristown, all the sewage matter being disposed of in cesspools.

Rudolph Hering made the following report as to the disposal of sewage in Arthur Kill:

OCTOBER 14th, 1902.

The Sewerage Committee of Morristown, N. J., Mr. Robert D. Foote, Chairman:

GENTLEMEN—Complying with your further request to state to you my opinion on the disposal of the sewage of Morristown into the Arthur Kill, through the joint sewer now about to be constructed to the foot of Bay Way, I beg to report as follows:

The disposal of sewage by dilution is a satisfactory one, provided the dilution is sufficient to prevent a putrefying process taking place. Sufficient experience is now available to indicate the amount of water necessary under different conditions to dilute a given quantity of sewage so that the results will give no offense.

The Arthur Kill is a tidal stream which receives its waters from Raritan bay to the south of Staten Island, and meets the tidal water coming from New York bay through the Kill Von Kull. The meeting of these tides is in the neighborhood of Corner Stake light, near Shooters Island, at which point there is little, if any, flow of water. To discharge sewage at the latter point would clearly not give it a proper dilution. But the point proposed, namely, at the Bay Way, is nearly two miles below the meeting of the tides, and the amount of water which is available twice a day for diluting the sewage is contained in a tidal prism approximately two miles long, about an eighth of a mile wide and four and six-tenths feet deep, giving an average flow of water passing Bay Way four times a day of over 30,000,000 cubic feet.

In my opinion the dilution affected hereby, provided the sewage is discharged as far from shore as practicable, will be quite sufficient to inoffensively dispose of all the sewage which is likely to be discharged by this sewer for a generation to come.

COLLINGSWOOD.

A report from F. M. North, Borough Clerk of Collingswood, states that the sewerage plant of the borough, the plans for which, providing for a septic tank and filtration beds, were approved by this Commission May 14th, 1900, is owned and operated by the Collingswood Sewer Company, a private concern.

Richard T. Collings, President of the Collingswood Sewer Company, reports that the works were placed in operation September 1st, 1901. That no estimate of the amount of sewerage for the first year was made, owing to the amount of leakage or intake water. That up to September 1st, 1902, seventy-five houses had connected with the sewer. That there was no factory waste and no factory had been connected as yet. That the general results of operation of the plant have been satisfactory except for leakage from Newton creek into the main pipe, which washes silts into the pipe. That no complaints against the plant have been received. That the operation for the first year cost about $500. That no analyses have been made.

RIDGEFIELD PARK.

D. S. Servoss, Chairman of the Sewer Committee of the Board of Trustees of the village of Ridgefield Park, reports that three sections of the sewer system of the village, plans for which provided for a system of sewers dischorging crude sewage into the Hackensack river, have been completed and are now in use, having been accepted by the village on January 20th, 1902. That 118 connections have been made with the sewers and that more would have been connected had it not been for a scarcity of plumbers. That there were complaints and opposition to the construction of the sewers before their completion, but since then that the opposition has disappeared and that no objections were made at the final hearing of the Sewer Commissioners or upon the final confirmation of their findings by Supreme Court Justice Dixon. That one or two objections have been made since that time to the Sewer Committee; one from the State Sewerage Commission, requesting the extension of the outlet of the sewers to below low-water mark. That this work is now being done, the necessary pipe being on the ground. That the Sewer Committee feels gratified with the manner in which the completion of its work has been received by the people of the village.

HADDONFIELD.

C. D. Stackhouse, Clerk of the borough of Haddonfield, reports that the sewerage system of the borough, the plans for which, providing for a sewer system and sand filtration beds, were approved by the Commission February 11th, 1901, is still incomplete, owing to difficulties encountered in the construction, but that they would probably be in operation by the first of December, 1902.

PLAINFIELD.

Andrew J. Gavett, City Surveyor of Plainfield, reports that the disposal plant of that city, plans for which, providing for a septic tank and contact filtration beds, were approved by this Commission December 24th, 1900, was placed in operation in February, 1902. That the average number of gallons treated daily is about 650,000. That there are 1,575 sewer connections. That there is no factory waste as far as known received in the sewers. That thirty-one factories are connected, but presumably only water from lavatories reaches the sewers. That the separate system of sewers is in use. That the results of operation are satisfactory. That no complaints of odors are received. That the cost of operation includes the salary of the day operator, $67.50 per month, and the night operator of $45 per month. Other help has been employed, mainly in construction. That analyses by the chemists of the local Board of Health are being made, but were not completed at the date of this report. That analyses had been made by the State Sewerage Commission.

VINELAND.

The Clerk of the borough of Vineland reports that the sewage disposal works of the borough, the plans for which, providing for sand filtration beds, were approved July 12th, 1900, were placed in operation in May, 1901. That there has been no estimate made of the number of gallons of sewage treated. That

218 houses are connected with the plant. That there is no factory waste in the sewage purified. That two factories are connected with the sewerage system. That the general results of the operation of the plant have been good. That complaints of odors from the plant have been received. That nothing more than the usual good care of the beds was taken to prevent nuisance of this character. That the cost of operation has been $350 per year. That no analyses have been made.

RED BANK.

O. E. Davis, Chief Commissioner of the town of Red Bank, reports that the disposal works of Red Bank, the plans for which, providing for a grit basin and a filtering tank, were approved January 27th, 1902, were placed in operation June 1st, 1902. That about 200,000 gallons of sewage have been treated each day. That 220 houses are connected with the system. That no factories are connected and no factory waste is treated. That the combined sewerage system is in use. That the results of treatment are good. That no complaints of nuisance have been received. That the cost is very small, being the salary of one man. That no analyses have been made.

STATE REFORMATORY.

Joseph W. Martin, superintendent of the State Reformatory at Rahway, reports that the sewage disposal plant of that institution, plans for which were approved June 25th, 1900, has never been in operation, owing to its non-completion according to contract by the builder. The sewage of the institution has been discharged into the Rahway river without treatment, and no complaints of this have been received.

Respectfully submitted,

BOYD McLEAN,

Secretary.

APPENDIX.

Bacterial Treatment of Crude Sewage. Report upon the London System, by Professor Frank Clowes, D.Sc., F.I C., Chief Chemist to the London County Council. A Summary of Results, with Final Recommendations.

The State Commission presents below the important conclusions of Dr. Clowes, Chief Chemist of the London, England, County Council, upon the bacterial treatment of sewage. As noted in the report of the New Jersey Commission of 1901, the experiments with the London sewage have been going on for a number of years, but not until this report by Dr. Clowes have definite conclusions been stated. As will be seen, the bacterial system of sewage treatment recommended by this Commission is approved with positiveness. The London system has been one of chemical precipitation, conducted at large cost (see report 1901). Dr. Clowes not only makes statements and recommendations as to London, but summarizes the reports of the other cities of England, and reviews the report of the Royal Commission upon the same subject. The whole makes an extraordinarily interesting report, and is highly valuable for reference. It is accompanied by a large amount of data, which may be found in the original report. The system recommended by this Commission and now in operation in Plainfield, as described heretofore, is substantially that recommended in London.

REPORT OF DR. FRANK CLOWES, CHIEF CHEMIST TO LONDON COUNTY COUNCIL.

INTRODUCTORY.

The period of experimental treatment by bacterial agency at the Council's outfalls has for the present been concluded, and the time appears opportune, therefore, for briefly stating why the experiments were undertaken, the nature of the experiments, the results which have been arrived at, and the recommendations which they suggest.

ORIGIN OF THE EXPERIMENTAL BACTERIAL TREATMENT.

The whole of the raw, unsettled sewage of the Metropolis was formerly allowed to flow, without any previous treatment, into the Thames. The result was that the stream, more especially in summer time, became insupportably foul. The foulness arose partly from sewage mud or sludge deposited on the foreshores, partly from black sewage scum floating on the surface of the river, but also from putrid changes occurring in the sewage substances dissolved in the water itself.

It was decided to remove the main source of this nuisance by subjecting the sewage to straining or screening, and then to settling or subsidence, and to pass the more or less clear effluent from this settling process into the Thames many miles below London. Under this scheme the coarse screenings are now disposed of on farm land and the foul, settled matter, or sludge, is carried out and discharged on a falling tide in the estuary. The sedimentation of the sewage has in recent years been much facilitated by the addition in moderate proportion of chemical solutions.

The above treatment, which is still in operation at the outfalls, has prevented entirely the fouling of the foreshores and of the river surface with sewage sludge.

Those who proposed the above remedial measures, however, stated that the sewage effluent would still carry into the river a large amount of putrescible matter in solution, and recommended

that, as opportunity occurred, the effluent should be further purified by land treatment or by other means, before it entered the river.

This further treatment has never yet been attempted on the large scale. No suitable land for land treatment existed at the sewage outfalls, and no other method of treating the effluent was known at the time.

The Massachusetts experiments on the treatment of sewage effluent in coke-beds, which enabled the bacteria present in the sewage to effect the necessary additional purification, were subsequently published. They appeared suitable to the purpose in view, and the Main Drainage Committee of this Council accordingly authorized my predecessor to start an experimental trial of the process at the Council's outfalls.

At the time of my appointment as Chemical Adviser to the Council, the results arrived at by my predecessor were so promising that I strongly recommended their continuance on an extended scale; and for four years, with the assistance of the chemical staff and with the co-operation of the Superintendents at the outfalls, I have conducted this experimental purification of the sewage effluent, and have arrived now at results and conclusions which I am convinced are of the greatest importance, and are worthy of the most serious consideration of the Committee and of the Council.

DESCRIPTION OF THE BACTERIAL EXPERIMENTS.

When I recommended the Committee to continue the experimental treatment, there was a large bacterial coke-bed, one acre in area, at the northern outfall which was dealing with a small portion of the present effluent before it entered the river. This bed was arranged only to treat the chemical effluent; it was not of satisfactory construction, nor was it filled with suitable coke material. Further, it was impossible, owing to its low level, to empty it at all states of the tide, and accordingly it could not be filled as often as was necessary, in order to obtain the knowledge which was required. At the desire of the Committee, however, this bed has been maintained in action for over eight years, and it is now still giving admirable results in purifying the present sewage effluent.

But, with the sanction of the Committee, I have had in constant operation, and under most careful observation, a series of smaller coke-beds. These beds have received a special supply of raw sewage which came direct from the main sewer, and was entirely unmixed with chemicals. The process of working these beds has been subject to constant improvements and extensions, which have been suggested by experience and observation. I will only here describe the final method of experimental treatment which has been adopted.

The raw sewage, which has been screened from its coarser matters only, is pumped continuously into a settling tank, the rate of supply being so adjusted to the capacity of the tank that the sewage remains about six hours in the tank before it flows away through an elbow-pipe beneath the surface of the liquid into the coke-beds.

In this tank practically the whole of the suspended or floating particles of the sewage settle as sludge, and are allowed to remain undisturbed. It is found that a considerable proportion of this sludge disappears by bacterial action. During the first period of six months, before the bacterial action was fully started, 25.6 per cent. of the sludge disappeared, and during a subsequent similar period more than 50 per cent. of the sludge was removed by bacterial action. The portion which disappeared was the most putrescible portion of the sludge, which is at present carried to sea in the Council's sludge boats. Its disappearance would reduce the freight which these boats are required to remove. But it is probable that a considerable further reduction in the "sludge" cargoes might be effected by properly devised detritus settling tanks in which road sand would subside, and from which it might be removed to the marshes without giving offense. This reduction in the amount of sludge, which is secured by bacterial action alone, would be of the greatest importance.

The sewage as it flows from the settling tank is less pure than the effluent which is at present discharged into the river at Crossness, and is quite unsuitable for direct discharge into the stream. But by the subsequent coke-bed treatment it is rendered sufficiently pure to support the life of fish, and to insure it against undergoing, even in summer time, any offensive change.

In the experimental treatment, the settled sewage is therefore allowed to flow into a coke-bed, which is a tank filled with suitable

coke fragments to a depth of six feet. As soon as the bed is filled to the surface of the coke, the supply is stopped, and the sewage liquid is allowed to remain in contact with the coke for two hours. It is then drained off from the bottom of the bed, and constitutes the "bacterial effluent." After the liquid has flowed away, the coke-bed remains empty for two hours, and is then refilled with a fresh supply of the settled sewage, which is treated in precisely the same way as the preceding charge. The coke-bed receives and purifies four charges of settled sewage in the twenty-four hours.

CONCLUSIONS ARRIVED AT BY THE EXPERIMENTAL TREATMENT.

The points which have been established by the experimental work are the following:

1. That by suitable, continuous, undisturbed sedimentation, the raw sewage is deprived of matter which would choke the coke-beds, and the sludge which settles out is reduced in amount by bacterial action to a very considerable extent. This reduction might undoubtedly be increased by the preliminary removal of road detritus.

2. That the coke-beds, after they have developed their full purifying power by use, have an average sewage capacity of about 30 per cent. of the whole space which has been filled with coke.

3. That the sewage capacity of the coke-bed, when the bed is fed with settled sewage, fluctuates slightly, but undergoes no permanent reduction. The bed does not choke, and its purifying power undergoes steady improvement for some time.

4. That coke of suitable quality does not disintegrate during use.

5. That the "bacterial effluent" of settled sewage from the coke-beds does not undergo offensive putrefication at all, even in summer heat, and can never become offensive. That this effluent satisfactorily supports the respiration of fish.

6. That the use of chemicals is quite unnecessary under any circumstances when the above method of treatment is adopted.

RECOMMENDATIONS FOUNDED ON THE ABOVE CONCLUSIONS.

It would appear desirable, therefore, without delay, to commence the treatment of the London sewage by the above bacterial method. The construction of the necessary works will take time and will involve expenditure, but unless it is taken in hand, all considerations tend to show that owing to the increased abstraction of water by the water companies, both at their existing intakes and at the newly-constructed reservoirs for storm water, at Staines, a large portion of the lower river will continuously deteriorate. This deterioration would arise from the increase in the amount of the discharge of sewage effluent and the decrease in the upper river flush. Possible trouble arising from these causes will be absolutely prevented by adopting, under proper conditions and on a large scale, the treatment which has been strikingly successful on the experimental scale. It must be remembered that the condition of the river cannot be improved by any suddenly-adopted action.

If the treatment is introduced without delay and is gradually extended it may reasonably be expected that the increasing deterioration in the lower river water will first be checked and will ultimately be prevented; while the gradual development of the treatment will cause the expenditure to be spread over a period of years, and will prevent it from being unduly burdensome.

It must be remembered that the present settling channels would serve, as at present, for settling purposes, but by the altered method of working them they would also act as sludge destroyers. They should, however, undoubtedly be preceded by grit chambers. It must be further borne in mind that the expense involved in the purchase and application of chemicals would be dispensed with.

By a considerate adoption of the method, therefore, the expenditure might be distributed, and need not be large at any one time.

A fuller statement of details is supplied in subsequent sections.

SUMMARY OF INFORMATION FURNISHED BY TOWNS AND DISTRICTS IN WHICH THE BACTERIAL TREATMENT OF SEWAGE HAS BEEN EMPLOYED.

At the end of this report a tabulated statement of the results of the bacterial or natural process of treating sewage in some of the principal centers throughout the country, is appended. It has been thought that this information would prove useful as a means of comparing the results of the various experimental and permanent installations with the results obtained by the London County Council, and would show how extensively the method is already in use. It would also serve as a guide in extending the use of this method of treating sewage to fresh centers of population.

Some of the authorities have furnished most exhaustive records of the experiments and work which they have carried out, and, with the exception of Glasgow and Huddersfield, the opinion expressed is entirely in favor of the treatment of sewage in bacteria beds by a method suited to the requirements of the district and to the character of the sewage.

At Glasgow the results of the treatment of sewage in experimental bacteria beds indicated a purification from putrescible matter of 95 per cent., while the open septic tank was the means of reducing the amount of sludge by 54 per cent. Similar results have been accepted as satisfactory at other centers. The objection to the use of bacteria beds at this center appears to be that the area required for their installation at the Dalmuir Sewage Works for the treatment of 49,000,000 gallons, would be 164 acres, while the system of treatment by lime and sulphate of alumina could be satisfactorily carried out on a superficial area of 23 acres. By this latter method it is claimed that every trace of suspended matter is removed, and that 30 per cent. of purification from putrescible matter is effected.

At Huddersfield the sewage is of an exceptional character, since 30 per cent. is derived from manufacturing processes, almost wholly woolen, and it contains a quantity of soap, fat, and dyes, and a variety of chemicals used in the dyeing and finishing of woolen goods. The best results were obtained by treating the sewage with a small quantity of lime and sulphate of iron, followed by double contact in bacteria beds. The beds which were

used for this purpose retained their capacity much better than those which dealt with either the crude sewage or with the septic tank effluent.

A careful consideration of all the information obtained from the various centers where bacterial treatment has been tried convinces me that the process has been uniformly successful when the construction and use of the necessary plant has been reasonably and properly carried out. The only exception that appears possible to this general statement is interference which is caused by the sewage being of a very unusual character.

The following summary includes the opinions which have been expressed by all the authorities who have tried the bacterial system of sewage treatment and have reported to me on their work:

Accrington—The whole of the sewage is treated by the bacterial method, and the results are satisfactory.

Acton—The experimental treatment was successful, and the effluent was approved of by the Thames Conservancy. The whole of the sewage is to be treated bacterially.

Aldershot—"When this is done (the construction of secondary coke-beds) I think Aldershot will have every reason to be proud of the manner in which it has solved the very difficult question of how to dispose of the sewage in a satisfactory manner, and will have one of the most efficient systems in the kingdom." Annual Report of the Medical Officer of Health for 1901.

Aylesbury—The result of the treatment is considered to be satisfactory.

Barnsley—The result of a temporary experiment was satisfactory.

Birmingham—The Engineer to the Birmingham, Thame and Rea District Drainage Board states: "The results obtained were perfectly sufficient to warrant me in saying that the sewage of the Birmingham, Thame and Rea district can be efficiently treated on prepared bacteria beds."

Bristol—The degree of purity of the effluent from bacteria beds is satisfactory.

Burnley—"We are convinced that the scheme adopted by your Committee will prove an efficient one, and that the treatment of the sewage of the borough will be carried out in a more satisfactory manner and with less cost by this system (bacterial tank supplemented by land) than it could be by any other which has come

under our notice." Highways and Sewage Department of the County Borough of Burnley, Report on Sewage Disposal, 23d April, 1901, p. 20.

Bury—"From the results obtained up to the present, the corporation have decided to extend the works on similar lines" (*i. e.*, chemical treatment followed by subsidence and by bacteria beds).

Chorley—"If we had to start *de novo*, we should adopt exactly the same principle" (chemical precipitation, followed by bacterial treatment).

Darwen—"Having already proper precipitation tanks and filter (coke) beds, we do not think it advisable to change the system, as we are obtaining satisfactory results, but, if a new scheme were to be laid down, many modifications would be made."

Glasgow—The effluent from the bacterial treatment was stated on a recent visit from an officer of the Council to be entirely satisfactory and non-putrescible.

Huddersfield—"Owing to the final effluent being frequently unsatisfactory, and also to the rapid decrease of the capacity of the coarse bed, the use of this system on a large scale is not contemplated. The sewage of Huddersfield is of an exceptional character."

Hyde—A complete scheme of sewage treatment, based upon the results of experiments of bacterial treatment, has been submitted to the local government board for approval.

Keighley—The Borough Engineer states: "In my opinion, bacterial treatment ought to satisfy any river authority. My Council do not intend putting down a permanent installation so long as our present system of intermittent land filtration is satisfactory. There is no doubt the beds will gradually become choked, but to cleanse or renew, I think, would be cheaper than chemical treatment."

Kettering—"The provision of filter-beds has very much improved the character of the effluent."

Leeds—The Chairman of the Leeds Sewerage Committee states that the result from a process of continuous bacteria-bed treatment "are very good indeed, giving a purification of 95 per cent."

Leicester—A process of bacteria-bed treatment, followed by final purification on land, has been favorably reported upon by the Borough Engineer and Surveyor. See report to the Highway and Sewerage and Sewage Works and Farms Committee, 1900, p. 122.

Lincoln—The City Surveyor says: "The external authorities (through whose districts the effluent stream runs), who previously had been dissatisfied with our farm and polarite-bed effluents, have expressed themselves satisfied with our bacteria-bed effluent, we therefore are completing an installation to deal with all our sewage."

Manchester—Extract from the Annual Report of the Rivers Department for the year ending 27th March, 1901, p. 74: "The result of the work recorded in the foregoing pages, while emphasizing the necessity for care in the construction and management of sewage purification work, gives the Committee every encouragement in carrying out the scheme for the bacterial treatment of Manchester sewage according to the general principles advised in the Experts' Report, 1899, and sanctioned by the Council on September 5th, 1900." The experts recommended preliminary sedimentation and screening followed by bacteria-tank and bacteria-bed treatment.

Middleton—The Borough Surveyor states: "If of sufficient area, and properly managed, they (bacteria beds) will act satisfactorily."

Nelson—The results obtained by experimental bacteria beds were quite satisfactory.

Oldham—Extract from a report entitled "The Treatment of Oldham Sewage in the year 1900," by the Medical Officer of Health, p. iii. "With the exception of a few days during the year, when the weather was very dry, the method (bacterial treatment) has been entirely successful."

Ormskirk—The Surveyor states that "the results obtained at the Council's farm, after the sewage running through lagoons into settling tanks and then run onto the land and afterwards through the coke breeze filter-beds, are very satisfactory, and meet the requirements of the authorities."

Oswestry—The town clerk states that they "have no doubt as to the success of the bacterial treatment. Our results are continuously satisfactory, and the effluents keep free from putrescence."

Reigate—"The result of three years' searching trial is so satisfactory as to encourage the Council to sanction the outlay and adopt a scheme for treating the whole of the sewage of the borough on the lines adopted by the experimental plant."

Salford—The Borough Engineer states that "we can fully de-

pend upon the bacteria beds to give a satisfactory effluent, even when working night and day, almost without intermission." Permanent beds to treat the whole of the sewage are being constructed.

Sheffield—"The degree of purification obtained has been uniformly satisfactory. The loss of capacity of the beds continues, and experiments are being conducted with the object of reducing this as much as possible. Permanent works on bacterial principles are contemplated, but working details cannot be decided upon until further experiments are completed."

Southport—The Medical Officer of Health says that the "bacteria beds are only small experimental ones. * * * They have, however, worked entirely to our satisfaction so far as we have tested them, and they have always produced a clear and non-putrescible effluent."

Walsall—The Borough Surveyor states that in the Bloxwich district first-class results are being obtained in the bacterial treatment of the sewage.

Wolverhampton—The Town Clerk states that the results of the coke-bed treatment are good, but that a permanent installation is doubtful owing to the presence in the sewage of iron salts in large quantities.

York—In a report to the Sewerage Committee, dated October, 1901, the City Engineer states (on p. 41), with respect to an experimental plant consisting of an open septic tank and continuous treatment in coke-beds, that the results were excellent and the filtrate was non-putrescible. That "the system is adaptable for larger quantities per square yard than any other experiment," and that there is no loss of liquid capacity in the coke-bed.

SHORT SUMMARY OF THE EVIDENCE GIVEN BEFORE THE ROYAL COMMISSION ON SEWAGE DISPOSAL.

It has been suggested that the results arrived at by the Royal Commission on sewage disposal would be of great value to the Main Drainage Committee of the Council. The Commission have now published their minutes of evidence, and a careful perusal of the evidence given by the independent experts, including engineers, bacteriologists and chemists, shows that they are in general

agreement in maintaining that the only known method of producing a satisfactory sewage effluent on a large scale is by the adoption of one or other of the various systems of bacterial treatment.

The bacteriologists gave evidence to the effect that the purification of sewage was a combined anærobic and ærobic process, and that the best results were obtained by a more or less perfect anærobic treatment, followed by an ærobic treatment. The evidence in support of this view tendered by Professor Marshall Ward and by Dr. Sims Woodhead, is mainly based on theoretical grounds, and will be found to be of great value and interest.

On the other hand, Dr. Adeney, Colonel Ducat and others claim that their processes are entirely ærobic in their character. In face of the above evidence this contention appears very doubtful, and it is more likely that the one treatment succeeds in combining the two processes.

The great majority of the witnesses agree that crude sewage cannot be successfully treated by contact beds alone, since, although the results are good and a non-putrescible effluent is produced, the liquid capacity of the beds diminishes so rapidly that they soon become useless.

In order to prevent this choking of the beds and to maintain their liquid capacity, almost all of the schemes described include a preliminary process of sedimentation which is in most cases also rendered an anærobic or so-called "septic" process. Its main objects are to free the sewage from mineral suspended solids and to cause the complex suspended organic solids to pass into solution and to become simplified in nature. In the subsequent ærobic process, usually carried out in coke-beds, opinion is divided as to the respective merits of a continuous and of an intermittent supply. It must be said that those who support the continuous treatment make out a good case so far as the results obtained are concerned. The continuous system seems to produce nitrates in larger amount than does the intermittent system, but at the same time the effluent is by no means as free from suspended solids which appear to be washed through the bed. Some special method of distribution of the liquid to the bed is required by the continuous treatment, and this is not only a cause of additional expenditure, but also of additional trouble in maintenance as compared with the intermittent system of supply.

It is generally agreed that the liquid capacity of a new bed falls rapidly when it is first started, but it is maintained that this decrease soon ceases, and that a permanent capacity can be insured by an intelligent working of the bed. The extreme capacity values vary from 20 to 33 per cent. of the whole space represented by the bed when full—including both coke and liquid. An average of about 30 per cent. would represent the average permanent capacity of a working bed.

Three fillings of the beds per day were advocated by most of the witnesses, and the quantity of sewage per day dealt with by an acre of bed, three feet in depth, was placed at not more than 800,000 gallons. This is undoubtedly understating the capabilities of the bacterial system. Deep beds have given quite as good purifying results as shallow beds.

The quantity of sludge which disappears by anærobic action in the settling or "septic" tank is variously estimated at from 20 to 60 per cent. of the whole amount deposited in the tank. It is curious to note that Mr. Whittaker claims that no sludge disappears in his septic tank, though he admits that large quantities of gas are found. (Questions 5742-65.) In cross-examination on this matter, he can hardly be said to have proved his statement.

It was generally admitted that a septic tank effluent is capable of being rendered non-putrescible by one contact in an ærobic bed.

Professor Letts, in his evidence with reference to the purification of Belfast sewage, stated that salt prevented the formation of nitrates. This perhaps accounts for the low proportion of nitrates found in the effluents from the Crossness beds, as compared with that found in the effluent from the Barking beds, since Crossness sewage contains an abnormal quantity of salt.

Dr. Adeney's evidence will be found to have a bearing on the present and probable future condition of the river Thames.

Briefly, it may be said that although the experts differed in small matters of detail, they agreed in the broad principles of sewage purification by bacterial means, and their evidence is a strong confirmation of the results obtained by the experimental work carried out at the Council's outfalls.