COMMONWEALTH OF AUSTRALIA.

PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS.

REPORT,

TOGETHER WITH

MINUTES OF EVIDENCE AND APPENDICES,

ON THE QUESTION OF

THE CONSTRUCTION OF A MAIN SEWER

FOR THE

CITY OF CANBERRA.

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MEMBERS

OF THE

PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS.

FIRST COMMITTEE:

EDWARD RILEY, Esquire, M.P., Chairman.

SENATE.	HOUSE OF REPRESENTATIVES.
Senator the Honorable JOHN HENRY KEATING.	JAMES EDWARD FENTON, Esquire, M.P.
Senator PATRICK JOSEPH LYNCH, Vice-Chairman.	WILLIAM FYFE FINLAYSON, Esquire, M.P.
Senator WILLIAM HARRISON STORY.	The Honorable HENRY GREGORY, M.P.
	SYDNEY SAMPSON, Esquire, M.P.
	WILLIAM HENRY LAIRD SMITH, Esquire, M.P.

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LIST OF WITNESSES.

[*Extract from "Hansard," 18th January, 1914, page 2271.*]

PUBLIC WORKS COMMITTEE—CANBERRA WATER SUPPLY AND SEWERAGE SCHEME.

Mr. KELLY.—In reference to the questions which I asked the Prime Minister yesterday in regard to referring to the Public Works Committee the water and sewerage scheme for the Federal Capital, will the Prime Minister now promise to refer at least the sewerage scheme to the Committee?

Mr. FISHER.—The Minister of Home Affairs will submit that work to the Committee, and the reference will have this advantage—that some work incidental to it may be in progress at the same time as the investigation.

MAIN SEWER FOR THE CITY OF CANBERRA.

REPORT.

THE PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS, to which the Honorable the Minister of State for Home Affairs submitted for inquiry and report the proposed construction of a main sewer for the City of Canberra, has the honour to report as follows:—

1. The Chairman of the Committee received an intimation from the Honorable the Minister of State for Home Affairs to the effect that the Government desired the Committee to inquire into and report upon the question of the construction of a main sewer for the City of Canberra.

The Committee was aware (*vide Hansard* of 18th December, 1914, page 2271) that the Right Honorable the Prime Minister had promised the House of Representatives that before the work was undertaken the matter would be referred to the Committee for inquiry.

REASONS FOR THE PROPOSAL AND INQUIRY.

2. An economical and efficient means of disposing of the sewage of the City is essential. Furthermore, relations between the Commonwealth and the Government of the State of New South Wales respecting the water of the Murrumbidgee River demand that the utmost care be taken in treating sewage and disposing of the effluent so that there shall be no possible pollution of the waters of that river.

DESCRIPTION OF THE WORK.

3. The proposal of the Department of Home Affairs briefly was that for the purpose of disposing of the sewage of the city a main sewer should be constructed commencing from a point on the western boundary of the City and extending in a south-westerly direction to Western Creek. Here the sewage would be subjected to what is known as the biological or septic tank treatment, and the resultant effluent utilized for irrigation purposes.

4. The length of the main sewer from the City boundary to the sewage farm would be about 3 miles.

The average depth would be about 35 feet, being from a minimum of 5 feet at Yarrolumla Creek to a maximum of 80 feet through some of the ridges. The fall throughout has been governed by the distance from the outfall at Western Creek to the most distant locality of the city to be sewered, which is about 7½ miles, due regard being paid to a contingent extension should the City expand eastwards in future. The grade also has been fixed to provide for a sufficient depth to permit of the Royal Military College at Duntroon and both portions of the City lying to the north and south of the Molonglo being sewered.

5. The type of sewer proposed is egg-shaped, 5 ft. 6 in. by 3 ft. 8 in., with concrete block invert and sides of concrete or brick, as may be found suited to the nature of the country to be negotiated. The capacity of the sewer, based on a fall of 3 feet per mile giving a mean velocity when running two-thirds full of 2·34 feet per second for a period of twelve hours, is 940,000 cubic feet. This will be sufficient to carry the sewage of a population of 125,000. The velocity mentioned is said to be a safe one, and will avoid scouring and injury to the lining of the sewers. It is stated that the section suggested is a most economical size both as regards facility of construction and the amount of material involved, bearing in mind the sewer capacity afforded.

COST.

6. The cost is estimated at about £5 per foot run, or a total cost for the length of approximately 3 miles of £75,000.

INSPECTIONS BY COMMITTEE.

7. The Committee having heard the officials' explanations of the proposed work, and having by inspection and inquiry acquainted itself with the system carried out at Werribee for the disposal of the Melbourne sewage, and the systems in operation at Balmoral, Folly Point, and Chatswood, for the disposal of portion of the Sydney sewage, visited Canberra, and carefully investigated the site proposed for the treatment works, paying special attention to the lay of the country, the nature of the soil, &c.

EVIDENCE.

8. A large amount of evidence was taken, and, as will be seen from the list of witnesses, the Committee in the course of its investigations had the benefit of the advice and opinion of four medical men (including the Director of Quarantine, the Senior Medical Officer of the Department of Public Health, New South Wales, and the Chairman of the Board of Health of Victoria), six engineers, and an expert in sanitary science.

VARIOUS PROPOSALS.

9. After some deliberation the question resolved itself into the consideration of three distinct schemes, viz. :—

(*a*) That proposed by the officers of the Department of Home Affairs, and which may be called the Departmental scheme.

(*b*) That put forward at the invitation of the Committee by Mr. Joseph Davis, Director-General of Public Works, New South Wales; and

(*c*) That proposed by Mr. W. B. Griffin, the Federal Capital Director of Design and Construction.

10. Briefly the differences were as follow :—

(*a*) The Departmental scheme provided for the construction of 3 miles of sewer to carry the sewage to Western Creek, where it was proposed to treat it by septic tank process, and (if considered necessary) filter beds, and spread the effluent over the land, of which an area of about 3,000 acres was available. This area could, if desired, be utilized for the growing of lucerne or other approved crop. The sewer was to be of such a size as to serve the needs of a population up to 150,000. The area set apart for the sewage farm was capable of dealing with the effluent from that amount of sewage, and avoiding any likelihood of contamination of the Molonglo River.

(*b*) Mr. Davis' scheme was to save the cost of construction of approximately 1¼ miles of sewer pipe by treating the sewage on an area selected by him in the vicinity of Yarrolumla Creek.

He proposed, while approving of the Departmental scheme of constructing a main sewer to provide for 125,000 people, to make provision at the present time for the treatment of the sewage of a population of 15,000 only, which population it is anticipated would not be exceeded for the next ten years; install a septic tank and filter bed, and either run the resultant effluent into the Molonglo River, or, if thought necessary, treat it on the land. He indicated an area of about 60 acres which he considered suitable for this purpose. This area could, however, by terracing, be extended to about 150 acres.

(*c*) Mr. Griffin's scheme was to install separate units of the Emscher or Imhoff tank in various portions of the city as occasion required; treat the sewage at an early stage, and discharge the effluent (which it is claimed is innocuous and non-putrescible) into the ornamental lakes in the City or into the river.

THE COMMITTEE'S INQUIRY AND CONCLUSIONS.

11. Taking into consideration first of all the scheme put forward by Mr. Griffin, the Committee was satisfied from its personal investigations and by the opinion of the majority of the medical men and engineers who gave evidence that it was unlikely that treatment works within the City boundary could be managed without offence at certain times of the year at least. It was, therefore, decided that such scheme could not be recommended.

12. The proposal put forward by Mr. Davis received long and earnest consideration. The shortening of the proposed sewer by about a mile and a half and the consequent saving of approximately £37,500 was a strong argument in its favour. On the other hand the disadvantages pointed out were (*a*) the comparatively limited area available for the disposal of the effluent; (*b*) the possibility of contamination of the Molonglo River; (*c*) the possible depreciation of the value of the land in the vicinity, (*d*) the fear that the existence of the treatment works near Yarrolumla might tend to limit the expansion of population in that direction; and (*e*) the conviction that with the expansion of settlement it would be necessary to remove the treatment works further out—probably to the position now recommended under the departmental scheme—thus involving finally a considerably greater expenditure by, say, 1935 in capital cost and interest than if the departmental scheme were adopted at once. (*Vide* Appendix B.)

13. Taking all facts into consideration and bearing in mind that the ideal of the planning of Canberra is that it shall be a City replete with all the improvements which the accumulated knowledge of scientific town-planners throughout the world has shown to be advantageous, and free from those features which experience has proved to be objectionable, the Committee decided to avoid the risk of contamination of the Molonglo River and the establishment of treatment works in a position liable to cause annoyance to the future inhabitants, and to that end recommend the adoption of the scheme as proposed by the Department of Home Affairs.

14. Although in the course of its investigations the Committee gathered some valuable information as to the various styles of septic tank and systems of treatment of sewage, it realizes the rapid strides being made in sanitary science and refrains from suggesting the adoption of any particular system in view of the fact that what is considered the most up-to-date system at the present time may be superseded by a more efficient system by the time it will be necessary to erect treatment tanks at Western Creek.

The Committee, however, strongly recommends that immediately prior to the date on which it is proposed to erect treatment tanks, exhaustive inquiries be made with a view to the installation of the most up-to-date system then obtainable.

RESOLUTION PASSED.

15. The resolution passed by the Committee is shown in the following extract from its Minutes of Proceedings :—

Mr. Finlayson moved—That the scheme for the construction of a main sewer to Western Creek as proposed by the Department of Home Affairs be adopted. Seconded by Mr. Sampson.

Mr. Gregory moved as an amendment—That the scheme suggested by Mr. Davis for treatment of the sewage near Yarrolumla Creek be adopted. Seconded by Senator Lynch.

The Committee divided on the amendment—

Ayes, 3.	Noes, 6.
Mr. Gregory,	Mr. Riley,
Senator Lynch,	Mr. Finlayson,
Mr. Fenton.	Mr. Sampson,
	Mr. Laird Smith,
	Senator Keating,
	Senator Story.

And so the amendment passed in the negative.

The Committee then divided on the motion—

Ayes, 6.	Noes, 3.
Mr. Riley,	Mr. Fenton,
Mr. Finlayson,	Mr. Gregory,
Mr. Sampson,	Senator Lynch.
Mr. Laird Smith,	
Senator Keating,	
Senator Story.	

And so it was resolved in the affirmative.

Edward Riley

Chairman.

Office of the Parliamentary Standing Committee on Public Works,
120 King-street, Melbourne,
10th March, 1915.

PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS.

MINUTES OF EVIDENCE.

MAIN SEWER FOR THE CITY OF CANBERRA.

(Taken at Melbourne.)

MONDAY, 25TH JANUARY, 1915.

Present:

Mr. RILEY, Chairman;

Senator Keating,	Mr. Gregory,
Senator Story,	Mr. Sampson,
Mr. Fenton,	Mr. Laird Smith.
Mr. Finlayson,	

Percy Thomas Owen, Director-General of Works, Department of Home Affairs, sworn and examined.

1. *By the Chairman.*—I produce plans, notes, and specifications in regard to the construction of the main sewer at Canberra, a work which is actually in progress at the present time. I submit three copies of notes, which outline what has transpired in relation to the proposed sewerage system at the Federal Capital from its very inception till the present time. These notes, in conjunction with the plans, will, I hope, give the Committee a sufficient insight into the works to which they relate to enable its members to ask for any further information they may desire on various points. I suggest that Mr. Hill, the engineer, should be examined in regard to the details of the scheme.

The witness withdrew.

The Committee adjourned.

(Taken at Melbourne.)

TUESDAY, 26TH JANUARY, 1915

Present:

Mr. RILEY, M.P., Chairman;

Senator Keating,	Mr. Gregory, M.P.,
Senator Story,	Mr. Sampson, M.P.,
Mr. Fenton, M.P.,	Mr. Laird Smith, M.P.
Mr. Finlayson, M.P.,	

Percy Thomas Owen, Commonwealth Director-General of Works, further examined.

2. *To the Chairman.*—I have prepared the following notes in regard to the sewerage scheme for Canberra:—

NOTES ON SEWERAGE SCHEME, CANBERRA.

1. The construction of main sewers, to be followed by sewage districts and reticulation as soon as practicable, was one of the early engineering works in a scheme and report submitted by the Director-General of Works in June, 1910.

2. In that scheme there is a paragraph as follows regarding sewerage:—

Sewerage Scheme.

Relations with the Government of the State of New South Wales respecting the water of the Murrumbidgee River demand that the most efficient measures shall be taken to insure innocuous disposal of effluent; a biological treatment, combined with broad irrigation, should meet the case.

Those relations—City Site to the Molonglo and Murrumbidgee Rivers—had a great influence in the investigations regarding sewage disposal.

3. When the City Site—within the Yass-Canberra region—was being determined one factor was to ascertain whether a suitable site was available for sewage disposal; the investigations disclosed that the site shown on the accompanying map meets requirements.

4. The Commonwealth Statistician, in February, 1910, gave a forecast of population, on the assumption that works would be in full progress in 1914, and the estimated population was as follows:—

1914	...	...	21,250
1915	...	...	20,150
1920	...	...	14,200
1925	...	...	15,400
1930	...	...	16,700
1935	...	...	18,150

5. Although no estimate of ultimate population can be made now, it is considered that the main sewerage treatment works undertaken by this generation should be capable of progressively—by extension from time to time—meeting the needs of a population of 125,000 or more.

6. Although the population at the time of occupation at the seat of Government would be about 15,000, engineering considerations, in addition to requirements of prospective population, called for a main sewer of the size specified, and shown on accompanying drawings, capable of carrying the sewage of 125,000 people.

7. Whilst investigating a site for sewage treatment works, prominent consideration was given to the distance from the city at which such works should be located from reasons of both hygiene and sentiment. The adopted distance from the city boundary is 3 miles.

8. The levels adopted for the sewer are such that sewage pumps within the city area are avoided, and there will be gravitation to the outfall works from all portions of the city area on both sides of the Molonglo River, and from the Royal Military College (just outside the city area).

9. During August, 1913, Mr. Thomas Hill, Engineer for the works at Canberra, furnished a report—[*vide* paragraph 14.] The scheme submitted was that the sewage treatment should

be by biological action and subsequent irrigation with the effluent. The report was approved and submitted by the Director-General of Works, and in February, 1914, the Minister for Home Affairs directed that a specification should be prepared. In July, 1914, Mr. Hill submitted the specification and plans—[*Copies herewith marked "C" and "D".*] Investigations of the geological formation had been carried out in the meantime by means of test shafts. The positions of shafts are shown on the plan, while the nature of the country encountered is mentioned in the specification.

10. The principal features of the design are briefly as follow:—

The sewer pips will be concrete of egg-shaped section with internal dimensions 5 ft. 6 in. height by 3 ft. 8 in. breadth, manholes for access at 500 feet intervals and ventilators at 1,000 feet intervals. The estimated cost of sewer from the city boundary to the treatment works is £75,000 based on costs current at the date of the report. The course is almost direct from the city boundary to the site of the treatment works. The greatest depth of sewer below the natural surface is about 90 feet, the average depth about 40 feet. The fall throughout has taken into account the distance (about 7½ miles) from the sewer location near the Jerrabomberra Creek to the most distant locality of the city to be sewered, due regard having been had to possible sewage districts should the city extend eastwards. The capacity of the sewer is based on a fall of 3 feet per mile, giving a mean velocity, when running two-thirds full, of about 2¾ feet per second.

11. The following plans accompany these notes:—

"D," showing sewer route.
"E," of Canberra, showing relation to city site.
"F," showing section of sewer and details for manholes and ventilators.

12 The site of sewage farm, general direction of main sewer and relative position of City Site are as shown on the map of the Federal Territory which accompanies the report regarding the upper Queanbeyan reservoir.

P. T. OWEN,
Director-General of Works.

25th January, 1915.

No definite decision has yet been arrived at; but in the reports I have submitted I have recommended the adoption of biological treatment of the sewage, or, in other words, septic treatment combined with broad irrigation with the effluent. There are a good many variations of biological treatment. There is, for instance, that of sedimentation, in which lime or other chemicals are used to precipitate the solids held in the sewage. These are collected in the form of sludge, the effluent is carried off, and the sludge may be septically treated or taken out dried and caked, and, if possible, marketed. Under the system such as we propose the sewage would enter a septic tank, and there would be biologically reacted upon It would then be aerobically treated either on treatment beds, or by simply discharging it on an irrigation area. In selecting a site for sewage treatment 3 miles from the city boundaries we were governed by considerations of hygiene and sentiment. Many people say that with modern biological treatment there is no smell given off by such works, but actual experience shows that there is. A few days ago I met Mr. Hickson, Engineer of the Perth Sewerage Board, and he told me that, whilst they were not supposed to give off any odor, he had never met with one which did not smell at some time or other. It has to be remembered that we are trying to build a garden city in connexion with which everything is to approach perfection as nearly as possible. In these circumstances I felt that the establishment of sewage treatment works within the city or close to it would be regarded by the general public as unforgivable. Whatever system we adopt it is impossible to say that the works may not smell one day out of the 365 of a year, and we should be for ever accursed if sewage treatment works were established within the city boundaries, and were to smell even only one day a year.

3. *To Mr. Gregory.*—I am told that the works in Perth sometimes give off a smell. A responsible officer, in preparing a scheme of this kind, must never lose sight of the fact that it is one to deal with sewage. Even if he does forget, no one else will, and sentiment counts for much. The average man would not care about buying vegetables grown on a sewage farm. I personally would not use such vegetables. It may be only a matter of sentiment, but the prejudice I think is general. There are certain advantages in other directions associated with the establishment of the sewage treatment works at a distance of not less than 3 miles from the city. In the first place, liquefaction is secured. The sewage practically becomes liquefied before it reaches the septic tank, and that in itself is an advantage.

4. *To Mr. Sampson.*—Under the Emscher system the sludge is precipitated, and treated septically. The sludge, instead of the whole of the sewage, is septically treated, and the effluent is anaerobically treated. Under the septic system which we propose very little sludge is obtained. Mr. Hill will be able to advise the Committee as to the results that have been secured with the tanks we have in the Federal Capital area, but the tanks are small. Where sewage is carried over a much greater distance than that proposed by us, putrefaction sets in, and very bad odors arise. As will be seen from the plans I have submitted, we provide for a series of ventilators. Some of these will be up draughts, while others will be down draughts. Shafts will be sunk varying in depth according to the section. Our sewage will traverse only a short distance, and in the case of short distances simple liquefaction sets in. In connexion with the Melbourne sewerage scheme, I understand, putrefaction sets in before the sewage reaches the treatment works owing to the distance which has to be travelled.

5. *To Mr. Fenton.*—It is not intended to allow any storm-waters or surface drainage to enter the sewers. It would be possible to resort to incinerator treatment to get rid of the sludge, but that would be scarcely worth while in this case, as the quantity of sludge from the sewage of a city with a population of 15,000 would be small. There are many processes other than those I have already mentioned for the treatment of sewage. The city of Dublin treats the sludge with rotary driers, and where possible sells it in cake form. It has, however, to carry a good deal of it out to sea. The city of London also carries sludge out to sea. The manure value of these sludges is extremely low. I learn from a pamphlet written by Mr. Joseph Davis, Director-General of Works for New South Wales, that in England it has been found difficult to dispose of the manure. The people are prejudiced against it for the reason that it represents sewage.

6. *To Mr. Laird Smith.*—We shall remove the sludge whenever it is necessary to do so. The quantity, as I have said, will be small, but when necessary we shall cart it away, and if it has any value as a manure, we shall distribute it.

7 *To Mr. Fenton.*—To submit it to incinerator treatment would involve a rather lengthy drying-out process, but that has been done in some cases. I am not prepared to say that a sewage farm of 3,000 acres, or more, as we propose, will mean in course of time considerable settlement there. It has not yet been definitely decided whether pathological germs or bacilli can live through the septic treatment. It is said by some authorities that they can, while others hold that they cannot. But if the pathological germs can withstand such treatment, then a good deal of risk would be involved, for instance, in depasturing milch cows on a sewage farm. That risk would not attend the grazing of sheep on such areas. I discussed this matter with Sir Maurice Fitzmaurice when he was here a little while ago. There was a small irrigable area at Jervis Bay, and I pointed out to him that it was open to me either to use it for sewage purposes, or to take the sewage effluent over some rocky country into Jervis Bay. I told him that I was inclined to adopt the latter course, and he agreed that it would be the wiser one to follow. When I asked him what were his views in regard to irrigation with sewage, he said that he did not think it would be worth while at Jervis Bay, and the value of such areas, except for grazing, was rather doubtful. I know that sheep are grazed on the Melbourne and Metropolitan Board of Works' farm at Werribee, but I do not know that vegetables are grown there, and it was the use of these areas for market gardens that I had in mind when I referred just now to the possibilities of settlement. In the case of the Melbourne and Metropolitan system, there is no septic treatment. I should not object to beef or mutton raised on the Werribee Sewage Farm, but I should personally be opposed to using milk taken from cows grazed there, in view of what we know as to the spread of intestinal diseases—such as typhoid fever—by the consumption of milk. I certainly think that the sewage farm will be found valuable for grazing sheep.

8. *To Mr. Sampson.*—The use of vegetables grown on such areas would certainly be objectionable if, despite the septic treatment to which the sewage was subjected, pathological germs still lived in the effluent with which they were irrigated. I would suggest that Dr. Cumpston be interrogated on that point The main sewer for which our plans provide will be capable of carrying the sewage of a city of at least 125,000 people without additional pressure That is a conservative estimate. Mr. Hill believes it would meet the requirements of a population of 150,000. If the population of the Capital extended beyond that limit, I think another sewer would be put down. The sewer for which our plans provide would not be enlarged. One sewer would, of course, be better than two, but with such an extension of population as you suggest, the laying down of a second sewer would meet the difficulty. Although we are not likely to have for very many years to come a population of 125,000 in the Federal Capital, I think that a main sewer of the size we now propose is desirable. It is an economical size to construct, since it is one in which a man could work with the least difficulty. If a smaller sewer were constructed the cost of excavation and filling in would be greater. It will mean an excavation about 6 feet in diameter. When you go above that size, the cost of construction is immediately increased. According to statistical estimates, we may assume that something like two centuries will elapse before we shall have at the Capital a population of 200,000. To provide at the present time sewers sufficient to meet the requirements of such a population would mean the expenditure of a large amount of capital, from which there would be no adequate return for generations to come. Such a system would cost more than would be involved in scrapping this sewer, so to speak, at the end of 200 years, and building a larger one. I do not think any material saving would be made by reducing the scheme we propose. I have questioned Mr. Hill very closely on the subject, and he has assured me that the sewer for which our plans provide is economical and desirable from an engineering point of view. The section is 5 ft. 6 in. by 3 ft. 8 in. That he regards as an economical section. It is also economical from the point of view of the readiness with which it can be cleaned. A man would be able to move along it at any time without difficulty. With a smaller pipe he would have to stoop to a considerable extent, and would therefore not be able to work so freely. The septic tank at Duntroon at present is very small, and so far there has been no sediment. We have to provide there for the requirements of only 400 people, so that we cannot draw any final deductions from the experience gained from its use. If any sludge did occur it would be taken away. If it were of any value as a manure it would be spread; if it were not, it would be buried.

9. *To Mr. Fenton.* — I do not attach much value to the sewage farm itself except for the grazing of sheep and cattle. We do not anticipate a population of more than 4,000 or 5,000 people for the next few years. The sewage from a town of that population would enable us to irrigate 4 acres, so that there is not much in this scheme from the point of view of irrigation with the effluent.

10. *To Mr. Finlayson.*—The area to be drained by this scheme at the present time is 9 square miles. If the civic authorities think it worth while the whole area will be sewered. There is no limit to the extension of the system beyond that of the capacity of the main sewer which, on a very conservative estimate, is sufficient to meet the requirements of a population of 125,000. Mr. Hill will tell you that it will be sufficient for 150,000. We base our estimates as to the capacity on a flow of 30 or 40 gallons of sewage per diem per individual with what are known as "peak" flows. That is to say, in the early morning, owing to the use of baths and so forth, there is a bigger demand on the sewerage system than during the rest of the day. Mr. Hill is working on the basis of a flow of 40 gallons per head per diem. The flow in the sewer is based on a fall of 3 feet per mile, and when it is running two-thirds full we get a mean velocity of about 2¾ feet per second. The flow in the pipes is determined according to recognised engineering formula. I shall endeavour to obtain for the information of the Committee figures showing the experience of cities with a population up to 100,000 which have adopted this system. I have never closely examined the sewage farms connected with big cities where the system which we propose is in vogue, but I have been over both crude and effluent sewage farms. I have not been in charge of such a farm. I am satisfied from what I have seen and read that this system will be satisfactory from a hygienic, as well as from an agricultural point of view. It is indeed, to my mind, the only way to deal with this sewerage scheme. I am a strong believer in biological treatment for it as opposed to any sedimentation process.

The biological treatment of sewage is, in my judgment, the only way in which to safeguard the public health. The prevailing winds at Canberra are westerly, and a good deal south of west. In the winter there are very strong winds from the west, whereas the summer winds are mostly from the north-east. The prevailing summer wind may be described as the tail end of the Sydney north-easterly, which usually reaches Canberra in the afternoon. There is no danger, in my opinion, of any smell from the sewage farm, distant as it will be, 3 miles from the city boundary, reaching the city itself. Part of the farm will be a little higher than, say, Camp Hill. The existence of the treatment works might be realized at times when passing them, but no smell from them will reach the city. The maximum depth of the main sewer from the surface will be 90 feet, and the minimum 5 feet, the average depth being 40 feet. That will mean tunnelling. We have in the first place to secure a fall of 3 feet per mile, and we have also to carry the sewage to a certain locality where it can be treated. The sewer will run in a straight line under the hills, and it is where it passes under these hills that the maximum depth will be reached. Shafts will be sunk, and we shall then tunnel from one to the other Our original estimate of £4 per foot has been increased to £5 per foot. Further investigation has shown that we shall have to pass through a little more hard rock than we anticipated In some places where we thought to meet with decomposed rock, we shall not do so. Another factor is that since the original estimate was made wages have increased. The Committee may take it that we have now so fully examined the character of the country to be traversed by the main sewer that the estimate of £5 per foot will not be exceeded. It will take eighteen months to construct the sewer. Some of the shafts are already down, and certain portions of the plant required for boring and raising the material are being got together by Mr. Hill. There will be an independent storm-water system, which will be designed in accordance with the city's requirements. The storm-waters will have to be discharged into the Molonglo River at a point below the dam which will contain the ornamental waters. A different route will be followed by the sewer for drainage purposes. There are cities where it would be possible to provide for storm-water and sewage being carried along the one drain. Where you get more than a given percentage of storm-water, you can discharge the whole of the sewage quite independently of any septic treatment. The sewage itself in such a case would be so largely diluted that it might be allowed to go free without any special treatment. But that would not be possible at Canberra. It would not do to allow the sewage to run free of the treatment tanks. If storm-waters were allowed to enter the main sewer the effect would be to wash out the septic tank. It is absolutely necessary to have contact in the tanks for a given number of hours, and in connexion with a septic system it is not desirable to have much dilution. Any substantial dilution would mean an interference with the biological action. I am rather inclined to think that the character of the country to be traversed is such that, instead of allowing the water to pass freely through it, and to drain off into any of the adjacent streams, it is if anything, a little too clayey, and would not drain very freely I think that any effluent used for irrigation would evaporate. The clayey character of the soil is rather an advantage. I should not be pleased with a soil that would discharge the effluent too freely. It may be merely a matter of sentiment, but I should prefer to see the effluent evaporate. I have seen the effluent from a sewage farm, and have heard it described as tasteless and clearer than ordinary water, but I have not tasted it. The main sewer will be constructed of concrete. It will not consist of concrete pipes, but will be built of massed concrete in the tunnels. The work will be done by the Department, and carried out by its own men. Our estimate is upon that basis. The only scheme suggested as an alternative to that which I have put before the Committee is one which was made to me in a casual way. I had better, perhaps, allow Mr. Griffin to describe it in detail to you. He was of opinion that the sewage should be treated within the city, that the effluent should be used on the parks and gardens, and that the sludge should be marketed. His proposal was that we should adopt the Emscher system. I have never heard it suggested by any engineer out here that we should deviate from the principle of establishing our treatment works beyond the city boundaries. My first objection to the Emscher system is one of sentiment. Then there is the real objection that it might create a nuisance. There can be no absolute guarantee that there will be no smell from works where sewage is disposed of. Then to distribute the effluent over our parks and gardens at the Capital would mean pumping it up, and the use of a separate system of pipes. I do not think any one would favour the use of the effluent rather than the ordinary water supply for our parks and gardens. Any possible gain in the way of administration from the adoption of the Emscher system would be discounted by the cost of the works. The sewage sludge, Mr. Griffin thought, would be of marketable value. If we had to deal with the sewage of a city with the population of Dublin some revenue might be obtained in that way. We might secure a market for some of our sludge, but even Dublin cannot find a market for all that her works produce, and has to send a lot of it out to sea. It is of low value as a manure, and the sludge obtained from the sewage of a population of 15,000 would be a negligible quantity. The tank used in connexion with the Emscher system is about 20 feet high, and the sediment is dropped to the bottom of the tank where it is treated septically. The discharge is taken from the top, and is treated aerobically. I asked Mr. Griffin whether he thought the public would ever forgive us if we erected such a tank in one of our public parks. Mr. Kelly, when Assistant Minister of Home Affairs, questioned me about the proposal, and I told him that I thought it would be absolutely wrong to adopt it; that we must consider the public, and take our sewage away from the city, and there treat it biologically. I have no estimate of the cost of establishing the Emscher system; Mr. Griffin has not supplied me with one. It would be less costly than that which we propose in the matter of the main sewer, but the treatment would involve considerable outlay. There are big treatment works at Bradford which cost about £1,250,000. As the Committee, no doubt, is aware, money can be spent like water on such works. Bradford is a very big city, and it experienced considerable difficulty because of trade wastes in sewage. I am unable to say what the Emscher treatment works would cost, but I turned down the proposal on the broad grounds I have indicated.

11. *To Senator Keating.*—I may briefly explain what is meant by the biological treatment of sewage. In the human intestines, and in everything that is given off through the alimentary canal, there are millions of bacilli or micro-organisms. The action of these bacilli breaks down the solids contained in the liquid of the sewage, and on its way to the septic tanks the sewage in this way becomes liquefied. It was Pasteur who discovered, in 1862, that there were bacilli in sewage, and in all decomposing matter, which affected the decomposition. It was then discovered that there is a bacillus which works in darkness (anaerobically), with the result that the solids are broken up and the ammonia liberated. The solids are liquefied by the anaerobic action of this bacillus. The next action is of an aerobic character. The sewage is oxidized, and the ammonia is reacted upon, with the result that nitric acid and nitrates are produced. That is a natural action. A thick scum is formed on the water in the anaerobic tank, the tank is 5 feet deep, and under this scum the bacilli work out this natural process. By way of experiment the carcasses of dead animals, such as cats, have been hung in a septic tank, and within a fortnight only the bones remained. In the course of time everything was broken down. This organism brings about certain chemical changes in the substances treated, and causes it to liquefy. When I speak of biological treatment in this connexion, I am referring to the septic tank system. After the sewage has been treated in the septic tanks the effluent is carried away. The effluent is passed over beds where it is treated aerobically, and rendered innocuous. Such treatment would be involved under the scheme proposed by Mr. Griffin, and would take place within the city. The sludge is made into cakes and sold if possible as manure, while the liquid has to be treated aerobically, because very often it is putrescent. There is no septic treatment at the Werribee Sewage Farm. One disadvantage in connexion with the Melbourne sewage system is that the sewage has to be carried such a distance that it decomposes before it reaches the farm, and gives off a very bad smell. Enthusiasts will tell you that there is no smell associated with a septic tank, but the man on the corner, or, in other words, the man who knows, will tell you that there is, notwithstanding that the tank is sealed. Tunnelling will be carried out in connexion with the main sewer, the inside measurements of which are to be 5 ft. 6 in. by 3 ft. 8 in. I do not think there is any likelihood of the tunnel being fractured unless an earthquake occurs. There is certainly no likelihood of any landslip. Mr. Knibbs' estimate of the probable population of the Federal Capital has not so far been borne out. He estimated a population of 20,150 in 1915, but there are certainly not 20,000 people there to-day. I presented a report to the Minister in 1910, and Mr. Knibbs' estimates hinged on what would the number of men working on the construction of the Capital, and the completion of the several schemes. I told him that in 1914 our public works there would probably be in full swing. I gave him to understand that if that were so, we should be employing 2,000 or 3,000 men, and we assumed that in addition the civic population would be building their houses. Mr. Knibbs, in forming his estimate, took into consideration the number of Government employés that we were likely to have, and made that the basis of his calculations. But, instead of having 2,000 or 3,000 men at work in the Capital, we have only, roughly speaking, about 400 at the present time. Then again, I was under the impression that in 1914 the general public would have been obtaining leases of city sites, and erecting buildings there. The general public loses sight of the fact that the people themselves are going to build this city. The Government will erect certain public buildings, provide sewerage, water supply, and so forth; but the people themselves will build the city. All these factors were taken into consideration by Mr. Knibbs, but our estimates are not being borne out, inasmuch as the works are not in full progress. The estimate of population to which I have referred in my written statement may be put back three years. I think that the scheme for which we are providing in order to attain certain objects is an economical one for immediate requirements. No sewage pumps will be required in connexion with it, but an effluent pump will be necessary at the sewage farm. The variations in the depth of the sewer, ranging from a maximum of 90 feet to a minimum of about 5 feet are entirely due, of course, to variations of the surface. The main sewer will follow a continuous line. I think that a great many cities allow a certain proportion of storm-water to enter their sewer pipes, but the local authorities, as a rule, will not permit more than a certain percentage to flow into them, and would rather be without any storm water at all. The storm-waters of Melbourne do not go into the Board of Works sewers. The run-off from the hills at Canberra is very great during heavy downpours I have never seen anything worse, and the problem of dealing with these storm-waters will prove a very serious one. They come down the side of the hills at times in a sheet. Reverting to the question of ventilators, at some points there will be down draughts—the air will be travelling down—and in others there will be up draughts—the air will go up. It will depend, of course, on atmospheric pressure.

12. *To Mr. Gregory.*—I have recommended the adoption of the septic system. Mr. Hill is the expert officer of the Department who will carry out the scheme. He has had considerable experience in connexion with the Melbourne and Metropolitan Board of Works. It is true that the septic system has not been adopted here, but we have done a certain amount of septic tank work in the Federal Territory, and, as you are aware, we engineers profit by the experience of others all over the world. Exhaustive inquiries have been made into the various systems in other parts of the world. Mr. Joseph Davis, Director-General of Public Works for New South Wales, some time ago made inquiries on behalf of his Government, and made a special tour of inspection in England as well as on the Continent. I cannot say off-hand what is the largest city where a septic system is in force. Climatic influences have a good deal to do with the working of bacteria. We are conducting experiments. There are septic tanks in use in colder climates than that of Australia, and are working effectively. There may be cities with a population exceeding 60,000 where a septic system is in use, but I cannot off-hand mention any. Mr. Hickson, the Engineer of the Perth sewerage system, tells me that it is working all right, although occasionally the works give off a smell.

13. *To Mr. Laird Smith.*—The main sewer will be sufficient to provide for the requirements of a population of 150,000. There are English, American, and German septic systems, but I am unable to say that a combination of the three would prove better than any one of them. The

number of septic tank systems is legion. A septic tank, as you are aware, no doubt, is in the first place simply a filter. Whether we adopt a septic tank system or sedimentation, I think it is advisable that the works should be established outside the city. Where the septic tank system is adopted danger attends the entering of storm-water into the tank. Aniline dyes or other chemicals might thereby be introduced, and render the system unworkable. There is also the danger of getting too great a flow Experts are totally opposed to the introduction of storm-water, except in small regulated quantities, into septic tanks. It would be impossible to allow storm-water sewers to normally discharge into the tanks. There are bacilli in the effluent, but it is supposed to be non-putrescent. The bacilli that remain in the effluent after treatment do not make the water smell. The design of tank to be adopted has not yet been finally settled; the details have not yet been worked out. The main consideration so far has been whether the sewage should be treated within the city boundaries, or beyond them Mr Kelly mentioned the matter of treating the sewage within the city, but I did not entertain the proposal. An Emscher or any other kind of sedimentation tank could be used at the end of the sewer which we propose to construct. We have made tests of the country to be traversed, and have encountered a sort of dacito formation in places, but it does not "shoot" badly There is no sandstone along the route to be traversed.

(Taken at Melbourne.)

WEDNESDAY, 27TH JANUARY, 1915.

Present:

Mr. RILEY, M.P., Chairman;

Senator Keating,	Mr. Gregory, M.P.,
Senator Story	Mr. Sampson, M.P.,
Mr Fenton, M P.,	Mr. Laird Smith, M.P.
Mr. Finlayson, M.P.,	

Thomas Hill, engineer, Department of Home Affairs, sworn and examined.

14. *To the Chairman.*—The plans which have been produced for the information of the Committee dealing with the septic system at Yass-Canberra were prepared by me, and in connexion with that system I addressed the following memorandum to the Director-General of Works, Department of Home Affairs, on 16th August, 1913:—

I beg to report that considerable attention has been devoted recently to the design of the main sewerage system and storm water channels proposed to be established in the Federal Territory; but, in accordance with your instructions, the matter of storm-water drainage has been placed in abeyance until next financial year, as not being of an urgent nature, and attention has been concentrated upon the initiation of that portion of the main sewer from the city precincts to the Sewage Farm.

Herewith is submitted a requisition, together with a sketch plan, outlining the proposal in respect of this section of the main sewer. The length is about 8 miles from the outlet on the city boundary to the Sewage Farm. The average depth is about 25 feet, being from a minimum of 5 feet at Jarrolumla Creek to a maximum of 80 feet through some of the ridges. The fall throughout has been governed by the distance from the main sewer near Jerrabomberra Creek to the most distant locality of the city to be sewered, which is about 7½ miles, due regard having been had to a contingent extension from that point should the city expand eastwards in the future. The grade also has been fixed to provide for a sufficient depth to permit of the Royal Military College at Duntroon, and both portions of the city lying to the north and south of the Molonglo, being drained.

The pipe line is being carefully chosen with a view to reducing cost to a minimum. It would be possible to reduce the mean depth, but that course would entail an increased length of route, which would not be economical.

It is not anticipated that the country to be traversed will present more than ordinary obstruction to the laying of a main sewer, and the estimated cost of the section under notice is approximately £4 per foot run, or, for the 8 miles, say £99,000, of which an amount of £30,000 is proposed to be expended during the present financial year. Operations would begin at the Sewage Farm end of the line as soon as approval is received, and will proceed towards the city.

The type of sewer proposed is egg-shaped, 5 ft. 6 in. by 3 ft. 8 in., with concrete block invert, and sides of concrete or brick, as may be found suited to the nature of the country to be negotiated. The capacity of the sewer, based on a fall of 3 feet per mile, giving a mean velocity when running two-thirds full, of 2.34 feet per second for a period of twelve hours, is 910,000 cubic feet. This is a safe velocity, and will avoid scouring and injury to the lining of the sewers. Although a sewer of somewhat smaller size would meet requirements for the present estimated early population, the size of a main sewer should be liberal to meet extension beyond what is forecasted, and, further, it is necessary to have it large enough to permit a man to pass through for inspection and cleaning during periods in earlier stages, when population is small and flow corresponding. To construct a sewer of smaller size would entail practically the same cost, the same number of shafts would require to be sunk, driving would be more difficult by reason of the smaller working area, while the lining and concrete filling would aggregate about the same volume of material. It may be affirmed that the section suggested is the most economical size, both as regards facility of construction and the amount of material involved, bearing in mind the sewer capacity afforded.

The manholes on this main sewer, it will be noticed, have been located at intervals of 600 feet. These locations will coincide with those of the shafts necessary in construction, and the arrangement is considered to be economical. Ventilators would be located at intervals of 1,000 feet. The seven manholes will be of the usual type in concrete—3 feet square, with cast-iron covers and manhole steps.

Ventilators would be of the best galvanized iron, vent-pipe type, as adopted in the sewerage systems of Sydney and Melbourne.

Later on I was instructed to prepare plans and specifications of the work, and acting on those instructions I submitted to the Director-General of Works on the 14th July, 1914, the following supplementary report:—

" . .

FEDERAL CAPITAL: CONSTRUCTION OF MAIN SEWER.

Specification, together with plans (2), showing general lay-out, longitudinal section and cross section, and details of manholes, ventilators, &c., herewith. The results of the test shafts sunk are also shown on the plans, and described in the specification. They indicate that the ground which may be expected to be met is hard conglomerate. The estimated cost submitted in my previous report of 16th August last (16629), viz., approximately £4 per foot run, can now be definitely stated. Since the date of my report increases in wages have occurred, while the ground to be worked is found to be a harder formation than was anticipated. It is now estimated that the cost will be about £5 per foot run, or a total cost for the length of approximately three (3) miles, of about £75,000.

The scheme covers the first section of the main sewer, from the area selected as suitable for broad irrigation to the city boundary, at the point of natural take-off, and adopted to the lay-out of the Federal City, as per Mr. Griffin's plan. By this method the sewage will be removed from the city at a point representing minimum distance compatible with immunity from possibility of creation of a nuisance, and so providing the most economical proposition.

It is understood, from remarks made by the Honorable the Minister, and kindly conveyed by you to me, that the disposal of the sewage effluent within the city has been suggested for his consideration—in particular, methods of clarifying and treating sewage by the Emscher or Imhoff system of shallow sedimentation tanks, and treatment of resulting sludge—and that the construction and use of such a system would obviate the expenditure entailed by the construction of 3 miles of main outfall sewer.

This system—or a modification known as the septic tank system has been in operation in the Territory to date some installation serving the Royal Military College at Duntroon, treating the effluent of approximately 400 persons, and another at the Acton Settlement), and the effluent has been spread over suitable areas at low-lying levels, so far with success; the resulting sludges have been dealt with by flushing through the tanks, labour having objected to handle same. The areas available within the city proper for effluent treatment are, however, small, and it will be increasingly difficult—in fact, practically impossible—to so meet the needs of a growing population. Another point is the very possible pollution of the Molonglo, and lake, by the effluent, and I have prepared a rough plan, which is attached, showing the area of the city site and its relation to the Molonglo River, and the area covered by the lake. It will be seen therefrom that the effluent would, unless led by special channel to a point below the dam—a considerable distance, and approximately the length of the main sewer—find its way into the lake. This point was fully considered when selecting the so-called sewage farm area at a point as near as possible to the city, but below the lake area, and reference to the plan indicates that such a location has been found only about 2 miles down the river from the dam site, sufficiently large to insure thorough aeration and absorption, and at a sufficient distance from the Molonglo to prevent the accidental discharge of effluent into the Molonglo River, which might, in such a contingency, be strongly objected to by residents lower down the Molonglo and Murrumbidgee Rivers.

Further, the operation of systems such as the Emscher, Imhoff, or Elberfeld tank systems, which may be found to be modifications of the one principle, would be attended by serious difficulties in the Federal Territory, particularly in the matter of the disposal of the sludge independently of the effluent. To procure suitable labour for handling same would be most difficult, and carriage through the city and subsequent disposal by burial in areas remote therefrom would entail the possible creation of a nuisance unless sealed carts were used (in exactly the same manner as now applies in the disposal of excreta in connexion with the pan system). The sedimentation tanks would, I am of opinion, emit an offensive effluvium at certain times of the year, owing to the decomposition of the sewage whilst under process. The sludge requires to be removed at frequent intervals to avoid the destruction of much valuable organic matter by decomposition, since, unless so removed, it is liable to affect the sewage effluent by the products of its decomposition. Over and above these considerations, there requires to be considered the initial cost of the tanks, of the plant necessary for the removal of the sludge, and of the labour which requires to be constantly employed in maintenance, as against the gravitation scheme suggested, in which the sewage naturally flows to an area on which it is distributed by gravitation channels over the soil, requiring very little attention.

The small scale plan attached shows the general lay-out of the main sewer with its two main branches—one to the Military College, and taking in the area to the north of the Territory, and the other working along the south bank of the Molonglo to the south-eastern corner of the city, where it will be located at a level which will enable any future extension for some miles eastward, should the city extend in that direction, to be executed. It will also be noted that, whilst this system is not an expensive installation for the initial requirements of the city, it is capable of indefinite expansion without further cost than the cost of such extensions.

It is therefore submitted for favorable consideration that the main sewer be constructed as shown, by departmental labour, at an estimated cost of £75,000. I would submit that this is a pioneering service—similar to road-making, water supply, &c.—which can be more economically undertaken by departmental labour, as satisfactory offers were not received upon the occasion of recent invitation of tenders for execution of water supply works, and it is thought experience will be similar in the present connexion. At a later stage, when settlement is more pronounced, and propositions are located within the city area proper, contracts for execution could be let.

I am the chief engineer in the Home Affairs Department in matters relating to sewerage and water supply. For some years I was in the employ of the Melbourne and Metropolitan Board of Works, and whilst there I paid particular attention to the disposal of sewage at the Werribee Farm, where the system known as "broad irrigation" is practised. Since then in Adelaide, Sydney, and elsewhere, I have closely studied the sewerage systems in vogue, with the result that I have designed several small systems, including those in use at the Military College, Duntroon, Acton, Maribyrnong, and Jervis Bay. The experience which I gained at Acton and Duntroon has been in my judgment of the most valuable character. That experience leads me to think that it would be inadvisable to dispose of the effluent from a septic tank system in the Federal Capital city The risks are altogether too great. Particularly does my remark apply to the possibility of an accidental discharging of an effluent which might not be innocuous. If such an effluent got into the artificial lake at Canberra, the consequences would be almost unthinkable. The view which I hold is impressed more strongly upon me by the recollection that within a short distance of the Federal Capital city an area of about 3,000 acres is available for treating this discharge—an area which will be quite sufficient to absorb it for many years to come. That area is not so far removed from the city as to permit of decomposition setting in before the sewage matter reaches the point of treatment, and yet it is sufficiently far removed to prevent it ever becoming a nuisance. Even the best systems of sewerage are at times a little troublesome. The septic tank system which has been adopted in the case of Canberra is based on a flow of 40 gallons per head per day. Usually the tanks are three times as long as they are wide, and are about 6 feet deep. At Duntroon two tanks have been installed side by side, so that if any accident happened to one, merely by the opening of a valve, the sewage would be conducted into the other. It is proposed to discharge the effluent at the Twelve-mile Creek, thence to pass it through bacterial beds until it is distributed over the sewage farm with heads varying from 30 to 100 feet. The pressure main it is intended shall be of cast-iron, and the effluent will be distributed over sheet-iron troughs which will be moved daily to a fresh spot. The ground irrigated will thus be kept in a splendid condition of tilth. It will be soaked for one day, after which it will be allowed to set for a similar period and the plough and harrows will then be brought into requisition Afterwards the beds will be carefully levelled. Very few disagreeable fumes arise from those beds. The worst trouble at Duntroon comes from the laundry—from the hot soapy water which is suddenly discharged. The effluent from the septic tank system there—if the laundry water were eliminated—would be practically odorless. For an hour in the morning, while the cadets are taking their baths, the effluent is a little inclined to smell, but the moment it reaches the ground the odor is absorbed.

15. *To Mr. Gregory.*—At Duntroon the drainage water from both baths and the laundry finds its way on to the sewerage area.

16 *To Mr Finlayson.*—At the Federal Capital the distance between the shafts put down is about 500 feet. The trial shafts have been sunk to the depth of the sewer. The first ten shafts are already down, and we are beginning to open them out.

17. *To the Chairman.*—It is possible that exception might be taken to the size of sewer, but I would point out that a smaller sewer would result in inconvenience to the men working in it, and would cost just as much. The actual perimeter of lining is about the same in a large sewer as it is in a small one. It is proposed to build the egg-shaped tunnel with concrete, because the material for it can be obtained on the Molonglo. We have splendid supplies of gravel there, which are eminently suitable for concrete work. The

concrete tunnel at the Capital will be a cheaper proposition than would be a brick one, and will be just as good. A proposal was considered to run the sewage into an open channel in the city, and to pump it from there. But I would point out that any such receptacle for sewage in the city would not be a wise step; and further, that the country in the neighbourhood of the Capital does not lend itself to the construction of an open channel. The adoption of such a scheme would involve more expenditure than one of draining everything quickly into the Twelve-mile Creek.

18. *To Mr. Laird Smith.*—I have estimated the cost of constructing the sewer, including manholes, ventilators—and, indeed, everything—at £5 per foot. That estimate is based on the employment of day labour supervised by departmental officers. If the work were let on contract the same supervisors would have to be employed. The work of supervision has not been charged for. Both under the system of day labour and that of contract the cost of the employment of a clerk of works and of professional supervision would be the same. From where we have bottomed, I judge that the country is good shooting. Our experience at Duntroon, which extends over three years, is that we have never yet had to empty the septic tank there. We get no sludge. It is all decomposed and passes away with the effluent. I do not think that this is due to the fact that the system in operation is only a small one. The tanks are bigger than is this room. At Duntroon we break up the scum which collects, with the fire hose. We merely have a look at it, say, once in three months, and then take the hose and break it up. The bacilli are bred in the scum. I think that there is a lot of dead bacteria in the scum, which also acts as an air mat. There is no evidence of any solids in the effluent. At Duntroon the scum smelt rather high, and we thought of taking it away and burying it. But the labour available refused to move it, and so I recommended that the fire hose should be brought into use, and it should be broken up and distributed over the sewage area. We found that the chemicals in the soap used in the laundry emulcified in the scum and did not get as far as the gravel in the septic tank. In Acton we ran the hospital discharges into the tank and found that no harm resulted. The main sewer shown on the plan produced would have a greater carrying capacity if we increased the pressure, and thus would provide for a larger number of inhabitants than 125,000. As a matter of fact, one main sewer at the Federal Capital should be sufficient for the requirements of the next hundred years. It is not a matter of the internal area of the sewer, but of the velocity of the flow. It is possible to have too large a sewer, but you will doubtless notice that the flow of the sewer conforms to the wet perimeter. The friction on the sides is practically the same, no matter what may be the flow of water through it. The velocity is practically the same in the case of large flows as it is in the case of smaller ones. What is known as the wet perimeter bears the same relation to the area of the sewer, no matter what may be the depth. It is the friction in the sewer which retards the flow. An egg-shaped sewer has practically the same velocity, no matter what quantity of water may pass through it. At the present time, brick kilns are being erected at Canberra. The construction of the sewer with concrete is merely a matter of £ s. d., and of the supply of labour. If bluestone metal were costing a lot of money it would be very nice if we could put in the arch of the sewer in brick. In such circumstances the arch might be composed of brick and the other portions of concrete. But even if the lower portion of the sewer were composed of brick the bricklayer would have to fill in the back with concrete. The invert would require to be cemented to about a third of its height. We have not had the effluent which is discharged at the Capital analyzed for the simple reason that we cannot find any effluent. It goes right away on to the soil. The sun and the wind do the rest. We use it in the ratio of about a hundred people to the acre.

19. *To Mr. Gregory.*—I estimate that the cost of the tunnel, including manholes, ventilators, and everything else will be £75,000, or about £5 per foot. The concrete will be placed on mould boards 12 feet in length. The bottom is put in first, then boards are laid along, then the arch piece is placed lengthways a foot at a time so that we may be in a position to ram it, and get it solid. That method is just as economical and efficient as would be hydraulic pressure. We have put in concrete at as low a price as £1 per yard. As I have already said, bricks are not at present available for this work, whereas we have a splendid supply of material for concrete. We intend to put concrete through the tunnel hand-packed—that is to say, it will be mixed on the top, fed down, and hand-packed. I am of opinion that septic tanks established on the edge of the Federal Capital city from which the effluent could be pumped to a sewage farm would be a danger. I do not like the idea of a septic tank being anywhere in the city, especially as it would have to be in close proximity to the lake. In such circumstances in case of an outbreak of sickness the medical men would immediately turn their attention to the tanks. It is too big a risk to incur. If once the effluent got into the lake we can imagine what would happen. As a matter of fact, there are very few spots in the Federal Capital city where we could place our septic tanks. The natural point of gravitation would be about the centre of the city, another point would be its western boundary, and still another the northern side of the Molonglo, near the centre of the area shown on the map. All these places are quite close to the lake. In Melbourne all the sewage matter is gravitated to Spotswood, whence it is pumped up to a height of 160 feet to Williamstown, and thence finds its way by gravitation to Werribee, a distance of about 13 miles. Very offensive smells manifest themselves at the Spotswood pumping station. This is due to decomposition occurring in the sewage matter before it reaches the station owing to the long distance which it has to travel. I have seen effluents which quickly change in colour after passing through a big tank, and frankly I have never seen the effluent that I would trust all the year round. My statement is not a reflection on the septic system when one considers the variable flow of the effluent and the variation which occurs in its temperature. The septic tank, which has an activity of 30 degrees in the winter, will have an activity of 160 degrees in the summer. The quantity of hot water used by the people affects it. It is not possible to design a septic tank which will meet all conditions all the year round, and supply every day in the year an innocuous effluent. The suggested remedy is the distribution of this effluent over the soil. In England the temperature experienced is not as high as is the temperature at Canberra, where it is warm and dry. While it is cold at night there

the temperature at 9 a.m. is quite up to 50 or 60 degrees. There are many cities in the Old Country with a population of 30,000 or 40,000 which are dependent upon the septic tank system mixed up with storm water and trade waste. There are very few, however, which depend entirely upon septic systems. I would further point out that these cities are limited in the matter of the area available for sewage purposes. If they had a big area close at hand, and one which they could get practically for nothing, they would welcome it. The area available for this purpose at the Federal Capital is 3,000 acres. Birmingham, on the other hand, provides for a population of 1,000,000 on 2,500 acres, which is too limited a tract. The result is that the area is overcharged, and the authorities are going in for the bacterial filter, and for the removal of sludge. In Europe and Great Britain the chief trouble experienced is that areas are not available for broad irrigation, and consequently resort has to be had to mechanical filtration. At the Federal Capital, however, we have practically for nothing a large area upon which the effluent could be pumped. This porous country in the locality is being practically submerged by the lake. All the rest of the country consists of shale hills. The first patch of porous country is near the Yarrolumla Creek. If a septic tank were established in the city, and the effluent were pumped to the sewage farm the initial cost would be about £20,000, added to which there would be the cost of working—that is to say, the greater head and friction which would more than equal the saving which would thus be effected. In other words, the maintenance and interest cost would be increased.

20 *To Senator Keating.*—I am very familiar with the Federal Capital area and with the country surrounding it. I made a preliminary search extending over a week for a suitable sewage area there. There is no other site available at anything like the city level until one gets over to the Molonglo at Ginninderra Creek. For practical purposes no other area would be as suitable as the one suggested. By a sewage farm I mean an area on which the effluent may be discharged and on which English grasses may be laid down with a view to obtaining a revenue. It is a name which is given to a broad irrigation area, from which revenue is obtained by growing things. Personally I think that such a farm is most suitable for the production of fruit, because the effluent can be run between the rows of trees, but there would be a great objection on the part of people to fruit or vegetables produced on such a place, especially if a case of sickness should be traced to it. By the term "broad irrigation," I mean an area based on 100 people to the acre, as against irrigation through filter beds which represents 3,000 people to the acre. With broad irrigation the effluent is well spread, and the beds are not used too frequently. The word "broad" is used to contrast the condition which obtains here with the condition which prevails at Birmingham. Duntroon is situated on the north-eastern corner of the Capital city, from which it is distant less than a mile. The Acton settlement is located almost in the centre of the city area. It is proposed to incorporate the Duntroon system with the Federal Capital sewerage system. The main sewer on the northern bank of the Molonglo will pick up the college drainage. I have already said that the flow from the baths and the laundry at Duntroon goes with the rest of the sewage. That condition will obtain in regard to the sewerage of the capital. The system will take the water from baths, sinks, laundries; in fact, every polluted water other than street water. The water used in washing down carts, and in cleansing dairy floors and stables will be admitted into the sewer. A similar condition of things obtains in Melbourne, and also in the Mosman system at Sydney. It is the general condition in connexion with the septic tank system. The ½-inch lining of the sewer to which I referred consists of two parts of cement to one of sand. Below it is concrete. The interior surface is smoothed very finely, so that there will be very little friction.

21. *To Senator Story.*—I have revised my estimate of the cost of the sewerage system at Canberra. I originally estimated it at £4 per foot, but now estimate it at £5 per foot. I expected to meet with a little more gravel than we encountered. As a matter of fact when we came to sink the shafts we met more hard rock than we anticipated. The ground encountered is not treacherous. If it is dry a few laths will hold it up, but if water is met with it has to be timbered. Tenders were not called for the construction of the sewer, but only in connexion with the water supply. We specified that if the contractor took out too much ground, the excavation should be filled in with material equally good. We sank shafts in order to enable him to acquire a knowledge of the country which he would encounter. For this purpose we sank four trial shafts, and the contractor had merely to say where he desired other shafts to be put down, and they would have been sunk at the departmental expense. I cannot give off-hand the relative cost of bricks and concrete. At present the bricks would have to be brought from Sydney. But a year hence I am inclined to think that a brick arch and a concrete bottom would about equalize the cost. Bricks would not be cheaper than concrete, and one has also to bear in mind that the labour question is a difficult one. Sand is very plentiful in the locality, and Portland cement costs about 17s. 10d. per cask delivered on the job.

22. *By Mr. Finlayson.*—The extreme capacity of the sewer in relation to population has been put down at 150,000, but I think it would be possible by working it under pressure to increase its capacity by quite 50 per cent. In other words, it will be sufficient to meet the requirements of quite 200,000 people. My estimate is based upon the discharge of 40 gallons of water daily per head of the population. There will be a tendency at the Capital to use a lot of water. The actual discharge from the sewer is based upon Kutter's formula, which is well known. Melbourne and Sydney have main sewers of this type. The egg-shaped tunnel varies from 3 feet high, and a proportionate width, to about 9 feet high. Both Melbourne and Sydney have sewers comparable with the main sewer at Canberra, and their experience of it is satisfactory. At any rate, it is sufficient to encourage me to persevere with the idea I have put forward. At the junction of the main sewer with the tributary sewers, and at the junction of the two tributary sewers in nearly the centre of the city there is just the actual channel at the bottom of the man-hole. The tributary sewers are about the size of the main sewer. The tributary sewers would be the same size on the southern side of the Molonglo as is the main sewer—that is for a distance of about 4 miles. We had to get under the Jerrabomberra Creek, and could not alter the grade. If we adopted a smaller pipe we would have to make the grade steeper. The Molonglo falls about 3 feet per mile, and this sewer would have a fall of

about 3 feet per mile. From the city to Queanbeyan the length of the sewer would be 6 miles. The Molonglo from Queanbeyan has a fall of 6 feet per mile. At the city boundary where the 3-mile section commences, there is nothing but an open sewer. At the outfall end there is no treatment of the sewerage, except that it is discharged on to the farm. The septic tank is situated there, and the effluent from it is carried to the farm. There is a creek known as the Twelve-mile Creek running through the suggested area for the sewage farm. This creek empties into the Molonglo. The waters from the Molonglo do not run from the farm towards the city, but from the city towards the farm, so that any possible discharge from the sewage farm will be away from the city. I do not anticipate any difficulty in the way of seepage from the farm finding its way into the creek and thence into the river, because no sewage will be spread on the ground within at least a hundred feet of this creek. Then we propose to straighten up the creek channel, and actually line it with concrete so that if any seepage does find its way there, we shall see it coming over the walls and into the creek. But we do not expect anything of the kind. Our experience is that evaporation and aeration will get rid of it—that is basing the system upon the service of a hundred people to the acre. The total area of the sewage farm in Melbourne is 11,153 acres, of which 7,119 acres are under sewage treatment. The total area includes roads, &c. This area serves a population of about 600,000. The area available for sewage purposes at the Federal Capital is about 3,000 acres, and my statement that this will be sufficient to serve a population of 200,000 is based on my observation of what is being done at Duntroon, where a hundred people to the acre are being served very well. It will be seen, therefore, that the area available at the Capital is sufficient to serve a population of 300,000, but I would like to use a portion of it for revenue-producing purposes. If that farm were found incapable of dealing with the effluent, the next place we would have to seek would be the Ginninderra Creek. We should have to pump the sewage to some other area. We have tested the site suggested pretty carefully, and have found that it contains good ground for the purpose to which it is proposed to put it. I cannot imagine that it will prove incapable of absorbing an unusually heavy flow of water. At the junction of the two tributary sewers the depth of the main sewer is about 35 feet. The level of the sewer is 1,805 feet, and the surface 1,810 feet. In crossing the Yarrolumla Creek just outside the city boundary, the sewer is just on the creek bed. In Melbourne and Sydney the man-holes in the subsidiary sewers are situated 305 feet apart, and in the main sewers are 500 feet apart. These have been found by experience to be very convenient distances.

23. *To Mr. Fenton.*—The sewage of Melbourne is pumped in its crude state on to the sewage farm without any anaerobic, aerobic, or septic-tank treatment. The Director-General of Works and I differ slightly as to the necessity for biologically treating the sewage of the Federal Capital. My own opinion is that there is, *per se*, no need for septic tanks or anything of the kind there. I would deal with the sewage as that of Melbourne is dealt with; but in view of the fact mentioned yesterday by Colonel Owen, the relations with the Government of New South Wales respecting the waters of the Murrumbidgee and the Burrenjuck Reservoir, the desire to keep the Molonglo River also pure, and the fact that we have to deal with an inland town, it is perhaps advisable to pass the sewage through septic tanks before allowing it to reach the irrigation areas. Melbourne and Canberra in this respect are hardly analogous cases. Any excess of sewage not absorbed at Werribee is discharged into the bay; but if there were any possible excess discharged from the Canberra works it would flow into inland rivers. Having regard, therefore, to the special circumstances, the Director-General is wise in recommending that the sewage of Canberra be passed through the septic tank before being placed on the soil. Such treatment of sewage certainly reduces to some extent its manurial value for cultivation and grazing areas; but the manurial value of even crude sewage is very low. If I desired to fertilize an area, I should prefer to spend my money on superphosphates. Sewage has a water value, but its manurial value is very low, and one is fortunate in being able to dispose of it after it has been rendered innocuous by spreading it on the soil as in the case of any ordinary manure. A dray load of stable manure spread on an acre of land once a year would be equivalent to what would be obtained from an ordinary flow of sewage in a crude state. A crude sewage farm in the territory would be slightly more profitable than would a farm treated with the effluent from septic tanks; but the difference between the manurial value of the crude sewage and the effluent, I repeat, is very small. A crude sewage farm 3 miles beyond the city would practically give no offence to the inhabitants of the Capital itself. The length of the main sewer would tend to break up the solids. Crude sewage discharged from a main of very short length would be in practically its original condition, and the paper and other refuse would not be broken up. In order that sewage may be readily spread over the soil it should be of the consistency of a broth. The septic tank treatment will have that effect. I am inclined to think that the effect upon the sewage of the 3-mile run along our main sewer will be much the same as that secured by the septic tank treatment in dissolving the paper, and splitting up the solids, so that it may be readily distributed. By the time that the sewage reaches the end of the main sewer it will be dissolved. Three gallons of water are used to flush a urinal every time it is used, so that it will be recognised that the percentage of solids in sewage is very small. In the main sewer of the Melbourne and Metropolitan Board of Works there are very few solids. For the most part the contents consist of a black inky fluid. The sewage on being discharged from our main sewer, 3 miles in length, would be almost the same as the effluent discharged from a septic tank, and would be more valuable as a manure. Dr. Cumpston would be able to advise you as to the proportion of ammonia found in sewage. I have heard of ammonia being extracted from sewage, and used to drive a small lift, or a small engine used in pumping. If in constructing our sewer we met with strata that seemed a little dangerous—if we suspected any movement—we should stiffen our concrete with more cement, but once you "hold" such country there is no further trouble. Where large bodies of water are struck care is taken to use more cement so as to make the mixture denser, and to prevent any inflow of water. We have gravel and river deposits at Canberra, and we have crushers up there. If in laying the sewer we brought up stone which looked better than the gravel obtained from the river we should certainly crush it, and use it for our concrete.

24. *To Mr. Sampson.*—No considerable reduction in the size of the main sewer would materially reduce the cost. Mr. Knibbs originally

estimated that in 1935 Canberra would have a population of 18,150, and that there would be a population of 20,150 in 1915. That estimate has been reduced because of the decrease in the number of workmen employed there. A population of 18,000 would mean a flow of 800,000 gallons per day, and that would provide a satisfactory flush for the drain. The egg-shaped section which we propose will give practically the same flush, whether the sewer is running one-tenth or two-thirds full. That is one of the advantages of such a section. In connexion with the Emscher, and the Imhoff, or Elberfeld systems, to which I refer in my memorandum, sedimentation tanks are used. They are variations of the one system. A long deep chamber or tank is used. In some cases circular chambers 25 feet deep, and bell-shaped at the bottom, are used, while others are "V" shaped at the bottom, and are sometimes 100 feet long. The liquid is allowed to pass through these chambers at a very slow flow, say, 2 feet to the hour, and this permits all the solids in suspension to drop slowly and to settle at the bottom. Each chamber is fitted with a long pipe and valve, and when sedimentation has taken place the valve is opened, and the mud or sediment is allowed to pass out. The valve is closed again when the discharge becomes too liquid in character, and once the valve has been closed the process of sedimentation again goes on. The effluent goes off at the other end of the tank or chamber. It is claimed that anaerobic action also takes place in connexion with the sediment which falls to the bottom, and tends still further to purify the sewage, so that the effluent goes out at the other end of the tank in a fairly innocuous condition. These tanks are not hermetically sealed; they are left open. Many of them are to be seen on the banks of the Rhine. Cities like Bochum, which has a population of about 140,000, were compelled to take steps to prevent any pollution of the Rhine, and they therefore erected these sedimentation tanks. The effluent discharges into a canal so large that if any possible pollution does take place it is quite immaterial. If you substitute for such canals your ground area you have a similar comparison. Under our proposal, if there were any sediment it would have to be let off below the dam site. We could not allow it to go into the lake which is to be used for recreation purposes. There was a proposal made that it should be used for treating the public gardens. There is no specific name to the system which we propose; but I think that the Director-General has very properly described it as "biological treatment with broad irrigation." The pumping process is in no way responsible for the putrefaction that occurs during the transit of the sewage from Melbourne to the Werribee Sewage Farm. It takes place before the sewage reaches the pumping station. It is a long distance to convey sewage, say, from Surrey Hills to Werribee, at the rate of 2 feet per second, and putrefaction would still occur if the flow from the city to Werribee were by gravitation. I was in the United States for some years many years ago, but I have no knowledge of the septic systems there other than that which I have gained by reading the engineering journals. The increase from £4 per foot to £5 per foot in my original estimate of the cost of constructing the main sewer is due for the most part to the increase that has taken place in wages since my first estimate was made. Between the two periods there was an increase of practically 20 per cent. in rates of wages. The increased estimate is but slightly due to the fact that we are likely to meet with harder country than we first anticipated.

25. *To the Chairman.*—We observe the awards of the State Arbitration Court of New South Wales as being mostly applicable to the Federal Capital. In some cases there were slight increases made owing to the fact that men were called upon to work in a district far removed from any large centre of population, but these are being overcome as our numbers increase.

26. *To Mr. Sampson.*—The rainfall on the sewage farm area ranges from 18 inches to 25 inches. The mean rainfall is only 22 inches per annum, and having regard to the excellent tilth that we have on the irrigation areas such a rainfall, in its effect upon the sewage farm and the likelihood of any flow from it into the Molonglo, is an absolutely negligible quantity. The heaviest falls occur during the summer, and the water quickly evaporates. There are no big catchment areas immediately adjacent to the sewage farm, but we propose to line with cement the sides and bed of the Twelve-mile Creek, which runs between the catchment area and the irrigation area, and any area that will not be drained into the sewer will be drained in a natural way into this channel. No trouble is likely to be experienced in regard to the rain which will fall on the area to be irrigated with the effluent. We put from 7 feet to 8 feet of sewage on an ordinary acre at the present time, and the addition of another 18 inches per annum will be a very small matter. We do not propose that storm-waters shall be allowed to enter the sewer. It will be confined absolutely to domestic wastes, and to some small stable and what are known as "dirty" areas. During this inquiry the question has been asked, "Why should not the one sewer be used to carry off both storm-waters and sewage?" That would not be a feasible engineering proposition. We get heavy storms up there, and if certain limitations as to the fall were not imposed, the bottom of the sewer would be scoured out by the grit which would flow in with storm-waters. It is therefore necessary that falls in respect of storm-water channels should not exceed 6 inches to the mile, otherwise the grit sent down would be sufficient to scour away even bluestone, or any other rock. No proposition to combine sewage and storm-waters would be feasible in view of the fact that it is necessary to keep a sewer used for storm-water purposes at so low a grade that in dry weather flows the sewer would not be cleared, whilst after a heavy fall of rain the flow would be too fast for sewage purposes. During a heavy flow, the sides of a sewer used for both sewage and storm-water would be soiled; the water on receding leaving sewage on the sides, while after the flow it would dwindle away to a mere trickle. It is to avoid these difficulties that a minimum fall of 3 feet to the mile is necessary in the case of a sewer for domestic wastes, whereas in the case of a sewer for storm-water wastes a fall of from 6 to 8 inches to the mile is sufficient, and, indeed, dare not be exceeded.

27. *To Mr. Finlayson.* — The sewage must be kept moving at the rate of 2 feet per second. If it were rushed through the main sewer with storm waters the irrigated areas would be flooded, and the septic tank itself would be filled with sand. A proposal to have a combined sewer for sewage and storm-waters would not be practical engineering. The modern practice is absolutely in favour of separate systems.

28. *To Mr. Gregory.*—In order to avoid any risk of the effluent from the irrigation areas finding its way into any of the adjacent waterways we propose to line the bottom and the sides of the Twelve Mile Creek with cement for a distance of half a mile. We shall straighten out the channel,

and keep an area of 100 feet on each side clear. We shall have an ordinary 9-inch concrete bottom, using a weak concrete in the proportion of, say, nine to one I should not think that it would cost more than £5,000. That, however, is only a rough estimate. I have not taken out the actual figures.

29. *To Mr. Fenton.* — This will preserve the banks of the creek, which certainly needs a little attention. It would not do to leave it as it is, and to establish a sewage farm close to it, as we propose.

30. *To Mr. Finlayson.*—I have not an estimate of the cost of this tributary and the two branches of the sewer. My estimate of £75,000 relates only to the cost of constructing the main sewer for 3 miles. I cannot say at present what will be the exact route. The valley of the Molonglo is to be followed, but the actual plan has not yet been prepared. The construction of the main sewer is only the first step in a scheme that will cost fully three or four times as much as I have mentioned, more especially if we include in the total the cost of providing for storm water channels For the main sewer south of the Molonglo within the city area the cost will be, roughly, £100,000, and I think you may take it that the cost of the main sewer north of the Molonglo as far as the Royal Military College will be, roughly speaking, another £50,000.

31 *To Mr Fenton* - If the whole scheme were agreed upon to-day it would mean the employment of an additional 100 hands within the next fortnight We are now employing 50 we could then employ 150 I have sunk the shafts, but I am holding up the work a little, pending the decision of the Committee.

32 *To Mr Finlayson.*—If any other system of treating the sewage were adopted it would mean the abandonment of this work. As I have said, I have sunk the shafts, but am "marking time" a little I have not put off any men, but I shall not put on any additional hands pending the result of the Committee's investigation.

33 *To Senator Keating.*—We have Parliamentary authority for the expenditure that is being incurred We have £30,000 earmarked for expenditure on the construction of the main sewer between the present time and the end of June next In my memorandum to the Director-General of Works I state that "the pipe line is being carefully chosen with a view to reducing the cost to a minimum. It would be possible to reduce the mean depth, but that course would entail an increased length of route." In order to reduce the mean depth a detour would have to be made. At the Yarrolumla Creek crossing, a deviation would be required to be made southerly, and again westerly, while a deviation would require to be made southerly and again westerly, describing practically the two sides of a triangle, at Jerrabomberra Creek The individual connexions with the main sewer in some cases will consist of 9-inch ordinary stoneware pipes at a depth of 10 or 12 feet, with 6-in. branches. The ordinary pipe reticulation will be carried out in the city, and will consist of stoneware or cement pipes connecting directly with the main sewer.

34 *To Mr. Finlayson.*—We shall provide for ventilation by the erection of iron ventilators, similar to those to be seen in the streets of Melbourne, at a distance of from 300 feet to 500 feet.

35 *To Senator Keating.*—In constructing the main sewer we shall make provision for inlets as soon as we get into the city. The sewer will not have to be broken up to allow of connexions being made.

(Taken at Sydney.)

TUESDAY, 2ND FEBRUARY, 1915.

Present:

Mr. RILEY, Chairman;

Senator Keating,	Mr. Finlayson,
Senator Lynch,	Mr. Gregory,
Senator Story,	Mr. Sampson,
Mr. Fenton,	Mr. Laird Smith.

Joseph Davis, M.Inst. C.E., Director-General of Public Works, New South Wales, sworn and examined.

36. *To the Chairman.*—My experience of the construction of sewerage works extends over a period of thirty-five years. In Sydney several systems have been adopted. The Northern system drains to Bondi, and takes the sewage of the upper part of the city, and all the slopes which drain into the harbor. The Southern system takes another portion of the city, including Redfern, and all the slopes draining to Botany Bay. The Western system—the largest one—sewers all the suburbs up as far as Homebush, and drains on to a farm at Botany. The Southern and the Western systems are being combined, and the two volumes of sewage carried out to the ocean by means of an outfall sewer which is nearly finished, and which, when finished, will cost about £500,000. The necessities of the case have required that we should divert the sewage which has been treated on the farm at Botany, and discharge it into the sea. There are two reasons for the alteration: First the population round the farm is getting very thick, and secondly, the quantity of sewage which has to be treated is more than the area can cope with. The farm was a success until it got too small, and then, of course, the inevitable happened, it became a nuisance. There were complaints from the residents in the locality. In New South Wales we have some septic tank systems. We have what is known as the biological treatment in several places, namely, at Willoughby and at Mosman, which are quite handy to the city. I have no objection to the Committee viewing the system. If I were called upon to lay out a sewerage system for a new city to be established away from the sea, and it was necessary to instal a septic tank system, I would not put the septic tank in the city unless I was obliged to. There might be conditions where one would be compelled to put the septic tank inside the city, but that should only be resorted to as a last expedient; that is my firm conviction. The objection to placing a septic tank in a city is that there is always a certain amount of nuisance. It is possible, with the best management, to keep things clean; but unless they are kept very clean, and there is very good management, and great attention is given to all the parts of the treatment works, there will most certainly be a nuisance. That is my experience, do what one may. I think that there is more than a risk of a septic tank in a city being a nuisance. The septic tank system has been established in the country. There we have not the means of discharging the sewage directly into the sea, and therefore we are compelled to use the septic tank. Where I had a choice between discharging the sewage into the sea, and the adoption of the septic tank system, I would have no hesitation in adopting the direct method. I have very great confidence in the biological treatment of sewage. I consider it is one of the best sanitary discoveries which has been made for many years. I am not depreciating this method; but owing to the way in which the question was put to me I had of necessity to answer as I did. I have no hesitation in declaring that the septic tank would be better out of the city. I would be pleased to accompany the Committee on a visit to Canberra. I could not offer an opinion on the departmental proposal without a personal inspection. I think that I would be able to come to a more correct conclusion if I examined the locality.

37. *To Senator Lynch.*—When the septic tanks were first made use of a very great deal was expected therefrom, but as time passed I came to the conclusion that we were expecting too much from the combination. I prefer the direct system to the septic tank system, if you can get to the sea with a sewer. What I have been dealing with in my evidence has been the disposal of sewage in the best and most economical way. If you can make use of the sewage, and in that way increase the cultivation, there is no doubt that it is a very good thing to do I know quite well the Birmingham sewage farm, as I have been there many times I am acquainted with the development of the farm; in fact, I have watched it for more than twenty-five years. The Birmingham system is not on all fours with the Melbourne system. The Birmingham system, first of all, was the elimination of the sludge from the sewage and the effluent thereafter discharged into the river. After the Rivers Pollution Act was passed by the Imperial Parliament the river authorities insisted that the Birmingham people should treat their sewage on land. Although they took out large quantities of solid matter they did not treat the sewage, and so the authorities insisted that the sewage should be treated on land. A large area was purchased, not so much for the purpose of cultivation, although, incidentally, it gave cultivation, as for the purpose of purifying the sewage They were not satisfied with that method, and when the biological treatment reached a practical stage it was adopted by the engineer, Mr. Watson They converted their settling tanks into septic tanks, and constructed more tanks. From the septic tanks they conveyed the sewage to filter beds From the filter beds the sewage passed into another settling tank, from which they got a certain amount of sediment, and it went from there on to the land and was used for cultivation. Any which was not required on the land was sent to the river. The system at the present time is as nearly perfect as it could be. But that has meant the construction of works extending over a long course of years, and the expenditure of a very large sum. The sewage system deals with, not only Birmingham, but the whole district —what is called the district of the Stour. Every case must be judged on its merits. When Sir Maurice Fitzmaurice was out here he quoted the case of the sewage farm at Birmingham as not being a success, but then, in combination with the biological treatment, it was a success.

38. *To Mr. Gregory.*—The sewage from the Western system is discharged on to an irrigation farm. At Birmingham there was originally a very serious nuisance when the sludge alone was extracted from the sewage. But I would not say that there is a nuisance now; on the contrary. I reported on the sewering of Perth in Western Australia, and the authorities are carrying out the system I advised—the septic tank and filtration. I do not know of my personal knowledge that the smell there is very offensive at times, but I can quite understand that they would need to grow a great many flowers before the smell would be destroyed. You cannot have sewage disposal works without knowing that you have them. With the septic tank system, on a small scale, you do not have an objectionable smell. If you have a small house, and a small septic tank, and a good drain to take the effluent away after it has passed through the septic tank, possibly you would not experience any very serious inconvenience. But that is quite a different proposition from treating the sewage of a city, where you have thousands of persons to deal with. I cannot say that I consider that the septic tank system has reached a limit, so far as population is concerned. There is no limit; it is absolutely a matter of cost. It may be that the system in one place would be cheap, and that the system in another place would be dear. I mean that it might be too expensive to adopt in one place and not in another. On the other hand, what would be rejected in one instance might be accepted in another case. That would not be on account of climatic influences, but on account of cost. That the biological treatment is effective, and that it does, to a limited degree, what was expected from it from the very first, is unquestionable. The sewage as it is allowed to remain in the tank for twenty-four hours is liquefied. During the process it parts with some of the objectionable gases, and as it passes on to the filter beds biological treatment takes place. The septic action has the effect of dissolving the sewage and making it more suitable for filtration. You can quite conceive that the solids in domestic sewage would make it quite out of the question to pass the sewage through filters. When the sewage passes through tanks, the solids are dissolved and more or less digested, and then you can treat the matter on the filter beds. That is the whole thing in a nutshell. There are not different methods of septic treatment, but only one method. The principle of this system is the same, whether it is adopted in England, or Germany, or America, or Australia. Of course, our climate is very much in favour of septic action. As you can readily conceive in a climate where there are degrees of frost septic action is arrested. But in a climate such as Australia that action is facilitated. That I think would apply to the Federal Capital. It is a very good site, and has a very good climate. I do not think it is cold enough at Canberra to arrest septic action. The Local Government Board at Home insisted upon land treatment, in addition to the septic tank and filtration.

39 *To Senator Story.*—Our intention is to convert the sewage farm at Botany into a park Even if it were possible to get an area of land large enough to dispose of the sewage, I would still be in favour of taking the sewage out to sea You can quite conceive that, in some cases, the sea would be so far away that the cost of adopting the direct method would be prohibitive. But in this instance it is not. It will pay us well to spend £500,000 for the purpose of diverting the sewage from the farm and discharging it into the sea. There would be a danger of the sewage being brought back to the shore if the conditions of tide and wind were not taken into consideration in fixing the point of discharge Naturally these things have to be watched, and observations made for a period extending over all conditions If there should be floating matter carried down with the sewage, you can gather pretty well by these observations which direction it will take. I am satisfied that, so far as the Sydney scheme is concerned, there is no danger of a nuisance occurring. We have had sewage discharged at Ben Buckler in very large quantity. The internal dimensions of the sewer

ure 8 ft. 10 in. by 6 ft. 10 in. The sewage has been discharged at Ben Buckler for the last twenty-seven or twenty-eight years. I do not think it would do to depend upon septic action alone in any place except on a small scale. You must have filtration in addition to the septic treatment. I should very reluctantly agree to take the responsibility of putting in septic tanks and filter beds in a city where a large volume of sewage would have to be treated. The running of the sewage in a practically closed sewer for a distance of several miles would have somewhat the same effect as a septic tank; it would set up the septic treatment. The sewage needs to be under septic action for twenty-four hours; you would not get that in sewers; but the septic action would start unquestionably in the sewers under favorable conditions. If it were run slowly through the sewer it would have a considerable effect in that direction. Of course it would depend upon the time that the sewage was in the sewer.

40. *To Mr. Sampson.*—At Birmingham the removal of the sludge became a nuisance to the people in the neighborhood; the difficulty was to dispose of the sludge. It has a small manurial value if it is not treated by septic action. The strange thing about the deposit taken from septic tanks is that it lacks sterility. I do not know why that is so, but I have seen large quantities of the deposit taken out of septic tanks. It may lie on the land for a very long period, and not a blade of grass will grow. If the sludge were removed while it was fairly fresh it would have a manurial value, but very small indeed. It would not be a marketable commodity, because to begin with the sludge would probably contain 90 per cent. of water. Usually, in such instances, the sludge is passed into filter presses, and the liquid is removed so as to reduce the sludge to the smallest possible bulk, but even then the sludge cake that is produced in that way is a drug in all cases that I have ever seen. You cannot get the farmers to cart the cake away if you give it to them. In the case of the septic tank systems at work in the vicinity of Sydney, the effluent is discharged into the harbor. We do not make any use of the effluent. Originally the farm on which the sewage was discharged at Botany was used to a limited extent for agricultural purposes. But latterly it has been used entirely for the disposal of the sewage; the whole area is used for that. The area was so small, comparatively speaking, that it had to be devoted to the disposal of sewage. Years ago, when the sewage was small in quantity, the land was made use of for agricultural purposes. The reason why we did not extend the experiment was that there was no land available. When we had to face the matter of treating the sewage there or taking it out to sea, it was recognised that it was a question of putting down septic tanks and constructing filter beds on the farm, because the sewage had become so large in volume that the farm could no longer treat it, or of building a sewer to the ocean. It was found that the septic tank and the filter beds would cost more per annum than would cover the interest and sinking fund on the cost of construction of the outfall sewer which I have indicated to the Committee, and which is now nearly completed. It was done very deliberately, and done upon a recommendation from our Public Works Committee. That was because of the governing circumstances in our case. If we could have purchased land at a reasonable price to extend the irrigation farm I do not think that, in the light of our experience, I would have favored that course. I should have reverted to the biological treatment in those conditions, and fortunately we were able to show that the better plan is to take the sewage to the sea. I have made no study of the relative manurial value of the liquid from the ordinary system, and of the liquid from the septic tank method. But, for application to the land, in my opinion, the effluent from the direct system would be preferable to the effluent from the septic tank. I should say that the effluent from the septic tank would be very little more valuable as a manurial agent than ordinary water.

41. *To Mr. Laird Smith.*—The area of the sewage farm at Botany is about 500 acres. The success of the biological treatment is not largely dependent upon the filter beds and broad irrigation. The success of the biological treatment is owing, first of all, to the septic action in the septic tank, and then the passing of the effluent from the tank through the filters. It is not the filter beds that destroy the very unpleasant smell which arises from the septic tank. The sulphuretted hydrogen, which is liberated by the septic action, must find its way into the atmosphere, and it can be so arranged that it will discharge without offence to the persons living in the vicinity. That would be a good reason for objecting to the septic tank being placed within a city, or very close to a city. An analysis is made by the Metropolitan Board of the effluent which is discharged into Sydney Harbor. The Board have analyses made constantly, and these can be made available to the Committee. No microbes, dangerous to public health, have been found. A large percentage of purification takes place. The septic tanks here have to be cleaned out by manual labour. That is one of the directions in which I think we expected too much from the septic tank. It was anticipated that the sewage as a whole would be dissolved, and would pass away from the septic tank on to the filter. But that is not so. It leaves a certain depos t which is in the nature of soil, but which, as I have indicated, is sterilized. I do not think it is advisable to construct a septic tank which will clear itself of the sludge. I think it is desirable to have a septic tank which will be as still as possible in its action so that the microbes may have undisturbed possession of the sewage for the time being. There is no objection to allowing soapsuds, and such matter, to get into the main sewer and eventually pass into the septic tank. Large quantities of disinfectants militate against septic action. If large quantities of disinfectants are used, necessarily septic action is arrested. In the case of hospitals, if large quantities of disinfectants get into the septic tank, it interferes more or less with its working.

42. *To Mr. Fenton.*—I did not say that the nuisance arising from sewage depended largely on the distance which it travelled. If the sewage has not to travel very far I think it will have less smell. The staler sewage is the more offensive it becomes. From the stand-point of public health I do not think it would make very much difference whether the sewage of the Federal Capital has to flow 2 miles, or 15 miles, before it reaches the septic tank. In the case of inland towns where there was no opportunity of discharging the effluent into the sea, what we have done in most instances has been to pass the sewage through septic tanks and filter beds, and then discharge the effluent into the river or stream near the town. The orthodox and universally accepted method is to put the sewage through the septic tank, then through filter beds, and finally through the land before being discharged into the river. After the three successive treatments I think it is perfectly safe to allow the effluent to flow into a stream if the works have been constructed on proper orthodox lines. There should be no offence created, or pollution of the water. We have no figures indicating what the health of the people was who are working on, at, or residing on, the sewage farm at Botany, but I expect that we could get the information of the Committee, but it is generally understood that persons working on a sewage farm are as healthy as persons living away from the farm. I do not know that I agree with that, but it is what is generally thought. I think that there would be no objection to growing vegetables, or raising stock on a sewage farm. That is being done at Adelaide, and done very effectually. There they cannot get enough sewage. Theirs is a very fine instance of a really successful sewage farm The problem with the Adelaide people is not to dispose of the sewage, but to grow vegetables, and to raise cattle. That makes all the difference. The sewage simply goes through a silt tank. I do not favour any particular material with which to construct filter beds, so long as it will not dissolve. The harder the material is, and the larger its surface, the better. If you can get material very hard, in the nature of a sponge, that is the best sort to use. But you must not have in the filters material which will dissolve or break down.

43. *To the Chairman.*—Melbourne bluestone is very good for the purpose. We frequently use our Kiama bluestone for filter beds. We use blast furnace slag, too.

44. *To Mr. Fenton.*—I do not favour coke or any material like that, because it is too friable.

45. *To Mr. Finlayson.*—I did not indicate that the success of a septic tank is practically regulated by the cost. I should say that the success will depend upon the way it is constructed. In some instances it may be better to adopt the biological treatment, whilst, in some cases, it may be wiser to discharge the sewage into the sea, but that will depend entirely on the cost. If the cost were not entirely prohibitive I said that I would prefer to discharge the sewage into the sea. In the case of an inland town, however, that alternative does not arise, and the biological treatment, as we understand it, is about as good a system as we could have. I would not put a septic tank nearer than a mile from a large centre of population. In the case of a scattered population one would not say anything on this point. But where a population of any dimension is likely to grow up, I would not put the septic tank within a mile of the population. There are some cases, however, where we have to put the septic tank a little nearer than that distance. At Bathurst the septic tank was put down at a distance of from a half to three-quarters of a mile from a populous area. At the same time, if the conditions are equal for a large city, such as is contemplated at Canberra, I should say that a mile will be a very fair distance to adopt. There is no limit to the maximum distance. The decomposition of sewage in a sewer only anticipates the action which otherwise would take place in the septic tank. There are meteorological influences which will determine the distance of a sewage farm from the city. If you have to put a sewage farm below the town in the direction of the prevailing wind you necessarily have to take that point into consideration; but, again I say, it is far better to look at a sewage farm as a proposition, not for the treatment of sewage, but for the growing of vegetables. It is not well to look at a sewage farm as a proposition purely and solely for the disposal of sewage. As an alternative system of getting rid of the effluent, I suggest that after the effluent is purified it can be discharged into the stream without any risk, but, as I have said, it will depend very much on the way in which the works are constructed, and, still more, on the way in which they are managed They will have to be kept clean, for cleanliness is the main factor in these matters. The effluent should not be discharged into the stream unless there is a guarantee that the effluent is pure. I have never heard of a disease originating in vegetables grown on a sewage farm. Public prejudice is rather strong against the growing of vegetables on a sewage farm, but people would very soon get over that prejudice when they got cheap vegetables. I will let the Committee know the population which is served now by the sewage farm. What I said as regards the farm obtains to-day. The present condition of things is far from satisfactory. It is one which must not be continued a moment longer than is absolutely necessary. We would not extend the sewage farm if we could. It is because the system is not satisfactory that it is being altered A septic tank, to operate a farm of 1,000 acres, would have to be made sufficiently large to contain twenty-four hours sewage. It is usual to allow in a separate system of sewerage from 40 to 60 gallons per head, we allow 50 gallons per head With this data it is very easy to calculate what the size of the septic tank should be. Then you come to the filtration area. I suppose you may reckon that an acre of filter beds will purify 1,000,000 gallons of sewage, so that, here again, the calculation is quite simple. As regards the land treatment alone, I do not think that there is very much in it unless you find exceptional conditions. To begin with, the land must be sandy, as at Adelaide and other places. Again, you must be able to put on the sewage when it is wanted, and therefore you must have sufficient land to be able to do that. All these conditions are such that when you come to work them out you find that the system is not practicable, except as I said in very special cases. The volume of discharge is greater in summer than in winter. The land would deal with a larger volume in summer. The sub-drains are made to deal with the maximum quantity that passes through the soil. The main sewer for the Western and Southern systems is 14 feet wide and about 8 feet high. It is an oval sewer with a wider axis measured in the horizontal direction. The Bondi sewer discharging at Ben Buckler is the reverse of that being 8 ft. 10 in. high and 6 ft. 10 in. wide. There is a special virtue in the egg-shaped sewer inasmuch as with low discharges you get a larger velocity in the egg-shaped sewer than in the round sewer. Where you are providing for a small population in the first instance, and anticipating a growth of population, the egg-shaped sewer would be an advantage. You must take into consideration the ultimate population in any given area and provide sewers sufficiently large to cope with the sewage, although it may be many years before you reach the maximum stage. That always makes such works very expensive. The main arteries of a system should be made large enough to cope with the maximum population, but the reticulation can be carried out as settlement takes place. I would not say that the egg-shaped sewer is the best one to adopt. There are conditions in which it is of advantage. I think it would be an advantage in providing for an increase in population, and the consequent heavier discharge of sewage, otherwise the velocity, owing to the small discharge, would be low in the early history of the sewer, as compared with its later history. In the construction of our sewers we use bluestone concrete largely.

In the new outfall sewer we are using blue-stone concrete, and also some sandstone concrete with facing, so as to give as little friction as possible, and in that way increase the velocity. The fall of a sewer will depend entirely upon the velocity which is required. In the large sewer dealing with the suburbs on the northern side of the harbor, seeing that it will be a wholly separate scheme, and not partly separate, as in the case of the Western, Northern, and Southern systems in Sydney, we propose to adopt a low velocity, and in that case we will be able to lay the large sewer with a fall of about 1 in 3,300 feet. That is a very small fall, but it will give a sufficient velocity to make the sewer self-cleansing. We are supposed to take the polluted domestic water supply into the sewers. As regards the discharge from stables, and such places, I have no hesitation in saying that the position would have been better if we knew as much in the first instance as we know now. The original proposal made in Sydney was based upon English lines. No one had had any experience of the conditions here, an English engineer was brought out, and he applied English conditions, but they were not applicable to Australia. The English practice was to allow a portion of the storm water to get into the sewers; but that I think is a mistake. The sewers have to be larger, and it causes trouble at the treatment works. The proper plan for an Australian town to adopt is to keep the polluted water absolutely separate, and to treat the storm water in another way. In Sydney we have a complication of things to contend with. The amount of chemicals discharged from a hospital will affect the working of a septic tank if the chemicals happen to be disinfectants; still, in dealing with the sewage of a city we have no difficulty in allowing hospitals to be connected with the sewers. The amount of disinfectants discharged into the sewers is so small as to be ineffective.

46. *To Senator Keating.*—We have several outlets to the sea, namely, at Ben Buckler, Long Bay, Manly, and Coogee; we also have outlets on to treatment works, namely, one at Mosman, another at Willoughby, and a third at Chatswood. The water from bathrooms—in fact, all polluted water—is allowed to go into sewers. In connexion with the early systems we allowed for a percentage of storm water to get into the sewers. In the case of the early connexions people were allowed to connect their downpipes, stables, and yards, but that practice has been stopped, and our system is now carried out purely as a separate system. The inclusion of storm water affects the treatment of sewage. To the outlet at Bondi the sewage has to go about 6 miles, while the sewage from the western suburbs probably has to travel 10 miles to the ocean. The disposal works at North Sydney are not at all satisfactory. At the time the works were carried out the biological treatment of sewage was scarcely known, and the orthodox system was put into practice on the northern side of the harbor, that is to say, the settlement of the sludge and the passing of the effluent from the settling tanks over sand filters. That system was found not to be a success. Since the Metropolitan Board have had the management of the disposal works, they have done the best they could. They have treated the sewage by septic action, and passed it through sand, but it cannot be said to be a satisfactory method. We hope to be able to intercept and discharge into the sea the whole of the sewage which is now being treated at Willoughby Bay. That sewage is treated septically to some extent. I would not eat oysters found on the foreshores; I do not think it would be wise to do so. The biological treatment will absolutely get rid of all offensive properties of sewage. I think that that has been established beyond doubt. The system is not used at London, New York, or Berlin. At Berlin and Paris there are sewage farms. In the case of London they take the sludge to the sea and discharge the liquid into the Thames; they have greatly improved matters there. I can name more than one city of world-wide importance which uses the biological system. I can cite the cases of Birmingham, Manchester, and Leeds. I should think that the Birmingham system treats the sewage from a population of from 1,250,000 to 1,500,000. It treats the sewage from the population of Birmingham and district. Birmingham is the largest city I can instance which uses the biological system, but it is used by a number of very large cities such as Glasgow and Manchester. I should not say that the best system to adopt in the case of a newly-established city is the septic system. I will not say that it is the system that should be adopted. I have already said that I would prefer if we could to discharge the sewage into the sea. But if you cannot put the sewage into the sea I would say that the septic system is the next best one to adopt. It might be possible to discharge the sewage into a tidal river, or something of that sort. If it is the case of an inland town, where the effluent must be discharged into a river whose water is likely to be used for domestic purposes, then I should say the biological process is the only workable way of treating sewage matter.

47. *To Senator Lynch.*—I would not advise that the sewage and the storm water should be run together in one system. In the case of an inland town I would not anticipate any trouble from disposing of the storm water separately. It would not be likely to give forth an offensive smell, or to become a nuisance. I have never heard of storm water being treated in any way. In Great Britain they have the combined system, and discharge the storm water on to large filter beds. That is because the water is polluted by passing through the same sewers as the ordinary sewage. But I have never heard of storm water being treated, because, while it does carry a certain amount of vegetable matter, the most objectionable part of it is the silt, which is carried in suspension. It carries a large quantity of silt, and that may occasion trouble. In the case of the Federal Capital, I do not think that the storm water would be bound to collect a lot of foul matter in passing over the streets, lanes, and gutters. I assume that the city would be kept clean and tidy. One can quite understand conditions where it would be objectionable. If, for instance, a quantity of vegetable matter were allowed to collect, and a storm came on, naturally the storm water would carry the vegetable matter into the river. With regard to the relative merits of the direct method of treatment and the septic tank treatment, if you say that the sewage is wanted on the farm to intensify the culture, that is a sound method. But if, on the other hand, you want to dispose of the sewage, whether you get agriculture or not, that is unsound. If it is purely a proposal for sewage disposal, then the land disposal, in my opinion, is not worth consideration. The effluent from the septic tank has little or no manurial value. In running the effluent over the land you get the moisture. If water is a consideration to the locality, that would be the main reason for applying the effluent to the land. If the sewage is put on the land infrequently—and it would have to be put on infrequently to give the possibility of cultivation—you may expect no nuisance to arise. But if, on the other hand, you have to put on the sewage, whether it is wanted or not, in order to dispose of it, you may expect a nuisance to arise. I do not think it is possible to conceive of a septic tank system operated without bad odours arising. I think that in the development of the biological treatment the septic tank has remained as it was from the beginning—it is simply a glorified cesspit. The sewage must be allowed to remain long enough in the tank to cause it to be dissolved, and dissolved into such particles that it can be passed through the filters. But in regard to the filters there have been all sorts of developments. What was favored at first was a contact filter. But in a very little time the interstices of the filter got choked. I do not think that there are many contact filters in existence. After that it was found that it would be better to apply the sewage continuously on to the filtering material. Then the question was how to apply the sewage evenly, and in such quantities that the filtering material would be able to cope with it. That is really the state of development at the present time. Some persons favour one way of applying the sewage, while other persons favour another way. At Birmingham the sewage of 1,500,000 persons is applied from jets, and as one looks across the farm he sees a sort of fog. On the other hand, on some of the large sewage works in England the troughs travel backwards and forwards on top of the filter. As a trough mechanically travels, it overflows and applies in that way the sewage to the filter. There are all sorts of mechanical devices of that description. The chief object, I think, is to apply the sewage evenly and constantly. I would not be at all surprised to find that the system is capable of further development. In some instances we have converted our contact beds into sprinklers. In other cases we have had to take out the sprinklers and put in tipping troughs.

48. *To Mr. Fenton.*—There is very little difference between crude sewage and the effluent coming from a septic tank.

49. *To Mr. Sampson.*—I should say that you might be quite clear that there is very little difference in the manurial value, because there is very little manurial value in either case.

(Taken at Sydney.)

WEDNESDAY, 3RD FEBRUARY, 1915.

Present:

Mr. RILEY, Chairman;

Senator Keating,	Mr. Finlayson,
Senator Lynch,	Mr. Gregory,
Senator Story,	Mr. Sampson,
Mr. Fenton,	Mr. Laird Smith.

Walter Burley Griffin, Federal Capital Director of Design and Construction, sworn and examined.

50. *To the Chairman.*—It was my design for the lay-out of the Federal Capital which was accepted. In preparing the design I took into consideration the question of sewerage; but the system of treatment was not a matter which I considered as coming within my final determination then. What I have been insisting upon with the Government has been the appointment of an expert sanitary engineer to take care of that matter. My position, briefly, corresponds to that of an architect for a building. I look upon myself as a landscape architect having charge of the planning and construction of the city just as an architect has charge of a building. This matter of sanitary engineering is comparable to the plumbing which is designed as a detail coming within the construction of the building. The sewering of the Federal Capital is a question requiring an investigation, which should not be carried out in less than four to six months, by a man who has had a life-long experience in that field of work. I expressed my views on the subject to the Assistant Minister of Home Affairs, Mr. Kelly. When I approached the Minister I felt obligated by clauses A and G of my contract, which conform to what I have said as to my relation to the city, to advise the Minister concerning the plan of a sewer which I happened to see in Colonel Owen's office. I had asked Colonel Owen about the plan, and he told me what it was. It was approximately a plan of what I understand is being constructed now. But there was no recommendation covering the problem of the reticulation on the one hand which he considered a separate item, nor the problem of disposal on the other hand, further than that they had considered bacteriological treatment and broad irrigation. I asked if there were any reports concerning that matter, and Colonel Owen replied that there were none. I said that there should be an investigation before these very important questions were decided. I called the attention of the Minister to the matter and asked him to hold back the construction of the sewer until the whole matter had been gone into as a problem in sanitary engineering, and, by a letter from Pago Pago (since I had to leave immediately for America), I wrote to the Minister confirming what I had told him here, asking him to withhold his approval until my return, or to get the service of an experienced sanitary engineer to make an investigation meantime. I returned in six months, and, in writing, I recommended the engagement of either Mr. Calder E. Oliver, of Melbourne, or of Mr. J. T. N. Anderson, of Narrebthong, in Victoria, to make an exhaustive report in a period of from four to six months. I estimated that the report would cost the Government between £1,000 and £2,000. That would virtually mean a plan which could be inspected by the entire public, not only in this country, but abroad. It would have to stand scrutiny as a scientific problem worked out. At the same time I asked for the appointment of an executive staff, including sanitary engineers at moderate rates, to be engaged on the making of the plans and to carry them into effect. I also asked for the same thing to be done in respect to all services and equipment of the city, realizing in the problem of a new city the great possibility of combined simultaneous effort for economy with efficiency. I requested in writing that there should be appointed consulting engineers who were to cover other fields of mechanical and gas engineering. The Minister said he wanted to give these officers to me only as their services were absolutely required, as their appointment would entail considerable expense to the Government. He said that the appointment of the executive staff would have to wait until the other officers were appointed. Then I asked the Minister for full information concerning the works which were under way or projected. I first went to the wrong party. I went to Colonel Owen, who told me he thought it was none of my business. I told him that I felt obligated by my contract to have the information. I then went to the Minister for the information, and he asked me to apply for it through the secretary, which I did. I applied for a transcript of all the documents and details necessary to make me familiar with the whole

of the works and commitments. He said that that was too much of a contract for him to deliver, and that I should specify particularly what I desired. I said that I could not do that very well, because I did not know what existed. I asked him for an index to the information in the hands of the Department concerning all the works, and I am still waiting for it. I have never said to the officers of the Department that it would be an unnecessary expense to put septic tanks at a point 3 miles outside the boundary of the city. I said, that pending a thorough investigation by experts, that matter should not be determined. I cited instances of primary separation treatment in Europe and America as evidence that the project embodied other elements than the ones which had been considered. I am concerned about having the most economical and efficient system which can be devised, and that means an investigation extending over some months, comparing all alternatives on a competing basis of expense as well as of hygienic efficiency. It is a matter of science, and not a question of any one's opinion. It is a matter which should be determined impartially by an expert after a thorough investigation and grasp of all the facts. I have consulted the most eminent consulting sanitary engineers in England, Germany, and the United States. I have found that where they are up to date they are following the lead which science has given them even in the last five years. They are in practical agreement as to all essentials. With all the facts before him the sanitary engineer can come to a solution of any particular problem which will practically command the assent of the entire professional world. I do not know how permanent work for a scientific sewerage engineer could be found in the Department of Home Affairs. He would have, perhaps, only one or two such problems to be worked out in the Commonwealth. If, however, the Commonwealth undertook all sanitary engineering in place of the States it could afford to employ an experienced man. There are different ways of proceeding. We can do a thing ourselves. I could design a sewage disposal plant for I am a graduate of a college of engineering. I have had all the general training which is necessary, but I have not had actual continuous experience, and without practical experience I would not, in the interests of my employer, assume to do the thing. Nor if my duties had been scattered over a great field of engineering activities, would I have felt competent to design a plant, which is a speciality. As you know, the popular definition of an engineer is a man who can do for £1 what any fool can do for £2, and that is the essence of this problem. I could answer a question as to the location of a septic tank for the Federal Capital, but I want to answer the question with all the facts laid before the Committee so that its members will understand my meaning. I will resume the general statement which I was making. I had reached the point where I had returned to Australia from America and recommended to the Minister of Home Affairs the appointment of engineers. He first put me off, because of the expense involved. He later asked me for a decision based on the evidence of the officers of the Department. I took that evidence again and found that it was just the same as some months before. My request for full information was dated 16th June, 1914. My first recommendation, I believe, was dated 10th June, 1914. On the 1st August I was authorized, on my own suggestion, to ascertain if Mr. Oliver, Mr. Anderson, or Mr. de Burgh would be willing for a modest fee of 100 guineas to pass an opinion upon this question of the out-fall sewer with the view to its pointing out the necessity of an engagement for the full service which I was confident would be required. There are many factors to be considered, as I was thoroughly aware. On obtaining the consent of all I recommended Mr. Oliver, and appointed him. That recommendation, approved officially by Mr. Kelly, was withdrawn by Mr. Archibald. Then I found, from a perusal of *Hansard*, that the work of construction was about to proceed—in fact, I found later that the work was already proceeding—and I wrote to the present Minister in just the same way as I had written to Mr. Kelly, and stated my objection on the basis of a thorough investigation being necessary before committing the Department to any system of sewage disposal. I also pointed out that there were alternative methods which must be considered, and which elsewhere had obviated entirely the necessity for providing an out-fall sewer. In my judgment "expert" means experience. There are vast differences in the results to be anticipated. Civilization is just a matter of specialization, and, as I said before, this science has been developed in various countries where every town is a problem. In that way there has been built up a very special science which includes bacteriology, various phases of engineering, and hydraulics. We can do this work with our staff which is handling all engineering matters in a necessarily hurried and incomplete way, and with the aid of handbooks get at a result. But that result, I maintain, will be at great cost and cause great delay. All that I ask is that the problem should be gone into, tried out, and proved as has been done elsewhere. Another point I wish to make is that the system for the Federal Capital was determined upon in 1910, and that, as regards this very subject, a lot of water has flowed under the bridge since that year. The carrying of disease by insects has been proved. The double chamber, that is the two-storey separation tank, is an innovation since that period so far as the outside world has known anything about it. The first effective double-storeyed sedimentation and digestion process was installed only three years before 1910. You realize that I am not deciding these things myself. I am pointing out matters which I feel it is absolutely necessary should be investigated thoroughly. I ask the Committee not to accept my statements. I am taking my facts from the experience of others, and also from a personal investigation of what I consider the main reasons, and of important plants in Europe and America, for instance the largest septic tank system in the world, and the earliest two-chamber system. The largest septic tank system was established in Birmingham by Mr. John D. Watson, engineer, while the longest operated double-chambered sedimentation and digestion tank was installed at Essen, in Germany, by Dr. Karl Imhoff, engineer. I did not invite any expression of opinion from these men, but I asked for an explanation of their work, and the limitations which they have set down. I did not ask them for any kerbstone opinions on any problem I was interested in. Such opinions by whomsoever given are worse than worthless, because where any of numerous premises must be left out, taken for granted or assumed, the conclusion is not that of an expert, but of a layman. I think that an engineer, in order to be effective, needs to have a fee, and give his time to the work, and the results will invariably save a great many times the amount of his fee. That is the experience of private industries with consulting engineers; it has built up a whole business of consulting engineering in the more populous countries where such problems are coming before private interests on a large scale. There are

principles in connexion with the Federal Capital which could be worked out on such a basis as that, but which cannot be investigated in any other way. For instance, the recovery of waste gas from the coke ovens from Bulli to Kiama and their co-ordination for Canberra or Sydney. These things have to be treated in a very particular way, and gone into very fully before we can know whether they are feasible or not, before we can judge the possibilities. In planning a city like the Federal Capital, before the valuations of the lands are fixed, we have absolutely free scope to locate all our features, and to place only those things that are necessary for a population which we can locate ourselves and concentrate, and which we do not have to take as scattered by individual initiative. Such an advantage as putting these services together in conduits or combining by other methods which will accommodate all at one operation, instead of three, or four, or six required, if the services are provided for independently. There are a great many other matters that I could mention which indicate the necessity of investigating these questions all at once, of determining the engineering problem, putting it on paper authoritatively and fully so that anybody in Australia, or any other country, can investigate the problem, and on the facts given judge of the merits. Deal with the whole thing openly and above board, as a question of public policy. Taking the sanitation of the town in the same way as we consider the plumbing of a building; in making specifications there are two things which we always have to bear in mind, first, that the building has sanitary effectiveness; and second, the maximum economy. Dilution of sewage and broad irrigation are the primitive methods of disposal. They depend upon natural activities which, of course, can only be relied upon under certain restricted conditions. They are the oldest systems, going back indefinitely, and, of course, were developed without a knowledge of bacteriology and the scientific facts which are brought to bear on the whole problem now. Take some of the sanitary phases now involved. In this case a long sewer is necessary to get the disposal plant 3½ miles from the town. There will be, necessarily, a continuation of this sewer about 3¼ miles to the initial site of population, or to the various centres of the whole scheme as worked out, making a sewer 6 or 7 miles long from any boundary. That, of course, means a large amount of septicization. It means that the whole sewage will be putrifying, and giving off offensive odors, requiring, for instance, those vents which sometimes are offensive in themselves. I can point out to the Committee the putrified condition of the sewage at the Yarravillo pumps, situated at about the same distance; that is about 8 miles, run from the sources in Melbourne. Not only does this method of disposal require a vast area of land, but it depreciates the value of vast surrounding areas, because of the stench which is given off at times, and which cannot be avoided altogether in the surface-treatment of sewage. It is a breeding place for disease-carrying insects, particularly flies, which travel for many miles. In this case it is located in the direction of the prevailing winds. As a sanitary proposition one of its great defects is that it is combined with an irrigating proposition; the two things are antipathetic in many ways. I am speaking now of broad irrigation, where the utilization of either septicized or raw sewage requires a high degree of skill to maintain a balance between the diverse requirements of irrigation on the one hand and sanitation on the other. That may be obtained only in a very large plant where they can afford a rare kind of expert to manage, such, for instance, as they have at Berlin. I am now giving the Committee an idea of what alternatives we have to consider. There is the question of the contamination of foods which is a moot point amongst engineers and sentimentally. The manurial value of the effluent is purely problematical. There is no data to indicate that it has any value at all, indeed, it is doubtful whether it has. There may be one or two individual small cases, where the sanitary element is out of consideration, where the net returns exceed 10 per cent of the annual outlay. But that is getting on to the economical phase of the subject. I could give the Committee some opinions from leading engineers in the last two or three years which bear out what I have said as to the general proposition. As regards the sanitary aspect of the problem I might mention the effect trade wastes might have on an irrigating proposition because we do not know what trades there may be to consider. It is a unique problem in sanitation. We are going in advance of a knowledge of what we are to dispose of. We are depending upon predictions which may, or may not, be verified. Now let me deal with the economic phase of the question. That is the second point to be brought out in connexion with broad irrigation. At Canberra there are, I believe, 3,000 acres of land said to be reserved for this purpose. On the basis of the Melbourne capacity the area would be about 1,250 acres for a population of 125,000. The land, of course, will cost the Commonwealth approximately the same as the land in the Federal Capital itself. Another feature of this problem to be considered is the high pumping. I do not know what head will be required to reach the area of 3,000 acres, but it will be considerable. If we can use gravitation in place of pumping it is to be considered as an offset feature which we get in other systems, largely anyhow. The long electric transmission for pumping will involve an element of expense. We will lose a considerable proportion of the power and have an interruption and obstruction in the territory by another transmission line. But the worst engineering difficulty, economically speaking, will be the dead capital involved. If the cost of this scheme is estimated at £75,000, and it requires the outlay of another £75,000, which I do not say it will, to reach the initial town, there will be a capital of £150,000 invested prior to any necessity arising. In the course of twenty-three years, when the population provided for is expected, this capital, at 3 per cent., would have doubled itself if left on deposit with a savings bank. If it were put into earning sources available at the Capital it would be better employed. I have recommended one or two such sources to start with, and there are a good many of them to be considered. If the money were put into the cork industry, or in getting street frontages ready for leasing, or in providing hotels, or amusements, or even a Parliament House, there would be an absolute saving for the public. With the interest on that sum for one year it would be possible to install an innocuous local disposal system which would treat the sewage entirely out of sight, sound, or smell, and discharge an effluent which is non-putrescible, and that is our aim as a sanitary requirement. After the second year we would still have all the capital available for any purpose, and the population of 20,000, which is estimated to exist twenty years hence, provided for. Here is such a disparity that it merits investigation. The irrigation value of the sewage is computed to be about one-third to one-half of the value of pure or clear water artificially used for irrigation. In this case, however, the question is the utilization of all the waters

flowing from the city. Under the Murrumbidgee irrigation scheme the use of all this effluent is already provided on an area having half the rainfall, and more suitable soil where the value of the effluent as clear water, not as sewage, is thus four to six times as great for irrigation as it would be to the westward of the Federal Capital, without counting the difference in cost between gravity supply on the one hand, and pump supply on the other. In estimating the cost of this sewage-broad irrigation system, I have included only the cost of the out-fall sewer. On the basis of Berlin, which is the most favorable example of broad irrigation, the preparation of the land itself would cost as much again as the out-fall sewer: that is £75,000 to £100,000. With the system at Berlin, where they have the most favorable soil possible, more than half of their area is devoted to the filters which are necessary to go between the application of the sewage on the land and its application in growing crops. I am omitting the cost of the septic tank treatment at the outfall of the sewer at Canberra, but not the consideration of the question. The putting of the sewage into the Molonglo River would pollute its water.

51-2 *To Mr. Sampson.*—Certainly, the effluent from a septic tank is sewage. I have done some figuring here. It is a little abstruse, and is based on the cost of the Berlin plant. I estimate that the cost of the preparation of the land on that basis would be twelve times the value which would be added to the land by bringing the water there. I can substantiate the figures, but it is of no use to give them here. Turning to the systems alternative to broad irrigation I propose to confine my remarks to some which, in view of the practice throughout the world, it is most necessary to consider here. The first consideration involved is the early separation of the solids which can be precipitated if they are not carried over several miles. In the present state of science the difficulty of disposing without obnoxious features is otherwise insuperable. The only way of avoiding sulphuretted hydrogen odours is by an early separation of the precipitable solids from the dissolved and suspended colloidal matters in the sewage itself. That means necessarily an early treatment, relatively local; I should say, preferably, treatment nearer than a mile from the town, and the earlier the better, because raw sewage, when there is still oxygen dissolved in the water, is practically odourless; it is not offensive. Having separated the two elements, the precipitate will finally produce a sludge very much less in volume, absolutely innocuous as to odour, and not disagreeable in any way. The sludge can be taken care of on a very small plot ready at hand, and kept out of sight all the time if so required, as well as without causing any objection on the part of the neighbours, no matter how many there may be. I have seen sewage plants round which houses had been built, and it was stated to me that nobody had ever raised an objection. I could see no reason why there should be an objection raised. The sludge has the value of humus. The whole question of the manurial value of sludge is one on which no man can speak very positively in the present state of bacteriology. By many of the authorities it is considered that chemical fertilizers, even manures are, in the long run, more a detriment than a benefit, that the elements required to be added to the land should have a physical influence on the land rather than a chemical influence. Humus, opening up the soil area to be available to plant growth, especially opening up the soil to innumerable life, to the bacterial activity which goes on all the time, makes the inorganic elements in the soil available for plant growth. Ordinarily they are not available directly by the plant.

53. *To Senator Keating.*—I did not say a little while ago that the effluent from the septic treatment had about 40 to 60 per cent. of the value of clear water. I said from 33 to 50 per cent. as an irrigant. I can quote here, if the Committee are willing to bear with me, some experience by Whitney, Coulter, and Aaronson. I have had the privilege of meeting Mr. Aaronson and going into this matter with him. I will quote from a public statement he made at the time:—

Working Out the Soil—. . . . Our human presumption and vanity lead us to say, "Here is a soil to prepare which nature has worked thousands and thousands of years, and in thirty or forty years of agriculture we have worn it out; we are so powerful in our methods that we can destroy in thirty years what it took nature thirty or one hundred thousand years to produce." We may thus please our vanity, but it is not true. We are not capable of destroying to such an extent the productivity of the soil. It is as much of a presumption on our part as if we were to assert that in breathing the atmosphere for thousands of years we have spoiled it, and it is no longer good for breathing purposes. We can vitiate the air in confined localities for a short while, but ventilation will restore to it all the breathing qualities that it had before. It seems to me that the same is true in reference to the soil. By properly preparing the soil, by having physical conditions as they should be—and we must confess that scientifically we do not yet know exactly what the proper physical conditions of the soil are—and by developing rational methods of handling soils, we will be able to restore the fertility of the soil without the addition of medicines or chemical fertilizers. If we take into consideration the fact that the soil is not as it was regarded even a very few years ago, an inert substratum, but that it is, on the other hand, full of bacteria, of fungi, and that these microscopic fauna and flora represent a living world, the life of which is very intense; if we consider this, and study what conditions are necessary to stimulate the life of this flora and fauna, we will have in them powerful auxiliaries helping to maintain the fertility of our soils far better than any chemical agent or product can.

Experiments to Improve Soil.—From our experiment station in Palestine we selected one spot in the country which is renowned all the country over for its sterility. We supposed that if we succeeded in demonstrating that by purely rational handling of the soil, without any chemical fertilizer or any barn manure, just by improvement of the physical conditions of the soil; if we succeeded with soils that were cultivated four thousand or six thousand years continually without the addition of any manure or any chemical fertilizer; if we succeeded in demonstrating the advisability of new rational methods of handling the soil, this would be a demonstration not only for Palestine, but for other countries where agriculture has been practised for a much less time. It would take me too long to describe here how we did it. We took very large experiment fields—demonstration plots. We did not satisfy ourselves in demonstrating on three or four square feet, but we took parcels of ten or fifteen acres, which is the average field of our Palestinian farmers. By applying rational methods of so-called "dry farming," so well known in the United States, by ploughing better, by harrowing oftener, we succeeded in producing on our demonstration fields six and one-half times as much wheat as on the fields of our neighbours; fourteen times as much barley and twenty-three and one-half times as much oats. So you see, without going to the expense of introducing medicine, the effect of which may be very dangerous to the soil, in using the same implements as our neighbours used, by expending on the soil the same efforts our neighbours expended, we succeeded in improving its productivity to that extent. This, it seems to me, disposes of the question of worn-out and sterile soils.

Liming of soils is not a chemical fertilizing, and the application of humus as well as lime is really to be considered as physical treatment of the soil. Lime has a neutralizing effect. It does not add anything to the soil. It just takes away the acidity, that is, the poisons.

54-5. *To Mr. Laird Smith.*—The sewage does not add anything to the soil. I can quote Geo. W Fuller to the same effect, and other leading consulting sanitary engineers. I can cite an instance in Berlin which is the most favorable illustration of broad irrigation in the world. The conditions are ideal. The values of the crops taken off the sewage farm are not exceptional values. They are closely equivalent to the value of the crops taken off farms about the locality which have not the irrigation. It is predicted by leading authorities, Calmette in France, and, I believe, Dunbar in Berlin, that in only a few years irrigation farms will be replaced entirely by the trickling or intermittent filter and the sedimentation tank. In Berlin and Paris already the introduction of the other systems has begun, for suburbs of both cities are abandoning the sewage farm and resorting to the other methods of treatment. Berlin and Paris are the most notable examples of sewage irrigation to be found in the world. The sludge or deposit at Essen, produced by the Emscher process, when dried, makes a humus. It is practically like garden soil. I have had the privilege of handling and smelling it. There is nothing about the sludge which bears any resemblance to sewage. It smells faintly like burnt rubber, otherwise it is odourless. The precipitated material can be disposed of as garden soil or ordinary filling to any depth. It contains no elements of putrefaction. It is dried in several methods. The one which requires the least space is the open drained area, namely, .006 acre per 1,000 of the populat on. The deposit can be run into underground trenches, and the drainage may be sent back to the septic tanks and put through the process again. The technical name of this system is the Imhoff system. In this digesting process, two gases only are given off—carbon dioxide and methane. Cfl, has a calorific value, though I do not know just what. It is useful for burning. I believe that at Parramatta the gas from the septic tank is used. It is a useful gas and is absolutely innocuous. Ploughing into the ground is one way of disposing of the sludge; there it is disposed of out of sight entirely, and is never removed later. If you want to save the sludge, the process is usually to dry it and cart it away. It may be an element to be considered in connexion with Canberra, because of the lack of soil there, particularly of humus. That is the product of the digestion tank disposed of finally. None of it goes directly into the stream or the outflow. None of it is an effluent directly. The effluent itself must be oxidized by one or other of several systems. The prevailing one now is the trickling filter, the next one in point of economy is the under-fed double contact filter; it gives off no odour which is appreciable. The whole disposal of the sewage is below the level of the ground, never to be seen or evidenced in any way. It renders it possible to oxidize the effluent to a non-putrescible stage entirely out of sight and mind. The intermittent downward sand filter is the other alternative which perhaps has to be considered, especially in cases where there are natural sand deposits available. The combination of one of these methods with Imhoff preliminary separation, leaving the final effluent incapable of putrefaction and the whole thing disposed of entirely out of sight and mind, can be carried out at a cost of £19,000 for a population of 20,000.

56. *To the Chairman.*—There is no name for the system, it is a combination of systems. I have seen the systems in operation, but I have never seen the different parts in operation at one place, though I believe that they are now often operated at one place. That is about 12 per cent. of the cost of the other scheme without any disposal at all.

57. *To Senator Lynch.*—That sum covers only the cost of the works leaving out the connexions which, I take it, would be simply the reticulation. If you want to add a fraction for an outfall for a small distance, you can do so, it is not included in the £19,000 estimate

58 *To the Chairman* —The Emscher district, in North Germany, is a district which uses the first half of this system It includes a number of populous cities with populations varying from 200,000 to 10 000. The sewage is treated in local plants. I think that the largest plant handles the sewage from a population of 200,000. The sprinkling filter system has been worked out in connexion with the largest septic tanks in Birmingham. The virtue of this system, I take it, is that it offers a method of disposing of the sewage without incurring unnecessary expense and of insuring every sanitary requirement The whole treatment has been developed in the last few years. The city of Birmingham only recently abandoned its sewage farm There is no place in Australia where we can see the Emscher and filter system at work At the Federal Capital there is a great opportunity to install such a system on a small scale at practically no cost, that is, compared with the dead capital which would be invested in an outfall sewer, and to test the principle there

59 *To Mr Fenton* —I think that the city of Atlanta, Georgia, has installed a plant which combines all elements It has a population of over 150,000.

60 *To Mr Laird Smith* —I do not want to suggest a system for installation at the Federal Capital My suggestions are made with the view of indicating to the Committee that there are possibilities of doing this work on a much cheaper basis than can be done with one outfall sewer. It will serve just as well, and the cost will depend upon local conditions which I have not investigated, and which, I think, ought to be investigated by a competent sanitary engineer that is, a man who has had experience of all the elements involved He does not need to have experience of particular mechanisms they are simply a product of the science and have been developed during recent years. The Emscher system has only been in use seven years It can be introduced here experimentally, if not otherwise There are no patent rights or vested interests to be considered. I saw Dr Imhoff He has patents in America, and in reply to a question put to him by me he said, "In Australia we have no patents, and you can put in an installation if you want to do so"

61 *To Mr. Fenhagen* —The difficulties with such treatment are accentuated by frost which interferes with the aeration of the effluent. The possibilities are much more restricted in countries like the United States, England, and Germany, where the weather conditions are severe Another point is that the size of the digestion tank can be much reduced in Australia The efficiency is much increased by having a temperature which does not vary to any great extent. In other words, its efficiency is increased at the higher temperatures In northern countries they have to provide for a prolonged period of very low activity in the tanks The digesting operation would be faster here, and under better control.

62. *To the Chairman.*—My wish is to advise the use of a technical expert, not myself, to say that it would be a wise thing for the Commonwealth to install a small system as an experiment I would assume the responsibility, of course, if the Commonwealth could find no other means. The Premier of New South Wales offered to place the services of the State sanitary engineers at the disposal of the Commonwealth.

63. *To Mr. Fenton.*—I think that, in Australia, we have sanitary engineers who could recommend a system after making a thorough investigation over a period of from four to six months. That would not delay the building of the Capital; the reticulation could proceed, and the other matter could be managed independently. There are plenty of things to go on with which do not hinge upon the out-fall sewer. It would take two years to build that sewer. Our final system would be ready, and in operation, sooner than that period. I am not putting forward my own opinions, but facts which I have taken from men who have been installing the systems, and who have no axe to grind. Answering your question, I do not know any sanitary engineers in charge of large sewrage works in Australia who are seriously thinking of changing their plants, or adopting the systems I have been suggesting. That is entirely another problem. Owing to the proximity of the sea to Sydney, the problem here is very much simpler than, and entirely distinct from, the problem at Canberra. It is one thing to tear up a system by the roots, so to speak, and install a new system, and quite another thing to take the system which is the most economical one in the conditions as they are. On general grounds of economy and of public health, the system of local treatment is the better one. The sanitary efficiency is higher and the economical aspect is incomparably more satisfactory. It is impossible to avoid putrefaction setting up when the plant is located at a great distance, whether there is a septic tank or otherwise.

64. *To Senator Keating.*—By "a great distance" I mean a distance of 7 or 8 miles. How long it will take the sewage to get to the plant will depend upon the grades, and the amount of sewage flowing in the channel. In the case of Canberra I would consider a distance of 3 miles from the city boundary as "a great distance" from the putrefying stand-point. As regards the distance in which putrefaction would set up, perhaps a distance of 3 or 4 miles is about the dividing line. It takes, I think, about twenty-four hours to get the Melbourne sewage clear through the sewer.

65. *To Mr. Laird Smith.*—The distance will depend largely on the flow in the sewer. We do not know the proportion of water we will have as a contributor to the system.

66. *To the Chairman.*—I was placing before the Committee the alternatives between hiring an expert to go into this matter, and the other means which might be used, and I instanced casual opinions. Gratuitous aid, not casual, is a thing which I did not mention. It, of course, is very insidious, involving obligations. The gratuitous assistance of experienced men is not a policy which the Commonwealth should allow to be introduced. I am only recommending to the Committee what is the ordinary practice, almost everywhere, in Europe and America.

67. *To Mr. Laird Smith.*—I have not submitted a report on a scheme to any Minister; I have not been asked to do so. My only recommendation is a policy of engineering investigation on a thorough basis. I am only adducing evidence that there are possibilities which would come out of a full inquiry. I have a great many other duties than that of devising a sanitary system for the Federal Capital. It would be cheaper and better to appoint a sanitary engineer to make a thorough investigation. I have formed the idea that the scheme proposed by the officers of the Department is both extravagant, and not up to date. I will proceed to point out on a plan how my policy would fit in.

68. *To Mr. Sampson.*—There is no possibility of doubt about the purity of the effluent which would flow into the river, and, of course, in any system, purification has to be attended to.

69. *To Senator Lynch.*—The climate at Canberra is more propitious than is the climate in the case of any of the examples I have quoted to the Committee as standards of efficiency.

70. *To Mr. Laird Smith.*—I have had no practical experience of the system in any city. I have installed private systems in a number of cases.

71. *To Mr. Finlayson.*—I am aware that the septic tank system is in operation at the military college at Duntroon. I do not know whether it is open to any objection, I have not investigated it. If it is a single septic tank it is one on which you cannot rely. The very nature of the thing involves mixing the matter with the effluent, which has to be kept away from putrefaction. The essence of the system I suggest is first to segregate the matter which you are going to treat by putrefaction from the matter which you are going to treat by oxidization. They are separated by sedimentation. The sedimentation chamber is above the digesting chamber, and is arranged in such a way that the sediments to be digested are conducted between baffled plates through slots into the digestion chamber, and there is no contact of the flowing matter above with the digesting matter beneath. The details of that depend entirely upon the size of the plant. Sometimes it is done with one system on an arrangement of slots along rectangular tanks, sometimes by cones in annular tanks.

72. *To Mr. Sampson.*—I contend that, for a population of 120,000 persons, perhaps, eight separate systems of treatment would be more effective than one system. We would get closer to our sources of supply, and that is a point which must be borne in mind all the time.

(Taken at Sydney.)

THURSDAY, 4TH FEBRUARY, 1915.

Present:

Mr. RILEY, Chairman;

Senator Keating,	Mr. Finlayson,
Senator Lynch,	Mr. Gregory,
Senator Story,	Mr. Sampson,
Mr. Fenton,	Mr. Laird Smith.

Walter Burley Griffin, Federal Capital Director of Design and Construction, recalled and further examined.

73. *To the Chairman.*—Before continuing my statement I wish to express the hope that the Committee have no such impression left from my evidence of yesterday as appears in this morning's newspapers as to my position on the subject of this investigation. As cited from my contract yesterday, and from my whole attitude then, I reiterate that it was precisely to insure a proper solution of the sewerage problem among others that I was engaged by the Commonwealth. It would be as absurd to assume otherwise as that an architect is not responsible for the proper engineering of his building. The mere fact of the risk that the Commonwealth may be led to spend unnecessarily sums running into thousands of pounds in this particular work is

evidence of the necessity for a proper understanding of the situation. I have perused the evidence of Colonel Owen, which you, sir, placed at my disposal. I propose to go through the notes I have made before I deal with the evidence in detail. I would not be inclined to discuss this evidence in any circumstances, except as a grave issue depends upon my testimony in that respect. It is the seriousness of the decisions that he has made which impels me to address the Committee on these points. The evidence of Colonel Owen contains a number of statements which I would not take seriously in any other circumstances, especially the statements referring to a system I recommended for consideration, I am bound to take them seriously now seeing that they are used to justify actual work. It is quite evident to me from the evidence that, not only have the handbooks not been used, but no investigation has been made of the systems which I pointed out eight months ago. There is no evidence given here of any familiarity with that system or with how it works, notwithstanding that it has been published in volumes and to be found on the shelves in public libraries. I notice a good deal in the evidence of Colonel Owen as to what the officers have quoted me as having supported, and, by inference, that certain consequences followed therefrom. As regards the sewer itself there has not been time or opportunity, since last night, for me to investigate it, because I have not seen the plans. I have a copy of the evidence, but I find that there are certain plans, which I should see, as to the actual mechanism of the chief pipe. I cannot say from the printed evidence whether it would work or not. The egg-shaped sewer is not a new idea; it is only a question of fall and discharge. I do not know what the outlet is. According to the plans before the Committee the sewage is evidently not to be discharged by gravity; it is to be conducted by gravity to a pit, and thence, I believe, it will be pumped on to the land, but there is no evidence to show what is to be done with the stuff. There is a question in my mind as to whether the proposal would work at all, in view of the small and variable amount of sewage which would be discharged into the pit in the early stages of the city, and because septic action would proceed in that long, continuous line of pipe. It would be a septic tank extending over a distance of several miles. This is referred to here as simple liquefaction, but that is another word for putrefaction; whether it takes place in a septic tank, or in advance of it, it is the same process. In paragraph 2 of his evidence Colonel Owen says:—

> Whatever system we adopt it is impossible to say that the works may not smell one day out of the 365 days of a year, and we should be, so to speak, for ever accursed if sewage treatment works were established within the city boundaries, and were to smell even only one day a year.

That is a sweeping statement, and, in my opinion, it is not justified by the facts. I pointed out to the Department systems which obviated that danger, but they have not been investigated. Any system of sewerage requires attention. I do not say that it requires extraordinary attention, but it requires ordinary care. It is a necessity of any system. It is not a thing which we can avoid in any case. The conclusions of Colonel Owen are based on evidence that every septic tank, ordinarily considered a necessity, is an uncertain quantity in any case. I do not know a case where it has not failed to meet the expectations at certain times. I am referring to a large scale operation, and not to a small scale one. My point is that putrefaction under control, close at hand, is a safe way to avoid absolutely any nuisance whatever. There are volumes written about these matters. I have to select evidence which will meet the questions occupying the mind of the Committee, and the quickest way of proceeding is for me to meet the points which have been raised against the primary separation scheme. That is a short-cut method. I would not go into this matter if I did not feel that it was necessary for me to make my points clear. In his evidence Colonel Owen states that any system could be introduced at the terminus later on, if it were extended as far as proposed. At the same time, he indicates by inference that putrefaction would exist, and it would exist in the length laid down which would inhibit primary separation before putrefaction. Colonel Owen goes on to question the disposal of sludge, which is involved in my recommendation for an investigation, but his references to sludge concern an entirely different kind of sludge involved in the pure sedimentation system, which is a totally different system, such organic sludge being from six to eight times in quantity, and of an altogether different quality from sludge reduced to the mineral constituents. The amounts of water to be discharged, I suppose, is one of the questions to be taken up in connexion with Mr Hill's evidence. I would point out that his figures are a small fraction of the quantities found in actual experience in America. The conditions are different, but the hot, dry climate of Canberra indicates the requirement of a great quantity of water if it can be obtained reasonably. Colonel Owen told the Committee that the Department based their estimates as to the capacity on a flow of 30 or 40 gallons of sewage per diem per individual, whereas the American practice runs from 80 gallons upwards; even to 120 imperial gallons under a separate system. I suppose that Colonel Owen explained to the Committee the height of pumping. In this evidence it is not indicated, except in one sentence, on page 6, where he says:—

> Part of the farm will be a little higher than, say, Camp Hill.

which indicates 115 head anyway. He explained that, I suppose, to the Committee. It is indicated here to me. Lower down, in connexion with the storm waters, Colonel Owen says:—

> A different route will be followed by the sewer for drainage purposes.

I maintain that it will be unnecessary to have a different route, and that duplication can be entirely obviated. So that it is not merely a question of this trunk line of 3 miles, but of an intercepting sewer extending through the city, which is involved in his scheme. That entails another expenditure. On page 7 Colonel Owen states:—

> Any substantial dilution would mean an interference with the biological action.

If the biological action takes place at the head instead of at the foot it is not affected. Colonel Owen makes some reference to the soil out there, but I do not think that I need to go into that matter. He mentions clayey soil, and expresses the opinion that it is preferable to sandy soil. That is contrary to all the tenets of filtration that I have heard of. His statement reads:—

> I am rather inclined to think that the character of the country to be traversed is such that instead of allowing the water to pass freely through it, and to drain off into any of the adjacent streams, it is, if anything, a little too clayey, and would not drain very freely. I think that any effluent used for irrigation would evaporate. The clayey character of the soil is rather an advantage. I should not be pleased with a soil that would discharge the effluent too freely. It may

be merely a matter of sentiment, but I should prefer to see the effluent evaporate. I have seen the effluent from a sewage farm, and have heard it described as tasteless and clearer than ordinary water, but I have not tasted it.

I was born and brought up in Chicago, but I never heard of a sewage farm there. As regards the disposing of the effluent, where we do it close at hand in a concentrated way we select our material to meet the exact requirements of the disposal. We do that to get the maximum amount of aeration in the aerobic beds which, of course, eliminates from consideration, not only clay, but, in ordinary circumstances, all finely divided matter. Anything fine leaves the putrescible matters to fester on the surface, breed flies, and create a stench. On page 7 of his evidence Colonel Owen says:—

Any possible gain in the way of administration from the adoption of the Emscher system would be discounted by the cost of the works.

I believe that I answered that yesterday.

The sewage sludge, Mr. Griffin thought, would be of marketable value.

74. *To Mr. Laird Smith.*—I did make that suggestion to Colonel Owen. Sewage sludge has a marketable value, but it is a very insignificant amount. In the Emscher system it amounts to about .75 of a cubic foot of sludge *per capita* per annum. That would amount to, perhaps, 280 yards in a city with a population of 10,000 persons; it could be used for filling. In other places it is used for filling, and given away. It is absolutely odourless and innocuous. It can be handled with the fingers without causing any offence. I have handled it myself. The Dublin system, referred to by Colonel Owen, is not the Emscher system. Evidently, from the quantity of sludge produced, it must be a chemical precipitation system, which produces about twelve to twenty times the quantity of sludge that the Emscher system evolves, and the sludge there is not fully putrefied. It is in the putrefaction stage instead of having entirely passed that stage. Of course, it is offensive, and that is why it has to be incinerated, or treated by coking. The Emscher sludge is not handled until it is dry, and then it is handled with a shovel, just like earth. In all essential respects it is earth. It can be shovelled into waggons with no more offence than in handling garden soil. It is dried under several processes which I explained yesterday. The air-drying is the quickest way, and takes the smallest space. It is drained. It is not artificially dried; it is dried by exposure to the sun or under cover. No offensive odour is given off when it is wet, or when it is being dried, or after it has been dried. That is in contradistinction to the sludge at Birmingham. I have seen the sludge at each place, and compared them. Then Colonel Owen says, on page 7:—

The tank used in connexion with the Emscher system is about 20 feet high, and the sediment is dropped to the bottom of the tank where it is treated septically.

The tank is sometimes 15 feet deep, and sometimes 30 feet, but it is entirely underground; it may be put under cover and kept out of sight, except for man holes to gain access to the tank, as with any other system or tank. The system installed in Chatham, New Jersey, has six man-holes. I intended to bring with me to-day a sectional diagram, but I had not time to complete it. The sewage is to be treated entirely out of sight. In other words, the specifications require that the sewage should be entirely disposed of without ever becoming evident to the eye, or in any other way. It is all put underground, and, if desired, can be buried. On page 8 Colonel Owen repeats his statement about the cost. As I have said, the difference is in the very large reverse ratio. At the big treatment works in Bradford I believe wool-scouring has made a great deal of trouble, and that is a case of trade waste. One of the English schemes has adopted the two-storied tank system of sludge precipitation and septicization. I should think that, before coming to a final decision, Colonel Owen could have estimated the cost of installing the Emscher system from the same data as I have referred to. He refers again to the next action as being of an aerobic character. I have tried to indicate to the Committee that that is entirely different from the system which I have been explaining, in that it is not a matter of sequence, and of the anaerobic treatment preceding the aerobic treatment. It is only a question of selection. Part of the sewage is to be treated anaerobically, and part aerobically. The difficulty with the septic tank is that it does not do that. I am referring to the ordinary septic tank which has been in use for nearly twenty years. On page 8 Colonel Owen says:—

The effluent is passed over beds where it is treated aerobically and rendered innocuous. Such treatment would be involved under the scheme proposed by Mr. Griffin, and would take place within the city.

As I have pointed out, the effluent need not pass over beds; it might pass underneath, being entirely out of sight, mind, and knowledge of the populace. I indicated that by the one I would recommend as the best, and absolutely beyond question—that is, underground treatment. I did suggest yesterday that the effluent would be passed into the storm sewers, the ornamental lake, or the Molonglo River. It may be discharged into one or the other after it has passed through the aerobic treatment, which Colonel Owen recognises is necessary. He limits the possibilities here:—

The sludge is made into cakes and sold if possible as manure, while the liquid has to be treated aerobically, because very often it is putrescent.

There is no such process involved. I have never been an enthusiast on the subject of septic tanks and smell. I do not know that he implies that, but to avoid the smell of a septic tank one requires to have a knowledge of what causes smell. I am pointing out that there has been a great step further in advance since the installation of septic tanks in use here.

75. *To Senator Keating.*—There are non-septic systems of treating sewage which are successful, but I do not consider them nearly as satisfactory as those which involve the septic process. I do not know anything of the Neilson system, which I am told is installed at the Gladesville asylum, and other institutions in New South Wales. The question is whether that system can be expanded inoffensively. I know of no means whereby sewage may be transposed into an innocuous effluent without offensive odour, except the system I have mentioned, that is one involving preliminary treatment. As Colonel Owen states, the number of septic-tank systems is legion, but the difficulty is that they are all based on the same principle of septicization of the whole sewage. The system I have in my mind was started by Dr. Travis, at Hampton, and finally worked out by Dr. Karl Imhoff, in the Emscher district in North Germany. On page 10 of his evidence Colonel Owen makes this statement:—

Whether we adopt a septic-tank system or sedimentation I think it is advisable that the work should be established outside the city. Where the septic system is adopted danger attends the entering of storm water into the tank.

That danger could be obviated by this system which, in its home, takes care of all the storm water, except extraordinary flows, which are cut off automatically by weirs. On the same page Colonel Owen makes another statement about the effluent:—

There are bacilli in the effluent, but it is supposed to be non-putrescent.

He cannot have meant that, because it comes out of the putrefaction stage with all the oxygen gone. Then he makes another statement which I must answer:—

An Emscher or any other kind of sedimentation tank could be used at the end of the sewer which we propose to construct.

An Emscher system would not function with a septic treatment. It is dependent upon the separation of the raw sewage at a stage when it can be separated, that is, when the solids have not mixed with the liquids. With the aid of the diagram on the wall I will explain the whole process of the disposal of sewage on the basis of an early separation.

76. *To Mr. Finlayson.*—It is ten years, or more, since the city of Birmingham substituted a septic-tank system for the crude treatment of its sewage. It has now the largest septic-tank system in the world, and the largest filter area. I have a very complete history of the whole business from the designer of the system, Mr. Watson. Previously, Birmingham had a sewage farm which comprised a very large acreage, and which has been entirely abandoned. Whether the sewage was treated by tanks before it was delivered on to the soil I do not know. The tanks are now located adjacent to the city, and the effluent is conducted about 10 miles to the filtration areas. The single-chamber septic-tank system and plain sedimentation tanks are in use there. Approximately that is the complementary system suggested in connexion with the scheme for Canberra. I do not favour the single-chamber system. I believe that the process at Berlin is to discharge the sewage straight on to the beds. I do not favour that method for sanitary reasons. The solid faeces in the water are left on the surface; whether septicized or non-septicized they are left on the ground to fester, or if they are not left on the ground they have to be removed by mechanical process which involves a nuisance. "Naturally septicized" and "naturally putrefied" are synonymous terms. I do not know of any distinction such as is suggested. It is a complicated action of anaerobic bacteria in each case. The physical facts, the evidences to our senses, are the same to all intents and purposes, unless there is sufficient oxygen in the water to neutralize putrefaction. The trouble with the admission of storm water is the irregularity. If the flow could be continuous the matter could be easily managed. The very word "storm" indicates that the water is in varying quantity, and the processes applied to it necessarily cannot be uniform. The volume of water flowing into the sewer affects the treatment of the sewage. It must be remembered that there are two antipathetic conditions. The more water you admit into the sewer the less septicization of the sewage before treatment. On the other hand, the more water you admit the more expensive the treatment becomes, because of the required increased capacity of the tanks and the areas for distribution of the water. I did quote a German authority to the effect that Berlin would soon abandon its present system of sewage treatment, and the reason given for the proposed alteration is the expense. The new system is supposed to reduce the expenditure very greatly. That, however, is not the one and only consideration. The alteration is proposed on both sanitary and economic grounds. The discharge from the septic-tank treatment is offensive periodically and uncertainly. If the discharge were allowed to filter through a fair acreage of suitable soil the offensiveness would not be eliminated, because the discharge from the single-tank septic system contains solids periodically which would be precipitated on top of the ground, and there complete their putrefaction—of course, offensively. Another feature is that gases are given off. In the flowing of the whole sewage through the septic process gases come off which often are offensive, and cannot be traced. Periodically there is a whiff which may be smelt at a considerable distance, with no evidence of any discharge of solids having taken place. The single-chamber septic tank, in my opinion, does not complete the process of digestion or septicization, except in very small installations where the amount involved is slight. There, of course, the evidences of failure would not be sufficient to create a nuisance. It is a matter of scale. In the present instance I do not attach any weight to the popular prejudice against the installation of treatment works within the city, because the population is not there now, and people will go there free to take up their location accordingly. In Europe there have been cases where a prejudice against the location of the disposal system was shown, but after years of experience the prejudice was entirely overcome, and people established their homes within the limits of the supposed nuisance. The limits of the nuisance are varied. With a single-tank septic system a nuisance which might keep people away, might have to be a quarter of a mile off in the best conditions. With the Emscher treatment there would be no such limitation, I contend. In my evidence yesterday I indicated a system which could be located an eighth of a mile distant, that is a system of trickling filters. The odour that is given off from the trickle-bed filter, with fresh sewage, is not a putrefying odour. It is more like the odour of raw turnips. It is not a disgusting odour, but it is an odour which is associated with the process. Under the worst conditions the odour would extend about an eighth of a mile. I did not intend to convey the impression yesterday that my main objection to the system proposed by the departmental officers was based on the ground of expense. I took exception to the proposal on two grounds. I had my notes arranged under the headings of sanitary efficiency and economy. I estimated the cost of the departmental proposal when fully installed at £150,000, plus the cost of preparing the land for broad irrigation. I did not say that that disposal system is necessary, but that is what is advocated in the testimony given before the Committee, and what I was given to understand by Colonel Owen at the beginning. I do not think that the proposed location of the outfall sewer is suitable. I have not given a detailed investigation. The country at that point is very rough, and rough country is expensive country to distribute water on. It involves more difficulties. Again, the soil is too heavy. I am speaking now without having made more than a casual investigation of the proposal. I do not think that it is necessarily involved at this time. I think that a distance of 3 miles from the boundary is too far, both on the ground of sanitary efficiency and on the ground of expense. Distant treatment would preclude an innocuous disposition of the

sewage. On certain occasions it would give evidence of its existence, and that evidence would extend variable distances according to the treatment, but the minimum distance would be a quarter of a mile, because, at that distance, you could not use the separating system safely. I have not located any suitable site which might be used within a reasonable distance of the city under the ordinary system of sewer and septic-tank treatment, because I did not consider that it was a desirable alternative. It would not get first consideration. It would require a radius of a quarter of a mile. My consideration of this matter has by no means been mainly limited by my approval of the system I suggest. I have considered all the other leading systems, and this one without question meets objections which none of the others does.

77. *To Mr. Sampson.*—I do think most decidedly that, properly speaking, all the works at the Federal Capital come under my purview as Director of Design and Construction. I am unable, at the present time, to quote the terms of my agreement with the Department of Home Affairs. I had the agreement here yesterday when I referred to its terms, but I did not bring it with me this morning. The terms of the agreement, however, may be seen in schedule 16 issued by the Department. The agreement sets forth that I shall prepare plans and specifications for the works, and it includes services and equipment. In my opinion, it means, not only that all works to be constructed there by the Government have to be designed by me, but also that all the works have to be designed under my instructions, and carried out under my supervision. That is the position I occupy in the Department by my contract.

78. *To the Chairman.*—The contract has not been carried out as regards the details that I require. The staff that I need, and the full information that I require to make my position effective have been withheld from me.

79. *To Mr. Sampson.*—So far no plans of the proposed works have been submitted to me from the Department, except in relation to the sewer I asked particular questions about the water system, because the officers of the Department did not give me the full information. I asked them to make a synopsis, and Colonel Owen sent me that. I asked further questions which he answered. The water system was a work involved before I took office. I felt that the responsibility for that work did not devolve upon me. I did not want to assume the position of a critic of the Department in so far as my own responsibility was not absolutely involved. I have represented my position to the Department, and claimed that the whole of the works must be brought under my supervision and carried out under my instructions, but there has been no answer. At the present time I occupy an anomalous position. The Minister has requested me not to proceed, pending the submission to him of certain details of the plan for his consideration. He has restricted my operations to the preparation of a plan of the streets for submission to him for investigation of details I presume. That means the suspension of my authority as Director of Design and Construction. Regarding the sewerage, I recommended that alternative schemes should be considered before the scheme proposed by the Department was finally adopted, because the responsibility for the character of the works executed rested upon me. I gained a knowledge of the character of the departmental proposal from seeing the plan of Colonel Owen. When I went to see him about getting information the plan was under my eyes. I asked what it was, and he told me. I made a further claim. I asked to be supplied with all information concerning the plans and specifications and the commitments. That information has not been supplied to me. All my recommendations have been criticized by the departmental officers, and evidently action withheld in accordance with their criticism. The position I am put in now is that the Government does not consider that my general plan of the city has been accepted, and that I am a departmental officer subject to criticism and overruling by other officers of the Department. That is not the position which is defined in my contract, and for which I gave up my business in America to come here. I do not know that there is in operation in Australia a sewage disposal scheme similar to the one which I propose. I take it that any man with professional skill justifying my recommendation of his appointment could consider this matter so thoroughly that he would be able to weigh all the facts. He could consider the matter in more than a theoretical way; he could consult with others. I presume, for one thing, that he must be in consultation with other leading sanitary engineers in the world. He could obtain their evidence directly. I think it is advisable to get the recommendation of leading sanitary engineers, although they have had no practical experience in the operation and use of the scheme. They have had practical experience of the difficulties to be contended with, and possess scientific knowledge of the processes involved in the whole matter. It means a vast deal more than book knowledge only to enable leading sanitary engineers to pass a recommendation on a scheme such as the one I suggest. These men have not only had experience here, but they have been all over the world. They have seen installations elsewhere, and have been in contact with the engineers who constructed them. They are in direct touch with the whole field of knowledge. These systems of sewering are introduced from one country to another, usually by men who have made their investigations as from the countries into which they are introduced rather than by men who have made the investigations as from the countries where they are practised. You see, sir, there are two phases of the question. There is the local phase on the one side and the general experience of the whole world on the other. They have both to be brought into the consideration of the subject. I think that a man here is in just as good a position to investigate this matter thoroughly as is a man who is abroad. I will cite the particular work I am interested in now. These processes have been developed principally in three countries, namely, England, Germany, and the United States of America. They have been introduced across those countries generally by engineers of the countries into which they are introduced. I recommended that a thorough investigation of the subject should be made as a safe precaution to insure a proper authoritative stand on the part of the Government, and an authoritative demonstration to the public and the whole professional world that the subject had been thoroughly considered. I should make a definite recommendation of a system for the Federal Capital if this other method is not adopted by the Commonwealth. I am obligated by my contract with the Government to do this work. I do make tentatively a definite recommendation of the system I have advocated, pending substantiation of further detailed facts for which the data and the staff have not been supplied to me. I believe that the information could be obtained in Australia without going abroad for it. If the men here thought that they could not undertake the task, then we would have to go abroad. Not only at Adelaide, but at Paris, Berlin, and Pasadena vegetables are grown with the effluent from the sewage. That is done at fourteen places in the United States of America, and at a number of other places—a lessening number every year. In some cases exception is taken to the practice, and sentiment is at the bottom of the objection, while in other cases the objection is prompted by modern views on the transmission of disease. The variable quantity of effluent from every one of these systems is so far in excess of the facilities for distributing it, and the necessity of applying it at regular intervals for sanitary reasons that the manurial value is only what fraction can be adopted by the soil, and there is vast excess in every case. Above a certain percentage the manurial value that may inhere in the sewage is so far in excess of the possibility of the soil to utilize it that it is lost. We lose a third of the organic matter in the sludge, and that, of course, is removed from the sewage altogether so far as the sludge does not escape. The opinion I quoted to the Committee yesterday, regarding the application of artificial manures to soil, is a very advanced one. It is decidedly an argument against the application of manures to soil. Stable manures are valuable, largely for the sake of the humus they contain; the rest is problematical. Well-ripened stable manure is a humus which might be introduced into the soil as a physical agent. I mean by "humus" an inorganic matter that has a texture which permits air and roots to get through it easily. It makes the soil physically available to the plant. That is a large part of the advantage of stable manure, and it is also an advantage of the sludge I have referred to. I have stated that the physical factors were to be emphasized in the treatment of the soil, rather than the chemical factors. If it were considered undesirable to send the effluent into the ornamental lake it could be put into a storm sewer and discharged below the dam, but that would be done on sentimental grounds only. The volume of sewage regulates the proportion of friction to the hydraulic force. The resistance would be much greater with a lesser volume than with a larger volume. It is possible that it could be largely provided for by the shape of the sewer. The holding up of a scheme of this kind would not interfere with the general works in the Federal Territory. If the sewering project were held up for six or twelve months to get the necessary expert information in respect to the alternative schemes I have suggested it need not interfere in any sense with the carrying out of useful public works in the Federal Territory. I do not admit for a moment that from the final flow from the system I have been explaining there might be a stench to some extent or a disagreeable smell. A smell resembling the smell from raw turnips would be likely to be experienced by the residents within a maximum distance of an eighth of a mile in case of sprayed areas, but by increasing the area I would overcome that difficulty entirely, using a different type of filter. Therefore the eighth of a mile is considered as a negligible quantity. I do not think it would be more correct to base the flow in the sewer on the Australian consumption of water than on the consumption in some other country. The use of water depends upon growing habits; in Melbourne and Sydney, I understand, the quantity *per capita* is constantly increasing, and we do not know the limit thereof.

Ernest Macartney de Burgh, M. Inst. C.E., Chief Engineer for Water Supply and Sewerage, Public Works Department, New South Wales, sworn and examined.

80. *To the Chairman.*—I have had experience in regard to septic systems of sewering. I have been dealing with sewerage generally since 1885. I have had to deal with the construction of some of the septic tanks near Sydney, such as the tank at Mosman, which, perhaps, the Committee will inspect. In that case the difficulty was not so great, for the effluent discharges into Sydney Harbor. Under the Country Towns Water Supply and Sewerage Act I have also had to deal with the sewering of up-country towns. In towns such as Lismore, Hay, and Narrandera we have had septic systems in operation for some years. We have just completed a separate system at Wagga and Bathurst, and we propose to install septic systems at a number of other towns, notably Goulburn and Albury. I think that in New South Wales a good deal of experience has been gained in the method of treating sewage. I might go so far as to say that an improvement has been made. I think that our view with regard to the original scheme has been modified to a certain extent. When the septic system first came into vogue we were, perhaps, too optimistic with regard to the absence of offence. My experience is that the system needs great care in its operation. If I were intrusted with the laying out of a sewerage system for a new city I would, without hesitation, deal with the sewage out of the city by means of the septic-tank system. My views on the subject are very tersely summed up by the findings of the British Commission on the disposal of sewage, which I would like permission to quote. I may mention here that the Commission have been sitting for a period of seven years; they have not concluded their labours yet, but they have published a number of interim reports, and I may as well admit at once that their conclusions are a standard to us. Since 1909 they have issued several reports, but they have not modified the principle which they laid down in their report of that year on Sewage Disposal, Refuse Destruction, &c., and which is published in Vol. 2 of "Sanitary Engineering," by Moore and Silcock. I ask the Committee to listen to the following extract:—

> If a sufficient quantity of good land, to which the sewage can flow by gravitation, can be purchased for about £100 an acre, land treatment would usually be the cheapest method to adopt. Or, if the case were one in which it was necessary to obtain a high-class effluent, it might be cheaper to pay a somewhat higher price for good land, rather than to adopt artificial treatment, because effluents obtained from the treatment of sewage on artificial filters, as usually carried out in practice, are generally distinctly inferior to those obtained by the treatment of sewage on good land, and some addition to the ordinary artificial plant would therefore be required. On good land, a sewage of average strength, from which the major portion of the suspended solids has been eliminated by tank treatment, can be treated at about the rate of 30,000 gallons per acre per day, with the production of a high-class effluent. If the land available were only half this quantity its use might still be economical, if it could be acquired at about £50 an acre.
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> In cases where only clay land was available, it would generally be cheaper and more satisfactory to provide artificial filters.
>
> In considering the question whether land or artificial treatment should be adopted the situation and levels of the land available are, of course, important factors. And, whatever system is adopted, it is essential that the work should be so situated as to be capable of extension.

The Commission held the view that the best method of treating sewage, if the local conditions will admit of it, is on the land, but that a great

advantage may be gained if the treatment be a preliminary treatment in septic tanks and filters. That is the view which I hold.

81. *To Mr. Sampson.*—The effluent is still to be used as an irrigant just as in the case of an intermediary treatment.

82. *To the Chairman.*—Generally speaking, that is the system which is adopted in Great Britain. I do not know of any new system of dealing with a dense population without carrying the sewer a distance which would be inoffensive to the public. In the United States of America there have been several new installations. At Atlanta, and in Massachusetts, what is known as the Imhoff system has been installed. It was originally brought out in 1912 by a man named Travis, and since then it has been improved in the United States with the object of improving the septic tank, so as to reduce the nuisance, and get rid of the sludge. In my opinion, the tanks are an improvement, but they are not such an improvement as would justify placing them in a thickly-populated area, or dispensing with the subsequent land treatment. I would not, under any conditions, recommend the Commonwealth Government to put septic tanks near or in the Federal Capital. I should say that a perfect system for the capital would be to take the sewage away as far as you can, having reasonable regard to cost, pass it through septic tanks of the best kind, use aerating filters after the tanks, and then put the effluent on to the land. You would get a perfectly good effluent. It would not pollute the river, and there would be no nuisance in the city. I have not seen any of the new installations in the United States of America. The systems we have adopted in New South Wales are not based on the American system, or a near approach to that system. I am, of course, relying entirely upon the information published by the Americans in their technical journals and drawings. The difference is that we leave the sludge in the septic tank for a long time. We allow the digestion of the sludge to go on as long as possible until it has to be removed on account of the tank being filled. From the two-storied tanks the sludge is taken out at an early stage. You have to treat the effluent just the same to purify it, and you have to get rid of the sludge.

83. *To Mr. Laird Smith.*—I have had experience of the system at Birmingham. I spent a considerable time with Mr. Watson, the engineer, at Minworth Greaves. It seemed to work fairly satisfactorily when they had to remove the sludge. Mr Watson was getting a good effluent, a good amount of purification. Sewage contains solids and liquids. If you put sewage with solids on to the land, without first treating it in any form, nature will do its work in time; everything will break down and disappear, and will be dispersed, but an offence will be created while it is being done. If you choose to screen out the solids and burn them, or sell them for manure, or put them into the sea, and run the fluid on to the land, you will get a slightly better condition—that is, not so offensive—and again the land will deal with the liquid. To go a step further, if you make a septic tank and shut the stuff up in the tank organisms in the sewage will break down the solids, and reduce the greater part of them to a liquid. A little will drop to the bottom, which is called sludge—mineral. You get a dirty liquid in that way, and if it is run on to the land again the land will deal with it. If you put in what are technically known as filters, but which are aerating beds, and allow the oxygen of the atmosphere to act on the sewage you will get a further stage of purification. I think that the only difference between the new American tanks and the tanks we have been using is that the Americans remove the sludge at an earlier stage and take it away, whereas in New South Wales we leave the sludge in the tank to be reduced as much as possible. In travelling a distance of 3 miles in the sewer from the boundary of the Federal Capital to the septic tank the solids would not break up completely at the ordinary rate of flow, but there would be some considerable action. I know that Mr. Watson, of Birmingham, got a considerable breaking up of the solids in the 7 miles of sewer there. The new American tanks contain two compartments. They allow the solids to drop to the lower compartments from which the sludge is taken, but mark you, they have to deal with the sludge just the same when they get it out. It is not correct to say that the sludge is just like earth; it is a matter of degree. I do not think that I know the Emscher system by that name. I would not be in favour of allowing the storm water at the Federal Capital to go into the main sewer if it could be avoided. It has a disadvantage, because the flow then is very troublesome.

84. *To Mr. Fenton.*—I have no reports on the operation of the sewerage system at Atlanta. I have only seen what has been reported in the American journals. I have not seen any statement that that system is successful as regards the prevention of offensive smells. It is difficult to say that it would be less offensive to deal with sewage which had travelled 3 miles than to deal with sewage which had travelled 7 miles. It is just a question of whether the fermentation had reached the point of putrefaction or not. With a flow of 2 feet per second, the sewage would take about five hours to travel 7 miles. I do not think that the more travelled effluent is quite so easy to oxidize, but I should not discriminate much between the two. In the case of the Federal Capital, I would not put the septic-tank system among the population under any condition if I could get it outside the boundary of the city. I would adopt all the improvements, and put the treatment works as far away from the city as I could, even if reports state that there would be no serious offence to the public from treating the sewage in the centre of a population of 10,000 persons. If I saw an installation of the system in a city, and was well impressed with it, I would still act upon my own view. There are such variations in the quality of sewage, and such great difficulties arising in treating it uniformly that I would not take the risk of dealing with it in a city, even though it costs considerably more to take the sewage away from the city. I might say that, so far as reports go, I would not be satisfied that the sewage could be treated in a non-offensive way in a city. I do not believe that it could be so treated. Even if I had a demonstration which would almost convince me that sewage could be treated in a city, I would still prefer to be on the safe side, even at considerable expense. If I could carry out a system for a city, and treat the sewage at an initial cost of about £30,000, I would prefer to spend two or three times that sum to take the sewage outside the city and treat it effectively there. The quality of the soil in a sewage farm is a most important matter. If the soil was inclined to be stiff, the surface would need to be worked more. The disturbing of the surface to a certain depth would increase the value of the land as a filter, but the quality of the land, I might say, would not be so important if the sewage had been passed through tanks and filters as it would be if you

were dealing with crude sewage. If the sewage from the Federal Capital were treated in the best septic tanks which could be designed, filtered, and then used on the land for cultivation, I think that the drainage from the land might safely be passed into the water-courses; but I prefer it to pass through land first.

85. *To Mr. Gregory.*—I do not find that we get better treatment with a small system than with a large system, where we have the septic tank close to the locality which is sewered. We find that there are other matters which affect the treatment very much more, but that would not be noticeable. Our chief trouble is to regulate the flow, to get a uniform treatment in all cases, and the bigger the installation is the more uniform flow you get. A long sewer rather tends to act as a fly-wheel, and steady the discharge into the tanks. The discharge is less jerky than is the case when the tanks are close to the town. It is slightly more difficult to treat sewage after putrefaction sets in than it is when it is delivered early into the septic tanks. The reverse used to be claimed, but the British Commission I have quoted formed the opinion that it is not the case. In my opinion, it is not much worse. After the sewage has passed through 7 miles of piping to the septic tank, there would be fermentation, but the sewage would not have reached the stage of putrefaction. They are practically the same thing. One is an advanced stage of the other. I think that a distance of 3 miles would be sufficiently far to take the sewage outside the boundary of Canberra so as to get rid of all noxious smells, if you are sure that the population would not spread in that direction. I would prefer to put the septic tank on the lee side of the city rather than on the weather side. I would not take a risk with any part of the scheme. In the systems I have installed I have never tried an adaptation of the American systems, that is, the double-chamber tank. I have had it in mind for some time to try one of them, but up to now I have been rather inclined to go in for simplicity. I felt that I had a difficulty about dealing with the sludge in small installations. In the case of Wagga, the septic tanks are located about a mile from the population. These tanks have not been working long enough to occasion any complaints in regard to the effluent. Septic tanks are usually worse at the early stages. At Wagga there have not been many connexions made; they are only just starting. At Lismore, the septic tank is right in the middle of the town. It was installed when the idea first came out. At that time it was thought that a man might almost have a septic tank in his dining-room. It is a single-chamber installation at Lismore, not the new American system. At first there was a lot of trouble on account of a smell arising, but the more recent reports of the mayor that I have seen state that everything is very satisfactory. They burn a certain amount of the gases from the septic tanks, but my own opinion is that the people of Lismore have got used to the smell. The water in the river at Lismore is not used for drinking purposes; it is brackish water, and the effluent from the septic tank is discharged into it. There have been no complaints made on that score; but if the water in the rivulet were not brackish, and we wanted to use it for a domestic supply lower down, we could not discharge the effluent there. The effluent is run through filter-beds before it is allowed to pass into the river. In the case of the Federal Capital, I would put the sewage through septic tanks and filters, and if I could not get good land I would put the effluent on the bad land.

86. *To Senator Lynch.*—In New South Wales, the septic-tank systems vary as regards size and rate of flow, and particularly in respect to the so-called filters. There is more variation in the filter system than in the septic-tank system. I think that we may improve the septic tanks, perhaps, on the lines of the American tanks we have spoken of, especially if we have any places where we can get rid of the sludge. I have not come to recognise any particular method as the most satisfactory in design of tanks. But with regard to filters, I think that we have come to a satisfactory conclusion in favour of what are known as continuous filters. In installing a new scheme, I would adopt continuous filters, because, with them, we would get a better effluent, better purification. I do not think that the local nuisance is reduced. My experience is that, under any system, you cannot treat sewage and oxidize it without creating a certain amount of smell. I have not had practical experience of the Imhoff system. My opinion of that system is based upon what I have gathered from reports and plans, and my experience of the action of sewage under certain conditions. I have not had any experience of the Emscher system. I told the Committee that I did not recognise the system by that name. I may possibly have read about the Emscher system, but the name does not bring it to my mind. In the case of Canberra, I would take the sewage right away from the city to where there is good soil, and if it had to be taken 3 miles I do not think it would be too far. Next I would put in a first class septic tank. I think that some of the improvements which have been introduced in America lately might with advantage be adopted, because the sludge could be disposed of readily on land at that distance from the city. Then I would put in first class continuous filters, and after that I would distribute the effluent on the land.

87. *To Senator Story.*—I will describe to the Committee what I mean by a continuous filter. The first filters that were used with septic tanks consisted of tanks filled with stone or coke or clinker. The tanks were filled with sewage, and, after an hour or two, the sewage was drawn off. The air then got down amongst the stones in the tank, and the fresh sewage which came in was aerated and drawn off in turn. With a continuous filter, the sewage is spread over the top, and allowed to trickle down to the stone or clinker, coming in contact with the air all the time.

88. *To Mr. Sampson.*—I do not recollect seeing in the reports of the British Commission any comment on the new systems, such as the Emscher system. The new systems have been developed since the book I quoted from was published in 1909. They have been applied mostly to Germany and the United States of America, but I think it is a mistake to use the expression "new system" in relation to modern installations in those countries. They are not new systems, but improvements in the method of constructing a septic tank. I feel quite satisfied as to what their object is, and how they aim at its achievement. It is a method under which the sludge is taken from the septic tank at an earlier stage and dealt with I quite see that, under certain conditions, it is an advantageous thing to do. If they do not object to dealing with the sludge I see no objection to dealing with the sewage at as early a stage as possible, because, in my opinion, it could not create as much nuisance and stench as it would if treated after it had travelled some distance in channels. I think that they must get quite a marked reduction in the local smell, but that fact

does not alter my view with regard to their having some smell. I do not believe it is possible by any method of treatment at Canberra to reduce the effluent to a state of absolute purity, so that it could be run off directly from the system into ornamental lakes, or anywhere within the city, and would be quite harmless. In my opinion, it could not be done in the city by any reasonable process. It might be possible to get a good percentage of purification. We do that with the existing tanks, but in the process a certain amount of offence is given off. I do not think that that could be absolutely avoided I admit that we get effluents which we could run into streams without land treatment, but they are variable. My experience, extending over thirty years, is that you want to aim at safety, and if you are in doubt to take a certain course all the time. The thing will not be any better than expected, and in ninety-nine cases out of a hundred it will be far worse. If I were the engineer responsible for sewering Canberra, with so much land available, I would not dream of experimenting. Under any conditions I would not deal with the sewage inside the boundary of the city, or close up to the city. I have had experience of the irrigation results in country towns here. We have done very well at Rookwood, where there is one of the first tanks that were put in. At the asylums the effluent is used in the garden. It was troublesome there to deal with the sewage on account of the disinfectants used in the hospital, and so on, but they did well with it. At Hay, where there is a very clayey soil close to the septic tanks, and no land treatment, everything is most unsatisfactory The tanks give a bad result, largely due to the fact that they are situated very close to the town, and that the sewage is lifted by the Shone system—that is, with compressed air—resulting, on account of the way it is worked, in it going through the tanks in waves. That is a very troublesome experiment. I think I would regard the effluent from the septic tank as more valuable than water for an irrigant. On suitable soil, I believe, it has a certain manurial value.

89. *To Mr. Finlayson.*—It is necessary to deal with the sewage of Canberra on the spot some how. The use of the septic-tank treatment lessens the area of land required for the disposal of the sewage, and it minimizes the nuisance arising from that land which is inevitable if crude sewage is put on it. In the case of Canberra I would highly recommend the septic-tank treatment before discharging the effluent on to the land. If the land selected there for the purpose is clayey it would be a disadvantage. It would be very much better if you had a light, loamy, alluvial soil. The disadvantage lies in the likelihood of the land becoming clogged with the sewage and rank. It would act more as a septic tank than as a filter, and the plant life on the farm, which destroys the objectionable properties of sewage, does not thrive so well on clayey soil as it does on good, alluvial soil. An open, porous soil is desirable. But if the stuff has already gone through the septic tank and filters it is not so necessary as otherwise it would be. In my opinion, it would not be a serious disadvantage that for that purpose the sewage should have to travel 7 miles. Certainly the longer the out-fall sewer the better the septicization and the liquefication. I think that if you adopt the septic-tank system at the end of the sewer, and you are not so concerned about a little smell at that distance any action which takes place in the sewer itself will be no disadvantage. I would not be influenced as regards the distance I took the stuff by the consideration that the very action of travelling helps to disintegrate the solids, because it would be much cheaper for me to keep it in the tanks when it got there than to lengthen my sewer to gain the object. The same purpose would be achieved by local treatment in the septic tanks. If the sewage were treated as I have suggested you might deal with the effluent from 500 to 1,000 persons on each acre of land. An area of 300 acres would be ample for dealing with the sewage from a population of 100,000 persons. I can quote the authority of the British Commission on that point. They believe that after the sewage has undergone preliminary treatment for surface irrigation the effluent from 300 to 1,000 persons may be used to the acre of land. With a separate system I would estimate the volume of water to be used at 50 gallons per head per day. We work on our own experience, and on this point there is evidence to guide us. You will have to take the configuration of the city, the climatic conditions, the volume of water supplied to the people, and so on. In our southern outfall sewer we have a larger volume than 50 gallons per head per day, but there some of the roof water has been allowed to enter. Our present practice is to cut out everything possible, except the sewage. The demand of the people for water is increasing uniformly. We use now about 48 gallons per head per day in Sydney In 1920 we expect to be using 60 gallons per head per day. The use of water for this purpose is increasing steadily. In our sewers we take up the trade waste in certain conditions. We do not exercise any discrimination where the waste from factories is discharged into the sea, but we would have to do so in the case of an inland town. It is governed a good deal by the condition of the waste as regards acidity or alkalidity. The trade waste from tanneries and kindred industries would be entirely a case of making analyses. The authorities would have to decide on the individual product, whether the occupier was to be forced to treat it before it went into the sewer or not. We could not generalize on the subject. It would be a matter for local consideration. If the factory effluent were in such volume, and of such a nature as to be detrimental to the working of the sewerage system, it would have to be treated by the manufacturer. The shape of a sewer is entirely conditioned by the flow of the sewage. The oval sewer is put in where there is a very small flow at certain periods of the day. In providing for an initial small flow, and in anticipation of an increasing flow the shape of the sewer I would recommend to be used would depend upon the gradient. It is rather too general a question to answer definitely. If the gradient were such that the later flow would have a velocity of about 3 feet per second it would not be necessary to use the egg-shaped sewer; but if the velocity dropped below that point it might be desirable to adopt the egg-shaped sewer. I would not let the velocity in the sewer fall below 2 feet per second.

90. *To Senator Lynch.*—In installing a system in New South Wales we form a view of the probable population of an area. We judge of its suitability for habitation, and in that way arrive at an estimate of the population per acre to be served. We always allow for the estimated future population of the area to be sewered.

91. *To Mr. Laird Smith.*—There is practically no unpleasant smell until putrefaction sets in. It is the fermentation or the breaking up of the material, and giving off of gases which cause the smell.

92. *To Mr. Sampson.*—Under the improved systems which have been advanced as alternatives

to the scheme proposed for Canberra, sludge would not remain so long in the septic tanks as it does under the system now in operation in Australia. In New South Wales we leave the sludge in the tanks for years. The period depends very much on the working of the tank, that is, on the volume of the sewage. Sometimes a tank accumulates sludge, at other times the quantity is very low, but if it becomes large it is removed and carted away. The sludge is said to be innocuous, but it smells horribly. With small systems like those with which we deal the less handling and supervision we have the better. I would not like to say whether the sludge is less liable to smell on removal if it is allowed to remain in the tank for a definite time than if it is allowed to remain there for a number of months. The sludge in both cases smells badly. Our sludge has remained in the tank for three or four years before I have had to touch the tank. I have heard the statement continually made that at that stage the sludge is absolutely innocuous, but my personal opinion is that it is extremely offensive. I cannot say whether the sludge from the double-chamber tank system is innocuous or not.

Walter Burley Griffin, Federal Capital Director of Design and Construction, *recalled and further examined.*

93. *To Senator Story.*—The scheme I explained to the Committee this morning for Canberra is not a combination of two systems, but a complete system. It happens that parts of the system have been developed in one country and parts in another country. None of them has been developed by the same man as a complete system; but it will be recognised as a complete system with variations such as I have indicated. It is becoming recognised as a complete system in that way, although, historically, the parts have been developed in different countries at different times. I should say that, in America, there are probably seventy complete systems installed. The system has only been known in that country for five years. It takes some time for engineers to get familiar with a system as it would here. I was going to show you a detail of a covered tank which I had taken from one of Mr. Fuller's reports. It is simply the same thing buried in the earth. On every ground it is simpler to have the treatment works close to the city. You avoid going to the expense of working backwards. After the odours set in, it is much more difficult to work backwards than it is to take a sewage before the odour is developed. By "odourless" I mean not offensively odourous. Water, for instance, is not odourless, but that fact would not influence anybody to go away from it. The odour of water does not depreciate its value to any one in Sydney. We cannot say that water is odourless, but it is practically odourless. I would compare sewage effluent at the final stage with water, so far as odour is concerned; in fact, some water which is not sewer-affected is offensive. At Canberra there would be no odour conveyed outside the plant itself. If you were to go there and sniff around you might detect certain odour which I have indicated already in the unfinished sewage, that is, sewage in process of transformation. You can take away the sludge and put it up to your nostrils and you may detect the odour of something like burnt rubber, but it is not anything which will be noticed by any one standing over the bed. I claim that, on any day, with ordinary management, people living to leeward of the treatment works would not detect any odour, nor would they do so on a muggy day or at night. Some of the sewage systems smell at night, but the treatment works at Canberra would not do that. I do not say that the effluent from the system would be fit to drink immediately, but I do say that it would be suitable for all other purposes. It could do no harm to allow the effluent to run into the ornamental lakes. It would contain no putrescible element. There might be some traces of bacteria which had gone through the whole process, and were still alive, but they would be oxidized immediately they got into more water. I would not advise that the effluent should be allowed to run into the water supply for consumption by the people without their knowledge. Certainly there would be harm in taking that course. In any possible conditions of the survival of bacilli the water should be oxidized and filtered. It could be done for Canberra if desired. I would not advise the Commonwealth to go to that expense, because there is no use in doing so. It could be done by extending sand filters. I do not think that the sentimental objection to my proposal would exist to any considerable extent, for the reason that the Australian people have never had the advantage of an experience of an innocuous sewage disposal plant. There has never been any authority for the assumption that any other system would be innocuous; there have been many rash statements made by men who have not investigated; but not by scientific engineers. You have noticed, no doubt, that the responsible men, who recommended installation of this system in new countries did so only after they had made very thorough investigation. I cannot speak as a sanitary engineer, and, therefore, I have to avail myself of the experience of sanitary engineers. To my mind, it is not an experiment; it passed that stage some time since. It has been adopted by leading engineers, and included with their recommendations, in most cases. It is bound to come into Australia, and when it does it will have to come on the basis of experience elsewhere. I have not any special reports in English from places where the system has been operated successfully, but I have general reports from engineers, usually instancing the experience of various places in their recommendations, as I am doing now. I hold in my hand a lecture by Rudolph Hering, on the "Inoffensive Collection and Disposal of Sewage." He is a consulting engineer in New York City, who, perhaps, has installed more of these plants than has any other engineer in America. He is the dean of the profession in America. He is a member of the Institution of Civil Engineers, London, and both in Europe and in America he is a recognised authority as a consulting engineer, which, of course, includes control during construction. He has had the working of biological systems; he has installed one plant after another. I cannot say what control he ordinarily exercises after the installation of a plant. He is, however, responsible, professionally, for the construction and the good working of a plant. In February, 1907, the Recklinghausen installation in the Emscher district, in Germany, was put into service. I am not sure that there are available here any reports from engineers on similar works under their control, but I think that I could get such reports in the course of time. I believe that I have a German report on the operation of the system in the Emscher district. Imhoff and Emscher are really two names for the same system. Emscher is the name of the district in which the system was installed, and Imhoff, is the

name of the engineer by whom it was installed. Some persons use one name, while some persons prefer the other, but they refer to the one system. I have personally seen the system in operation at two places in North Germany, namely, at Essen Nort, with a population of 200,000, and at another place with a population of 20,000. I am unable to tell the Committee the name of the replaced systems there. This country has been reviewed for some time, but what was done with the sewage I do not know. I do know, however, that the treatment was very unsatisfactory, and that the streams were clogged with sludge. I have seen a photograph of the streams previous to the installation of the new system. At the time of my visit one of the installations had been in use for about twelve months. I believe that the other had been working for about five years. So far as I could detect there was no difference in the degree of satisfaction which they gave. The new installation seemed to be just as good as the old one. In Germany the system has been adopted generally. I think it was regarded as the last word on the term treatment of sewage. I do not think that they will ever ask any more of that process. It has met all the objections raised to the old method, and that it is why it is a revolutionary move. It has brought to a conclusion one stage of sewage disposal. I am prepared to stake my reputation on the biological system, assuming, of course, that it is properly worked. There is no question that the system is good: it will do what is claimed. Apart from the reticulation it would take about £19,000 to set in the system. I am taking the American cost based on the disposal of 100 gallons *per capita* per day, with a population of 20,000. There would be no further expense to complete the system. My estimate of £19,000 includes all stages. I suppose it would cost somewhat more or less if we divided the system into two units. In framing my estimate I did not take into account the cost of labour and material in this country, because the wages for this class of work are higher in America than here. I have only tried to make this estimate inclusive; I have not tried to get exact figures. I am only acquainted approximately with the direction of the contemplated sewers at the Federal Capital. I, of course, have seen the shafts. I am not sure whether there is a low enough place to set down my system alongside the departmental sewer at any point. We could set it down at the city terminal. I think that is the only place where it could be done. That is about 3 miles or more from the centre of population as determined at the beginning. The sewage would have to be carried about that distance before it was treated. The biological system is independent of the quality of the soils, and the levels at the city boundary would be all right, I think.

94. *To Mr. Gregory.*—My idea is that, as the Federal Capital grows, there should be several primary separation tanks in the city. That would necessitate the laying of sewer drains from each tank. In the event of the biological system proving offensive, I see no reason why the sewage drains should be useless for the scheme recommended by the departmental engineers, if the gravity brings us down low enough at the point where they start. Their idea is to take the sewage to the westward of the city, and one of my suggestions is to take it to the eastward a slight distance. It would be quite as much to the west of the projected settlement as it would be to the east. The boundary lines on the plan exhibited here are purely imaginary lines. It is essential to successful treatment that the sewage should be treated as quickly as possible; but possibly that is a factor which we cannot determine now. Whether the method of treatment would be affected by the length of travel in the sewer would depend on the proportion of water to the sewage content. We have not the data to enable us to judge. I can only say that one system in Essen is taking care of a population of 200,000. If this system were adopted at the outfall sewer, that is 3 miles outside the city boundary, it would not be so effective as it would otherwise be, because the separation would be no longer possible. The septic action would mix the solids and the liquids so that they could not settle afterwards. The gases would be entrained in the solids so that they would float. They would be very difficult to control, and there would be no possibility of evading the odours. If a primary separation system were adopted and placed at the west end of the city prior to the commencement of the tunnel estimated to cost £75,000, it would be effective so far as treatment was concerned. My reason for not recommending its location there is that it would involve the expense of an intercepting or virtually outfall sewer 3 miles up to that point. In other words, it would only obviate a part of the expense which we might avoid. It would be possible to get rid of the effluent at the western end of the city; it would take care of itself. What I am referring to is the trunk sewer we would require from the initial city to the western boundary, which is about 3½ miles away. I want to obviate that duplication of the length, as well as the expenditure of the £75,000. I anticipate settlement towards the western end ultimately, but not early, because it will be distant from railway communication. Another factor comes in there. In this settlement, where the land is owned and controlled by the public, there is the possibility of attracting a population on an economic basis, and avoiding a great amount of that expense on sewers and reticulation of waste land which applies where ordinary freehold obtains. This is one of the engineering advantages of this scheme. My main desire is that there should be an investigation by practical sanitary engineers into the whole question before any expenditure is incurred. I want the investigation to be full and authoritative, and to be made by sound practical sanitary men, to whom I could refer the information I have regarding the systems adopted recently in Germany and America. I would suggest that an expert is better than an amateur; but that involves a matter of policy. It was in February, 1907, that the first complete installation of the preliminary treatment was completed. The other features I have referred to are much older. At that time they were not known outside the original neighbourhood where they were applied.

95. *To Mr. Fenton.*—My system practically reduces itself to a very short extension of the reticulation system, because it is proposed to be put close to our utilized areas. I do not worry about the disposal of the effluent. I would naturally put the plant as near as possible to the lowest elevation, in order to handle the whole stuff by gravity, and so greatly simplify the works. There the final storm-water intercepting sewer, which must be at the lowest point, could take away the purified effluent. If there were any legal objection made by New South Wales to the discharge of the effluent into the Murrumbidgee or the Molonglo at the present time, it would have to be rectified; but that is a matter of judgment for the responsible officers. It could be easily met, I think. If the State officers persisted with their objection, I would take the effluent at any convenient point, and put it through sand filtration. It would be a very much smaller installation, and very much nearer than the Department's. You could grow crops on the land if you wanted to. The additional expense would be a very small item; it means an increase of 25 per cent. I do not recommend an installation for 20,000 persons at this stage. I do not anticipate that population at Canberra for a number of years. We are simply following the statistician's figures. The annual cost of the scheme would grow in proportion to the population. I can only tell you that the annual cost of this treatment is lower than the annual cost of other disposal systems. At Essen only two men are engaged to work the whole system. They not only cart away the dry solids, but they attend to the intercepting bars, and things like that. They visit the works periodically. They are able to handle four or five other systems in the same neighbourhood. The engineer told me than the annual cost of maintenance is a very small item. I do not regard everything in connexion with the Federal Capital as a strictly business proposition, because it is to be a monumental undertaking. I, of course, recognise that every precaution should be taken to do nothing which would prevent people from going there. I am recommending to the Committee the system which, I think, will least deter population from going to the Capital site. Occasionally the smell from Werribee farm, in Victoria, travels 5 miles. I do not think that, under proper biological treatment, there could be offensive smells, even though the sewage would have to flow a distance of 3 miles to the point of treatment. We could easily determine that point by a little investigation, and if the system were found to produce that result we could subdivide the unit. The effect of oxidizing sewage, primarily, is to produce nitrates. Effluent which is merely septicized absorbs oxygen very rapidly. The avidity of effluent for oxygen has a detrimental influence on the water into which it is introduced. It means that the systems require a larger percentage of water to counteract the putrefaction. A volume of water only as large as that which is used in European countries would be unfavorable to my system, for the reason that the exhaustion of the oxygen in the sewage would come about much earlier. The larger percentage of sewage in the water exhausts the oxygen content in the water at a much earlier stage. After it has exhausted the free oxygen, the putrefaction and stench begins. The use of oxygen in connexion with sewage thus prevents stench. The greater the quantity of oxygen used the less stench there is. That is the dilution method of sewage disposal. It is adopted in Sydney.

96. *To Mr. Laird Smith.*—The lecture of Rudolph Hering on "The Inoffensive Collection and Disposal of Sewage," delivered on 30th April, 1913, contains the following paragraph under the heading of "Sludge Treatment":—

> As mentioned above, both for a disposal of sewage by dilution and on land, we generally get better results after the liquids and solids are more or less separated before any treatment is attempted than when they are mixed, because the methods of treating liquids and solids are essentially different.

That is totally opposed to the carrying of sewage for a long distance before treatment—

> Formerly, sedimentation and precipitation were secured in simple tanks, on the bottom of which accumulated sludge was retained, and, subsequently, depending upon composition and age, was more or less reduced in bulk by putrefaction.

That is the septic tank, as we know it under the old system—

> Now, double-decked tanks are used which entirely separate liquids and solids. Until within a few years

a satisfactory sludge treatment had defied every solution. At present it is possible to convert the settled solids, inoffensively, efficiently, and economically, into a material which is permanently inoffensive, and resembles garden soil or humus.

That is the preliminary portion of the system which I have advocated for consideration for the Federal Capital. The disposal of the dissolved and suspended constituents is the remaining stage. I have met Mr. Rudolph Hering. Any engineer will recognise Mr. Hering as a leader of the profession in the United States. He is older than some of the men who have forged to the front. The following portion of Colonel Owen's evidence, given in reply to Senator Keating, on page 8 of the report, is not correct:—

> It was Pasteur who discovered, in 1862, that there were bacilli in sewage, and in all decomposing matter, which affected the decomposition. It was then discovered that there is a bacillus which works in darkness (anaerobically), with the result that the solids are broken up and the ammonia liberated. The solids are liquefied by the anaerobic action of this bacillus. The next action is of an aerobic character. The sewage is oxidised, and the ammonia is reacted upon, with the result that nitric acid and nitrates are produced. That is a natural action. A thick scum is formed on the water in the anaerobic tank, the tank is 6 feet deep, and under this scum the bacilli work out this natural process. By way of experiment the carcasses of dead animals, such as cats, have been hung in a septic tank, and within a fortnight only the bones remained. In the course of time everything was broken down. This organism brings about certain chemical changes in the substances treated, and causes it to liquefy. When I speak of biological treatment in this connexion, I am referring to the septic tank system. After the sewage has been treated in the septic tanks the effluent is carried away. The effluent is passed over the beds where it is treated aerobically, and rendered innocuous. Such treatment would be involved under the scheme proposed by Mr. Griffin, and would take place within the city. The sludge is made into cakes and sold if possible as manure, while the liquid has to be treated aerobically, because very often it is putrescent.

I pointed out to the Committee this morning two or three parts wherein Colonel Owen was in error.

(Taken at Sydney.)

SATURDAY, 6TH FEBRUARY, 1915.

Present:

Mr. RILEY, Chairman;

Senator Keating,	Mr. Finlayson,
Senator Lynch,	Mr. Gregory,
Senator Story,	Mr. Sampson,
Mr. Fenton,	Mr. Laird Smith.

Mathew Montgomerie Neilson, sanitary specialist, sworn and examined.

97. *To the Chairman.*—I am a British subject. I am really a Scotchman, born in England, and have lived abroad most of my life. I have had a vast experience in dealing with sewage. About eighteen years ago, when I was in the Pasteur Institute, I started to study the fermentation of organic matter. As I was the only Scotchman in the Institute, Dr. Mario requested me to go to Great Britain to see the different systems which were being carried out there, as he thought they were a factor. I was received by Dibdin, the chemist, of London, with whom I studied for a week. I was introduced to the engineer, Hawkesley, and by him to Dolopine and Fowler, of Manchester. Then, for six months, I travelled through Great Britain, inspecting the sewerage works at Birmingham, Manchester, Glasgow, and Sutton; in fact, I saw the principal sewage works

which had been carried out in England. I went into the matter thoroughly with the manager of each works, and saw what was being carried on. I noticed then that the septic tank at Exeter, which was run by the Septic Tank Company, was working very badly. For a distance of 5 or 6 miles the banks of the river were black, and fish died for 8 or 10 miles down the river. I went down with Mr. Commin and Mr Cameron, the introducer of the Monk system into Great Britain. The septic system is really not a British discovery. It was discovered by a monk in Paris, and was called the Fosse Mouras system This tank was introduced in Paris by a monk at his own monastery, before the Austrians besieged the city During the siege the monks were driven away from the municipality. The Austrians took possession of the monastery, and billeted the military there. After the siege was raised, Mouras, the monk, who managed the cash department of the monastery, went first to inspect the cesspit which he had called the Fosse Mouras. Instead of finding it full of solids, as he had anticipated, it was full of a diluted black liquid which could be easily pumped out. He had made in the vault or ceiling of the tank an aperture which he covered with perforated zinc to prevent the solids from flowing into the street gutter Calculating the economy which other monasteries would experience by introducing the system in place of the night-cart method which was very expensive, he installed the system in several monasteries round Paris, and took out a patent In a short time enteric broke out near one of these monasteries, and serious complaints were lodged with the health office in Paris. A Commission of investigation was formed, and the Fosse Mouras method was condemned and ordered to be removed from where it had been installed. A report on this tank was published in British newspapers. Mr. Cameron, the city surveyor of Exeter, read the report, and thinking that the tank might be applicable to the colder climate of England, he introduced it there, calling it a septic tank. He met with the same failure as had been met with in France, and called in Dibdin, the London analyst, for advice to get out of his difficulties. Dibdin advised that a coke screen should be placed on the flats before the fluid was run into the river. A screen was installed, and after several inspections Dibdin found that the coke pan was not losing its capacity, and he called it a bacteria bed. That was the origin of the septic tank, and the bacterial filter in England. These lines which were introduced haphazard by both gentlemen have been pretty well conserved up to the present time, and they are entirely wrong in their elements, especially the tank. A tank to treat sewage must follow Nature's process. By putting sewage into a cesspit or septic tank without oxygen we work against Nature, and must get fœtid gases. The septic process is an anærobic process, that is a process without air. Sewage is greedy of oxygen Where you have no air the proteids of food as they are broken up and free the sulphur, must form sulphuretted hydrogen which has the well-known smell of a rotten egg. By translating sewage and allowing the free admission of air to the liquid you cannot possibly have evil odours. The sewage is more rapidly decomposed, and the resultant effluent from the tank is prepared for nitrification in ærating beds or filters. By the process of oxidizing a tank of less than half the capacity required for a septic-tank treatment will do more work without nuisance, and will prepare the effluent; whereas a septic tank prepares a fœtid effluent, which meets with an entirely different action in the filter, and, therefore, is inadapted and causes great loss of space in the filter. It is evident from this that less tank and less filter by an aerobic or oxidizing treatment will do more efficient work, and do that work without causing obnoxious smells. I have had the anærobic and the ærobic treatment photographed on two plans. The photographs show the different actions going on in the tanks. Any anaerobic bacteria found in the septic tank are very small and live a parasitic existence. They are never observed to feed on the fæcal matter, but only dart in the liquid apparently without aim. In the oxidising process under the same power the ærobic organisms are seen as large as a little finger nail, and are in proportion to the septic bacteria as a hen is to a fly. They are distinctly seen feeding on the fæcal matter just as fish nibble at food They also feed on enteric and other pathogenic or zymotic germs. Therefore, not only do they decompose the sewage rapidly, but they also destroy disease germs found in the effluent. I would not hesitate to be inoculated with the effluent from a properly constructed oxidizing plant and filter without any suppuration or fear of infection in my system. I have observed frequently that in wounds received by men carrying out the work on septic tanks most serious blood poisoning has followed scratches, but in the oxidizing process the wound has healed up clean and healthy. Sewage, in a word, should not be a foul liquid. A sewer should not contain foul gases. If air is allowed to circulate freely through the sewers, and the whole treated in a scientific manner, there will be no nuisance and no smell at any part of the process. It is not necessary to go to the expense of carrying the installation a long way off to avoid a nuisance, because some persons recommend the carrying of the installations miles out of the place. It often entails a very heavy expenditure. With a properly constructed tank there is no necessity for it to be located at a distance. Certainly I would not suggest that it should be built in a backyard, as some persons say. I always locate the tank at a reasonable distance, but there is no necessity to go to extra expense on that account, as there is no nuisance with the system. It differs from the septic-tank system in this respect, that I introduce oxygen into the liquid by passing it over sills with a drop to cause rotation in the following chamber. Then the liquid passes under a baffle or dividing board to rise over the following sill, and so the process is repeated. By these means the small particles of organic matter are broken up more speedily. Oxygen is introduced into the mass, and the ærobic organisms find suitable conditions for their life, and working while the septic organisms are reduced to a comatose condition like fish out of water. That is the difference between the putrid or septic action and the oxidizing process. The tank is built suitably so that air can be introduced, and, of course, it is of sufficient size for the work to be carried out. I might mention here that I am not a civil engineer, but an associate member. I never passed the examination for civil engineer. I was created an associate, and so I never carry the title of civil engineer. I am a doctor of microbiology. I am also a chemist by profession. When I was in Europe I was the Government expert for Italy, and afterwards in France I acted in epidemics as an expert when they broke out. I carried on my profession as an expert in France and Valetta in contagious outbreaks. I was called in to examine microscopically and to counteract the epidemics. I served for about three and a half years in the Pasteur Institute, where I was studying cancer corpuscles. I gave up medicine for

hygiene, convinced that prevention was more important than cure Having found in large cities an enormous sacrifice of human life through the want of proper hygiene, I determined to dedicate my life to hygiene, and so I left the medical profession. For the last eighteen years I have given my whole attention to the question of sewage disposal in a great many cities and towns. I was called over to Valetta by the British Government when an epidemic broke out in the Fleet, and the vessels had to be removed to Gibraltar. I caused two large tanks to be built above Slima, and the water to be discharged intermittently to Valetta and Slima to clear the sewers. Proper air inducts were placed on the lines of sewer, and the result of applying this simple method is that Valetta is now a healthy town. It is known that for its size it is the most thickly-populated town in the world From memory I cannot state the population, even approximately Up the hills one house is seen right up against the other. Simply by ærating the sewers and flushing them the noxious constituents in the town were entirely removed, and the sewers now are so sweet that one can walk through them without experiencing any offence It is about twelve years since I dealt with the sewers of Valetta The system I introduced still prevails. The authorities built huge concrete flushing systems with automatic flushers and salt water is pumped into these, as fresh water is scarce on the hills of Malta The sewers are flooded by salt water from the ocean. At Pisa the authorities were experiencing very serious difficulty with the effluent from the abattoirs. The water in the river was absolutely black and stinking. We introduced a system of tanks for the settlement of the paunch waste, and the fluid that was run off was treated by æration. By this means the nuisance was abated very much It was not, however, a complete treatment. I wanted to take further action, but it was not done. The authorities thought that what I had done was sufficient, and I received from the town a gold medal for my work. In the city of Florence for three years I carried out great alterations to the sewerage, and on leaving the city I received a gold medal from the medical faculty. The presentation to me was made by the mayor, and the *Lancet*, a scientific newspaper published in England, printed a lengthy report about the work I carried out at Florence. In the case of many other towns I have been called in, and I have rectified the sewerage and done one thing and another of that kind. While I was working at Malta I was requested by Lionel Phillips, Fricker and Eckstein, of South Africa, to go down to the Witwatersrand, and remove the septic tanks which had been installed there and introduce the oxidizing process. I went to Johannesburg and met the mine magnates at the Corner House, and Mr. Beynon, representative of the Septic Tank Company. With several of the magnates and Mr. Beynon I inspected the works, and immediately started on the Village Main deep, Simmer and Jack Village reef, and another one, whose name I forget. I altered the septic-tank system to the oxidizing system; the difference was very much remarked upon, and Mr. Lionel Phillips immediately requested me to pull out the septic tank at his residence and install my own system. In South Africa I installed about thirty works. I dealt with the sewerage system of Boksburg hospital which was creating a great nuisance. I have in my possession testimonials for all these works. A strike broke out, several of the mines closed down, and things got into a very bad condition. I consulted the health officer of the district about the advisability of my deferring other works till better times arrived. From South Africa I went to New Zealand, where I installed a work at Bunnythorpe for a dry-milk factory. In response to an invitation I came over to Sydney, and in New South Wales I have carried out over 300 installations, some of them being fairly important, such as the one at Kenmore Hospital for the Insane, near Goulburn, where an epidemic of enteric broke out in a community of 1,400 persons. This typhoid had existed for three years, and the authorities were unable to stamp it out. A grave was kept open for the next enteric patient who should die, and hopes of getting rid of the plague had been given up. I promised the authorities that if they would install the oxidizing system for the disposal of sewage the enteric would soon disappear from the hospital. An installation was made and with the exception of one or two rare sporadic cases, enteric has been entirely unknown for the last four years. The effluent from the oxidizing tank is pumped up to irrigate the kitchen garden. The doctors, the manager, the attendants, and the patients eat the vegetables grown in this garden, and enjoy them. At Gladesville Hospital for the Insane, where the Government had installed septic tanks, the authorities met with continual trouble. One of the buildings had to be closed, the doctor could not open his windows when the wind blew from that direction, and at the main offices the stench at times would be felt. After several attempts had been made to rectify the trouble, Dr. Eric Sinclair, Inspector General for Insane, requested me to alter the system It was altered, and afterwards I was requested to alter the other septic tank on the grounds. Both tanks are giving entire satisfaction, and never has cause been given since to any one to complain of a smell. The effluent from these tanks irrigates the vegetables which are consumed by the doctors, the staff, and the patients. The oxidizing system has been installed in this State at many convents, public schools, hospitals, and private houses. I have pleasure in reading to the Committee some testimonials I have received:—

"Belmont," Gordon-road,
Roseville, 9th October, 1913.

M. Montgomerie Neilson, Esq.

Sir,—I am sending you a few lines to let you know that the septic tank installed by you is working satisfactorily, and the effluent causes no trouble, and is doing a lot for the garden.

Yours faithfully,
R. L. Provost.

It will be noticed that Dr. Provost calls it a septic tank.

Convent of Mercy,
Goulburn, 3rd January, 1914.

I have pleasure in stating that the sewage treatment here is giving satisfaction in every way.

It has been used now for over one year, and I shall be well pleased if it continues as satisfactory as at present.

Sister M. Gabriel, Superioress.

To Montgomerie Neilson, Esq.,
Bull's Chambers, Moore-street, Sydney.

231 Macquarie-street,
Sydney, 10th October, 1913.

M. Montgomerie Neilson, Esq.

Sir,—I have much pleasure in stating that the septic tank you installed at "Beresford," Rose Bay, is working satisfactorily, and although within fourteen feet of the nearest window, I have never noticed any unpleasant smell.

Yours truly,
E. H. Rutledge.

I might state that all these tanks are open; they have two 4-inch apertures on them.

"Culwalla Chambers,"
Castlereagh-street,
Sydney, 2nd October, 1913.

Dear Sir,—In reply to your inquiries as to the working of the sewage tank installation on my property, I have pleasure in stating that at this period (which

is more than a year since we commenced using the system) I am quite satisfied with the result achieved.

Although the tank is relatively close to my house and has less than two square chains for the disposal of the effluent, I suffer no inconvenience in any way. There is no smell, and the effluent is all taken up properly in the soil.

Yours faithfully,
ERNEST F. DECK.

Mr. Montgomerie Neilson,
Bull's Chambers, Sydney.

Sydney, 10th February, 1914.

The Manager,
Colonial Bank of Australasia Ltd.,
105 Pitt-street, Sydney.

Dear Sir,—At the request of Mr. Montgomerie Neilson we beg to state that this company has had non-septic tanks for the treatment of sewage matter erected under Mr Neilson's specification and supervision on two properties in which it is interested, and that the results have been so highly successful that we are at the present moment considering the question of having another installation provided by Mr. Neilson on a hotel property in one of the suburbs of Sydney.

Yours truly,
For Toohey's Limited,
W. DAVIS, Manager.

We have put in five tanks for him.

"Kingsland," Cranbrook-road,
Rose Bay, 11th October, 1913.

Dear Mr. Neilson,—I am glad to be able to say that both the non-septic tanks you have installed for me are working well and proving most satisfactory in every way, and although one of them is placed only 13 feet away from the house we have never noticed the slightest suspicion so far of any offensive odour emanating from either of them. Again, and what to my mind is one of the chief recommendations of your non-septic tank, is the fact that the inadvertent throwing down and admission of any antiseptics does not destroy or impair its action which I believe so frequently occurs with other so-called septic tanks.

I wish you every success with your patent.

I remain, very faithfully yours,
NICHOLAS P. ELLIOTT.

Montgomerie Neilson, Esq.

I will now read a short description of the oxidizing process by Dr. C. Bickerton Blackburn:—

On Tuesday, the 27th day of August instant, I visited Gladesville Hospital for Insane and carefully examined the two systems for the disposal of sewage installed there. One of them, an ordinary septic tank was in stalled, I believe by the New South Wales Government, and is the form in current use. The other, a non-septic tank, I believe, was the invention of Mathew Montgomerie Neilson. The outstanding difference between the two systems lies in the length of time the waste products dealt with in these tanks are exposed to aerobic conditions. In the later stages the aerobic organisms begin to take a share, but the effluent so soon hurries over the concrete steps designed to assist this aerobic action that these can take small part in the treatment of the effluent. In the non-septic tank designed by Mr. Neilson, the conditions are quite different. Here the effluent passes first into a closed chamber under anaerobic conditions, but after a few hours passes on into a series of chambers exposed to the air where the rest of the changes take place. These chambers are so designed that the materials are by means of conveniently arranged rises and falls and "races" exposed again and again to the air till finally the effluent passes from the third chamber on its way to the filter. As a result of this totally different plan the stage of putrefaction is entirely abolished, for in and around the non-septic tank there is absolutely no offensive smell, in a fact there is no smell at all. At the septic tank, and, indeed, for a long distance on its windward side, the odour was most offensive and strongly redolent with sulphuretted hydrogen. I inquired from the head gardener and the medical superintendent at the hospital to ascertain what their personal feelings were as regards the effluvia of the two systems, and they were loud in their praises of the non septic tank and condemnatory of the septic tank, the latter of which they declare makes life all but unendurable in hot weather owing to the stench of its effluent. The effluent, as described by me, has been considered in the case of the non septic tank before it has passed to the filter whilst in the septic tank it had already passed through the filter, and was therefore in a state that should have been far in advance, had the tanks been any way similar of that of the non-septic tank.

As regards the difference between the two systems from the point of view of a patent, I know little, but certainly say that from the bacteriological point of view the two systems could hardly be more different.

Yours faithfully,
G. BICKERTON BLACKBURN.

Dr. Blackburn, a biologist in Sydney, was requested by the hospital authorities to make a report to them on the process. We had an application for a patent, and by the permission of Dr. Eric Sinclair, and at our request, Dr. Blackburn inspected an installation, and reported on the process. I asked Dr. Sinclair to obtain a report from an unbiased person, and so an inspection by Dr. Blackburn was arranged. We also had a report from the head of the hospital—I have not brought it with me—and one from Dr. Eric Sinclair himself. The report of Dr. Blackburn was written about three years ago. Since then, the other septic tank he speaks of at Gladesville has been altered to my process. There is no septic tank there now. I would be very pleased to show to the Committee an installation of my system. We have a large number of installations about Sydney. We can show you the process at Gladesville on any day, or if you like at Kenmore. I can show you eight or nine installations at hospitals or convents. The system could deal with a large city such as Melbourne or Sydney. Its great economy lies in the fact that it is automatic, as you will observe from an inspection of the plan I produce. It does not require attention to open sluices or cut off the effluent, because the whole is worked by a clock-like arrangement of air valves without any moving power. It is worked just by the pressure which is caused by the sewage. The working parts are shown on this plan. The cost of the whole thing, although we have these working parts, is not anything like the cost of a septic tank, as it is much smaller in its construction. There is also the very great economy of almost no attention being required. A visit once a week is more than sufficient. You give out the time of contact that you desire by a throttle on the feed pipe to the discharge chamber, and thereafter it will continuously work to that time in its discharge of each filter. As soon as a filter is full the supply pipe is closed by an air lock; the effluent remains in contact with the filter for the time required, and then discharges itself by a syphon, and remains empty till its turn again comes to be filled. This is all done without any moving parts, and without any attention. The installations at Gladesville and Kenmore are the two largest ones that I can recommend the Committee to inspect. The former serves a community of 1,200 persons, and the latter a community of 1,400 persons. A tank built for a community of 1,400 persons would treat the sewage from 2,000 persons without being overtaxed, because there is a great deal of latitude in the working of the tank, and the precipitated silt is removed once a year by a valve. The silt is absolutely without odour, and only a very small quantity accumulates. It is removed through a sludge lifting pipe. Speaking roughly, the installation at Kenmore Hospital cost about £1,000. Proportionately as the size of a system is increased the cost of construction is decreased. I may add that when you lift the cover off a tank, even in the first chamber where the sewage is, you will see frogs breeding and hopping about. That is evidence that there is no poisonous gas in connexion with the system, as I could demonstrate to you this afternoon at different places.

(Taken at Canberra.)

WEDNESDAY, 10TH FEBRUARY, 1915.

Present:

Mr. RILEY, Chairman;

Senator Keating,	Mr Finlayson,
Senator Lynch,	Mr. Gregory,
Senator Story,	Mr. Hampson,
Mr. Fenton,	Mr. Laird Smith.

David Miller, C.M.G., V.D., I.S.O., Administrator of the Federal Territory, sworn and examined.

93. *To the Chairman.*—With regard to rainfall and floods, I think that the best thing I can do is to refer the Committee to a parliamentary paper on the climate of the Yass-Canberra district, and numbered C.12,506. It is a report by Mr. Hunt, the Meteorologist, which shows the rainfall and the temperature for the Capital Territory. With the parliamentary paper, I beg to put in a map showing the rainfall of the Capital Territory. It will be seen that the mean average rainfall in the vicinity of Canberra is 23 inches. The rainfall increases very considerably as you get towards the mountains south of the Murrumbidgee River, and in the southernmost part of the catchment of the Cotter River, it will be seen that it is over 50 inches a year. As regards storms and the prevailing winds, I would like to put in as an exhibit—[*Exhibit D*]—a copy of a pamphlet entitled, "Information, Conditions, and Particulars in the Preparation of Competitive Designs for the Federal Capital City of the Commonwealth of Australia." The information desired by the Committee is supplied on page 11 as follows—

> The prevailing winds during the winter months are from points west of the meridian, and those from the south, south-west, and west pass over the snow-clad Alps, they are keen.
>
> During the summer, hot dry winds from the west and north-west alternate with cool winds from the south, while the frequent north-east winds from the ocean are refreshing, and serve to modify the summer temperature.

The winds are absolutely healthy, but, of course, they are somewhat trying, owing to the manner in which this place has been denuded of trees. The present conditions are not as favorable as they might be, nor as they will be after the reafforestation scheme has been carried into effect. It means replacing with trees of a suitable character the timber which was originally on this country, and which has been cut down. On the weather side of the city, that is on the western and north-western side, there must be belts of timber. The particular class of timber to be planted has not yet been determined upon, because we are experimenting. But it will be some hardy quick-growing tree. *Pinus insignis* has given most excellent results up to the present time. Having established belts of forest there, other planting may be carried out under their protection. When the scheme for establishing the Federal Capital was under consideration, one of the factors which the Minister of Home Affairs had to consider was the probable population of the city at varying stages, from the inception of operations up to the time of its being occupied for the purpose for which it is to be erected. That sequence of operations, which, of course, includes sequence of works prepared by Colonel Owen, Director-General of Works, was based upon the assumption that a design for a lay-out of the city would be adopted at a certain period. In that particular there has been a failure. I am not aware of any design which has met with the approval of the Government being available. Owing to the delay which has taken place, the sequence of operations and the sequence of works have been materially interfered with. In my opinion, a delay of at least two years has resulted. That contingency was not anticipated when making a statement of the probable population. The population of the city, at its establishment, would include the Governor-General and his staff, members of Parliament, Justices of the High Court, officers of Parliament, officers of the Civil Service, undoubtedly a small detachment of the Defence Force for garrison duty, the Military College, and civilians. The Commonwealth Statistician worked out the matter on those lines. It was anticipated that the number of workmen employed in the first eight years would be from 600 to 2,600. The works were to be spread over that period for economic reasons, and with the object of interfering as little as possible with the labour market. The average workman would have dependants, who might be put down at nearly 2.5. For the associated subsidiary population—that is for the conduct of business—the factor would be 2.17 in addition. That would make the total estimated population at the date of the establishment of the Seat of Government at Canberra 17,000 souls. The estimate of the population is that it will increase in the same proportion as the population of the Commonwealth, and that in fifty years after the first occupation of the city the population might be placed at 36,000 souls. At the present moment the population of the Federal Territory is not 3,000. There has been a marked increase in this way: at one period more than 1,000 men were engaged on the construction of works, railways, and similar matters. Many of the men brought their families here. At the present time the number of men engaged here is 600. They will continue to be engaged so long as the works are there for them to do. We have now all the raw material ready to go on with the preliminary work if Parliament provided the plans and the money. A brickmaking plant is under construction, concerning which the Director-General of Works will give all information. For the public purposes of the city the works section will require to turn out 15,000,000 bricks a year for the next seven years. No provision has been made for the bricks which will be required privately. A large quantity of Australian timbers has been purchased, and properly stacked, and is being seasoned naturally. As regards the supply of timber suitable for building purposes, we believe that to the south of the Murrumbidgee, in the parishes of Bloomanba and Orroral there are forests of very good quality hardwoods. That matter is being investigated now. Otherwise, the resources of the Federal Territory for building purposes are very few. More than 200 miles of road have either been made or placed in proper order for heavy traffic. In addition to that a railway has been brought from Queanbeyan on the Goulburn-Cooma line to Canberra. At the present time the vicinity of the power-house is the railway depôt. The erection of a power-house was indispensable. It is rapidly approaching completion.

99. *To Senator Lynch.*—Apart from the delay in the lay-out of the city, and the carrying on of works, I have no reason to alter my estimate of the growth of population. We have not had many inquiries from persons desirous of living in the Federal Capital as a kind of sanatorium, for

the reason that the climatic and other conditions of the Territory have not been advertised. But large numbers of visitors from all parts of the world have been much impressed with the splendid climate. There will be a combination of attractions here. Without the aid which we will derive from the engineers, architects, and landscape gardeners in making beautiful roads, parks, drives, and buildings, I do not think that the climate itself would induce many persons to come for the reason that in Australia there are other climates where accommodation of the best description is available for visitors. That is not the case here. I have no hesitation in saying that immediately the city starts it will be a great attraction to people from all over the world. I do not expect an influx of permanent settlers solely on account of the climate. As a layman of ordinary experience, and not as an engineer, I have no hesitation in saying that there would be an outcry if it were proposed to allow the sewage from the Federal Capital to find its way into the Molonglo River. I am strongly of opinion that no form of treating the sewage will be acceptable to the public of Australia except one under which the effluent, after treatment, is distributed over broad acres. I do not approve of the suggestion to the Committee that the effluent from the treatment works should be run into the Molonglo River below the proposed ornamental lakes.

100. *To Mr. Laird Smith.*—A board of competent officers was formed to inquire into the best means of disposing of the sewage, and I am absolutely satisfied that their finding was the best in the circumstances. All the levels were taken by the Director of Commonwealth Lands and Surveys, Mr. Scrivener, who prepared the plans, which, of course, are available. There is no question about the accuracy of the levels which have been taken, and which are indicated on the public plans.

101. *To Senator Story.*—I have considered the desirability of planting trees, which might be, to some extent, revenue producing as well as ornamental. Not only has the matter been considered, but already a large number of young trees (cork and oak) are in the nursery. Orders have been placed for olives—walnuts are already growing in the afforestation area—for the purpose of testing their suitability for this country. Up to the present time the results have been quite satisfactory.

(*Taken at Kenmore.*)

THURSDAY, 11TH FEBRUARY, 1915.

Present:

Mr. RILEY, Chairman;

Senator Keating,	Mr. Finlayson,
Senator Lynch,	Mr. Gregory,
Senator Story,	Mr. Sampson,
Mr. Fenton,	Mr. Laird Smith.

Charles Alfred Hogg, M.B., Ch.M., Edinburgh; Medical Superintendent of Kenmore Hospital for the Insane, sworn and examined.

102 *To the Chairman.*—I have had full charge of the institution for about five years. When I came here we had the ordinary dry earth-pan system, and disposed of the sewage in trenches about 18 inches deep; in fact, we dispose of some of it in that way now. So far as the trenches were concerned we did find it a satisfactory way of disposal, but we got the pans infected and the result, of course, was an epidemic of typhoid here. The trenches themselves were quite satisfactory, but we got a source of infection in the hospital, and the pans, although they were steamed every day, got infected. We had, I think, about eighty cases of typhoid. It was this epidemic that caused us to look out for another system which would be suitable to local conditions. We traced the epidemic to the use of the pans, but the pans would not have caused the epidemic unless there had been a typhoid carrier in the place. Unless they had been infected with the typhoid germ they could not possibly have caused an epidemic. Since the inauguration of the present system of sewage disposal the health of the patients in the hospital has been a great deal better. The method of treating the sewage now is more scientific, but I think that the cessation of typhoid cannot be attributed wholly to the installation of the oxidizing system, because we have inoculated all the patients against typhoid. We did not use the anti-typhoid inoculation while we had the pan system in use. Since the oxidizing process was installed we have not been troubled with any smells. The tarry smell which the members of the Committee noticed to-day is practically the normal condition of the tank. I do not think that the smell is offensive. Of course, it is a matter of opinion. I heard some gentleman say to-day that it was offensive, but, personally, I do not think it is. We had other tanks put in here on different lines—what they call septic tanks—and we converted them to the oxidizing system, because we found them by comparison anything but satisfactory. I think that the oxidizing system is better than the septic-tank system. As a medical man I do not think that the slight smell which emanates from the tank is injurious to health. I do not live exactly near the tank. This office in which we are assembled is situated about half way between the tank and the house. There have been no complaints about the tank. If the number of inmates increased I would have no hesitation in continuing the present system. I do not know of any better system at present. One does not know what further improvements may be made, but at present I think we should go in for an extension of the system if required. I have had experience in similar institutions, namely, at Gladesville, Parramatta, and Callan Park. Callan Park, which is near Sydney, uses the ordinary water system, discharging the sewage directly into the sewer. Gladesville uses the water system, but it also has tanks like the ones here, I believe. Parramatta used the pan system when I was there, but it now has the water system connected with the Sydney scheme. I have had no experience of a similar character in any other institution. We get excellent vegetables from the use of the effluent in the kitchen garden. I think that they are free from any danger of infection. I do not think I would care to eat vegetables like lettuces off a sewage farm. I would eat anything which was grown above the ground, such as tomatoes, or peas, or beans, but I do not think I would care to eat green vegetables like lettuces. With anything which was cooked there would be no danger, but I do not think I would care to eat lettuces, even if they were cooked. It may be a personal objection, because the question of cleanliness of irrigation comes in. I do not think that I would care to eat lettuces over which sewage had been spilled, not for reasons of danger, but for personal reasons. I suppose that my objection may be put down to sentiment. If the vegetables are cooked there can be no danger. On our farm we grow

peas, beans, cabbages, cauliflowers, cucumbers, tomatoes, carrots, parsnips, melons, and pumpkins. We have not been able to afford to use water in the vegetable garden in abundance. We have had to be economical, because water here is somewhat expensive. For the purpose of economy we prefer to use the effluent, so that one can scarcely make a fair comparison between the two methods of growing. If we could be lavish with fresh water we would prefer to use it every time. With one exception we grow enough vegetables on the farm to supply all the patients. We never buy any vegetables except potatoes. We have had no complaints of the quality of the vegetables. I am afraid that I cannot make a comparison between vegetables grown outside the hospital, and our own vegetables. I grow vegetables at my own house without the use of the effluent as manure, but I cannot say that I have noticed any difference.

103. *To Senator Keating.*—Counting the staff there are about 1,400 residents in the hospital. Of that number I should say that the septic tank is probably taking the sewage of 400. Up to the last twelve months I should say that the tank was taking the sewage of about 150, and the last 110 have only been connected during the past year. The tank has been in use for four years, and at present it is accommodating about 400 persons. As fast as we can get the material we are connecting all the sewers. When I said 400, I was referring to the day sewage. At night we have all the dormitories connected with the tank which brings the whole of the male side to about 600 or 700 at night. Every dormitory has a water closet, which is used at night. I cannot say that I have given consideration to the systems of dealing with sewage. Since I was trained in the university I have never had to consider the question. In connexion with the installation of the oxidizing system here, I did consider the system itself as distinct from other systems. I think that, so far as the tank goes, this is the most satisfactory system I have seen. Not only do I regard the system as satisfactory, but I think that the Department itself regards the system as satisfactory, because they pursued the policy of imitating this tank at Gladesville and Morriset. Wherever they have to put in tanks now, they follow up with this tank. So I think that one can fairly say that the system has given satisfaction to the Department of Lunacy. So far as I know, it is a satisfactory system for an institution of this kind. I can say that it is more satisfactory than any other system I know of. As regards its suitability for aggregations of population such as towns or suburbs, I should say that, provided they had a good plant to pump the effluent away from the town, the system ought to give satisfaction. I do not think it would do to leave the effluent in its reservoir for an unlimited time. I think it would have to be pumped away from the town. That is to say, the effluent which we put on a garden now would have to be got away from the town. I do not think that I have had sufficient experience of the system to say whether it is a limited system—that is, a system which is suitable only for a small community.

104. *To Mr Sampson.*—I do not think it would do the slightest harm to run the effluent from the tank into a running creek provided that the water of the creek was not used for drinking purposes, and I do not think it would do any harm then unless people objected to drink the water. I would not care to drink it myself. Speaking from a health point of view, I do not think it would do any harm, provided that the creek was a running one with a sufficient volume of water. I do not think it is desirable to run any sewage into a stationary pool. I should say that there would be a risk of contamination in so doing. If you were to leave water stagnant, even ordinary water, for an unlimited time, it would eventually start to stink, apart from any such contamination. I do not think it would be the best thing to do to discharge the effluent from a system into a creek or stream running slowly through a town. I do not think it would do any harm, but I certainly consider that the better system is to remove the effluent by pipes and pumping from the town to a sewage farm, or some such place. I do not think it is advisable to run the effluent into streams such as we get in Australia, if it can be avoided. It is only a matter of opinion. I am not speaking from anything I know. Although I have seen the effluent running into the creek here, I cannot say that I have noticed any nuisance from it.

105 *To Senator Story.*—Since it was put in operation here, I have never, on any occasion, noticed a stronger smell than the one we noticed from the tank to-day. In the garden there is a tank into which we run laundry water, but it is a different system altogether. We run our laundry water into a special tank. We do get a bad smell from that tank at times, but not from the tank which we all saw this afternoon. The tank in the garden is not a tank designed by Mr. Neilson, but one which we constructed ourselves.

106 *To Senator Lynch.*—I think it would be correct to say that the treatment works we inspected to-day in the grounds would accommodate the sewage from 1,000 persons. I think that the tank cost about £500, but we found our own labour. If you had to engage labour, I could not say what the tank would cost. We had our own labour, and the only thing we had to do was to buy the material. Mr. Neilson supervised the work. I think that, with the connexions, the tank cost us a little under £500. The defects of the septic tank system I described to the Committee were principally the bad smells. I think that, in all probability, it was due to the construction of the tank. I think that, in the case of a septic tank, the stuff is kept in longer, and it goes on to putrefaction, but in the oxidizing tank it does not go to that stage; it does not putrefy to the same extent. Of course, where you get putrefaction, you get a certain amount of smell. I have not found this system to affect the health of our community detrimentally. The death-rate in this hospital is about half what it is in any other hospital for the insane in New South Wales. The septic tank I described was situated in front of the new blocks. It was situated at about the same distance from this office as the present tank is. The smell from the septic tank did not penetrate all over the establishment, but it was felt a good deal near the buildings.

107. *To Mr. Finlayson.*—The septic tank had not a filtering bed. The tank we inspected to-day has three compartments. I attribute the improvement in our sewerage system to the introduction of the two extra compartments. I have not noticed that the oxidising system is likely to breed flies or mosquitoes. Mosquitoes are pretty bad here, but I do not know that I can attribute their existence to the tank. I think that wherever you get stagnant water, or even a tank which is always full, although there is a stream going through it, you will get mosquitoes. I do not attribute the existence of the flies to the presence of the tank. Flies have always been bad here.

I have been here for twelve years, and flies were always bad under the ordinary dry pan system, quite independently of the question of tanks.

108. *To Mr. Laird Smith.*—The original difficulty we had here was purely a septic tank difficulty, and, of course, putrefaction did set up. The great thing with the present tank is that you must have a sufficient flow to get your sewage through the first division, without remaining there too long. If you have a stagnant first tank with an insufficient flow of water, you will get all the drawbacks of the ordinary septic tank, that is, putrefaction and smell. The flow of liquid through the first tank must be regulated, so that it shall not stagnate too long. We experience no trouble in securing the regular flow.

109. *To Mr. Fenton.*—If we had a larger area of land available, we would not place the tank in the most remote portion if it meant that we would have to bring the effluent back to irrigate our garden. If we had an area of ground to irrigate farther away from the building, we would naturally put the tank farther away, provided, of course, that it would not interfere with the irrigation of the ground. The present tank was put where it is in order to irrigate a great deal of ground; its location was regulated not so much by the nuisance, but by its suitability for irrigating our vegetable garden and lucerne paddock. We could take the tank farther away, but if we did so we would have to bring the effluent back for irrigation purposes. We put the tank at the nearest point on our land, and irrigate away from the buildings. I do not think it would make much difference if we had a lot more land. I believe that we would still have the tank in the same position for practical purposes. I think that, under any system, a health officer would prefer to instal a treatment system on the fringe of the population rather than in the centre of it. Practically, one may say that the oxidising system here requires very little attention indeed. With some of the old-fashioned septic tanks a man was kept employed all day in regulating the tables they used to turn the effluent on to the filter beds. We send round a boy in the ordinary course of things; he has a look at the tank, and that is practically all the attention it requires. There is virtually nothing to attend to in a mechanical sense, for all the discharge is done by air locks. It is a question of how long it may take the air locks to corrode, and to require replacing. There is no moisture going into the pipes at all—just into the air locks. The appliances have been down in the large tank for four years, and in the small tank for five years. We have not had to renew them.

110. *To Mr. Laird Smith.*—We have not experienced any putrefaction with the system.

111. *To Mr Gregory.*—If our tank were situated 5 miles away, and our sewage had to be carried that distance in a drain, I think it is very doubtful whether putrefaction would set in before the sewage reached the tank. In Goulburn there is a number of these tanks in use; for instance, one at St. Patrick's College, and one or two in the centre of the town. I have not seen the tanks, but I understand that they are all giving satisfaction.

112 *To the Chairman.*—I think that the farther a sewage farm is put away from a city the better.

(Taken at Sydney.)

SATURDAY, 13TH FEBRUARY, 1915.

Present:

Mr. RILEY, Chairman;

Senator Keating,	Mr. Gregory,
Senator Lynch	Mr. Sampson,
Mr. Fenton,	Mr. Laird Smith.
Mr. Finlayson,	

William George Armstrong, M.B., Ch.M., Sydney; D.P.H., Cambridge, Senior Medical Officer of Health, New South Wales, Lecturer in Public Health, Sydney University, sworn and examined.

113. *To the Chairman.*—In dealing with the sewage of an inland town there are practically three methods by which the sewage can be finally disposed of. These methods are treatment on land, chemical treatment, and biological treatment. The trend of opinion amongst sanitarians and public health men generally is towards believing that the best of these three methods is the biological system, accompanied by final disposal of the treated effluent on land. The biological method is employed at a very large number of towns in England, America, and other parts of the world, and so far as my experience goes it is employed in Australia. My experience has been mostly confined to New South Wales, but the method is used very largely in this State, not excluding parts of Sydney. In certain parts of Sydney, in spite of its proximity to the ocean, there are certain districts the sewage of which is treated on the biological system. I have had experience of these three methods, and my personal opinion is that the best of the three is the biological method, particularly from the point of view of nuisance arising in the vicinity of the treatment works. I was about to say that a well-managed biological system is practically free from nuisance, but I do not think I should go quite so far as that. I do not believe that you can deal with sewage without some trouble, some offence, or nuisance in the immediate vicinity of the treatment works. But I am quite convinced that the method which causes the least amount of inconvenience or nuisance is the biological system. From my own experience of it I am convinced that it is the best system from that point of view. When I say that sewage treatment works are nearly always accompanied by a certain amount of nuisance in their immediate vicinity I do not wish to imply that it may be regarded as a danger to health. I mean to say that the smell which is inevitably connected with sewage works is by no means always a danger to health. It may be objectionable, and may cause a good deal of offence to residents in the vicinity, but it does not follow that it is a danger to health. Any possible danger to health from such works arises rather from living organisms in the sewage, which may evade destruction by the methods of treatment at the works, and reach water supplies, or may in some other way be carried into such a position that they could be swallowed by human beings. That I take it is really the danger from sewage works, particularly in the case of water supplies. Of course, all precautions ought to be taken to avoid such a danger as that. The position of treatment works in regard to a city is always a matter of great importance. Firstly, it is necessary that the effluent should be disposed of into some position where its drainage will not reach a stream which is likely to be used in the vicinity for domestic or drinking purposes. Secondly, the question of position is of importance on account of the nuisance caused, even if it is not a danger to health. I take it that no one here, no one in Australia, no one anywhere, wishes to be subjected to unpleasant odours arising from a sewerage installation. My experience is that Australians are very much more particular about such odours than are people in England. I mean to say that Englishmen will submit to unpleasant smells arising from sewerage works in a way which Australians will not. We are much more particular here than are people in the Old Country. I am not acquainted with the particular proposals for sewage disposal at Canberra. If I were asked to advise whether the sewage of a new city should be treated in the city, or, at a little more expense, at a point 3 miles outside the city boundary, I should certainly recommend the adoption of a position 3 miles outside the boundary. I think that no matter how good the system was there would be some nuisance arising in the city. I take it that Canberra is intended to be a fine example of a city. For instance, it is not going to be a manufacturing place, where slight offensive smells are of comparatively little importance. It is going to be an official and residential city, the capital of Australia; and, therefore, I think, it is of importance that the whole place should be kept as free as possible from anything offensive. I would certainly say that, in relation to such a city the sewage treatment works would be better located at some distance outside the boundary. I think if the sewage had to be carried a distance of 7 miles to a point outside the city putrefaction would set in before the sewage got to the filter beds. Fermentation begins as soon as the sewage enters the sewer, and unquestionably a certain amount of fermentation would take place in the sewage before it reached a point 3 miles away from the city; but I do not think it would seriously militate against any biological method of treatment which might be adopted. It would only reduce the time during which the sewage passed through the first stage in the biological treatment. Of the systems installed in and around Sydney I am rather inclined to think that the system of tanks at Chatswood is the best one, although I do not think there is much difference between that system and the one at Mosman. Unfortunately the two systems are subject to the drawback that they have an exceedingly good method of disposal of the effluent. It is discharged straight into the sea, and that does away with all trouble regarding the effluent. Therefore they are not, perhaps, the best examples to consider, but both systems act very well. The Department has not had a complaint about a nuisance from any individual with regard to either of those installations for many years. If land of the right sort were available I would prefer to put the effluent on the land rather than discharge it straight into a stream. It is quite possible that a stream might be available which was not being used, and was not likely to be immediately used for drinking or domestic purposes anywhere in the vicinity of the sewage works, but it does not follow that settlement would not take place on the banks of that stream within a period of years, and trouble might arise later. There is a possible danger if the water of the stream were used for drinking purposes. On the other hand, I would like to draw the attention of the Committee to the fact that about seven-tenths of the water supply to the city of London has received the sewage of many large towns. That proportion of the water supply is taken from the Thames, and the Thames above London receives the sewage of such large towns as Windsor, Eton, Reading, Oxford, and a number of small towns and villages. The sewage of all those places goes into the Thames, yet the people of London consume the Thames water, and it is the most healthy capital in the world.

114. *To Mr. Gregory.*—The effluent is not always run into the river without first being put on to the land. So far as I am aware the effluent is always treated on the land before it is discharged into the river, and further, the river water is subjected to a process of sand filtration before it is distributed in London That is regarded as a great safeguard. I mention the matter merely to show you that it is quite possible to treat river water into which sewage has gone in such a way as to render it innocuous.

115. *To the Chairman.*—From the residents in the vicinity of the three systems I have mentioned in and around Sydney, there are practically no complaints. Occasionally we have had complaints of a nuisance at Willoughby Bay—that is, at Folly Point; but that installation is undergoing reconstruction. Concerning the other two systems we have had no complaints for a long time. At Folly Point the spray system of distributing the sewage over the filter beds is being installed.

116. *To Senator Lynch.*—The discharge of sewage into the harbor has been a source of trouble to the oyster beds at Folly Point. From our point of view it renders the oysters dangerous for human consumption. The oysters removed from the foreshores of the harbor anywhere near the discharge at Folly Point are found to contain sewage organisms, and we regard them as dangerous for human consumption. We have never actually found typhoid bacteria in the oysters, but we find other organisms which flourish in sewage. I attribute the diseased oysters directly to the discharge of the sewage at this point The Fisheries Department has proclaimed an area in which no oyster fishing is allowed to be done. An area of Middle Harbor has been proclaimed by the Fisheries Department where it is illegal to remove oysters. The prohibition has existed for many years. We have had no evidence of the free swimming fish in the harbor ever having been affected in any way. The nature and the quantity of sewage discharged is not such as to affect such fish at all. It does not affect the health of oysters, and it would not matter but for the fact that they are eaten raw. I have seen a great many variations of the septic tank treatment. I have a decided preference for a large installation. For dealing with a large number of people such as the population of a town, I am inclined to think that a septic tank and contact beds constitute the best form.

117. *To Mr. Gregory.*—Contact beds are filter beds which are filled and emptied. They are beds enclosed, as for instance, at Willoughby and Chatswood. At Chatswood, the sewage is discharged from the septic tanks into beds full of clinker or broken stone, or some material of that sort. When a bed is filled, the sewage is automatically shut off. The bed remains full and resting for a certain period while the sewage is in contact with the material composing the bed. Then the bed is emptied, and remains resting empty for another period. Again the bed is filled. There is a number of beds, generally from four to six beds. The beds are filled, rested, emptied, and rest empty in rotation. That is the type of installation which is known as the contact bed. The other main exemplar of this biological system is the trickling filter. It is a type

in which, after treatment in the septic tank—in every case there is preliminary treatment in the septic tank—the sewage is discharged continuously in droplets over a large area of filter material which is practically the same as that in the contact bed. I would not in any circumstances allow the effluent *from any treatment works to run directly into* ornamental lakes in the city.

113 *To Senator Keating.*—I have not personally seen the Neilson system in operation; but our Department has had one or two tanks of that class inspected, and I have seen plans of them. I was not aware that it had been installed at the Kenmore Hospital for the Insane, but I know that it is in operation at Gladesville. It was installed at such institutions with the approval of the Department of Lunacy. I took no part in investigating the system before approval was given. In the case of those particular institutions the matter does not come within the province of my Department. The chemical treatment consists in the addition of one or other of several chemicals to the sewage. The chemicals used are either lime or alumina, or *sulphate of iron or copperas.* One or other of those chemicals is used, but the one mostly used is lime, the proportion being about a ton of lime to 1,000,000 gallons of sewage. The sewage is then allowed to stand. Matters in suspension in the sewage are precipitated by the action of the lime, and *they carry down with them* a small proportion of the matters which are in solution. The sewage is clarified, but not very much purification takes place beyond that of clarifying. The great drawback to the use of chemical systems is the very large amount of sludge which is produced. *There is always a great difficulty* in disposing of and dealing with the sludge. My experience is that chemical systems are generally accompanied by more offensive odours than are biological systems. In certain circumstances the chemical systems are very good, but my *experience is as I have just stated.* The chemical treatment is applicable to a large system. It is used in quite a number of very big towns in Europe. Practically the whole of the sewage of London now is treated with lime, and the sludge is conveyed to the sea in lighters. London is in a *favorable* position for getting rid of sludge. The sewage is treated at Barking and Crossness, on the Lower Thames. The sewage is treated with lime and the sludge is conveyed to the sea. The clear, supernatant fluid, after the deposit of the sewage, is discharged into the *river. That system* is, I think, applicable to an inland town. I do not think that the effluent is fit to be discharged into a river; certainly not into a river which, by any possibility, could be used for drinking or domestic purposes. The living organisms in the sewage include typhoid *germs.* I mention them as an example, but there are many other organisms which might be dangerous in such sewage. In connexion with an installation of that sort, typhoid germs are generally transferred to the human system through drinking water. It has not been absolutely proved that they are transferred to the human system through the agency of flies and mosquitoes, but the evidence in favour of the contention is so strong that it is practically accepted now by all sanitarians. With any sewage system precautionary measures should be taken as far as possible with regard to flies and mosquitoes from the point of view of health preservation. In my opinion, some measures should be taken, as far as possible, to keep flying insects generally away from every portion of the system, from the sewage and the effluent, because there is no practical *method known which* can be relied upon to remove all pathogenic organisms from sewage. I do not think that I know of a case where such precautionary measures have been taken on a very large scale, but measures which might be adopted should include the covering in of the tanks. Of *course, many septic tanks are covered in;* and, on the whole, I think it is rather a good precaution to take. The filter contact beds are not, as a rule, particularly exposed to flies. If the tanks are covered in, and the contact beds are heaped up with the material they contain to a height well *above the level of the effluent of the sewage, they* are practically free of danger from flies, and the effluent which finally comes from the filter beds is, one might almost say, virtually free of much danger from flies because, although the pathogenic organisms have not been entirely removed from *them, they are so greatly reduced in number* that any risk of danger would be infinitesimal. With a proper and up-to-date system for a Capital I consider that precautionary measures of that kind should be taken as far as practicable. I do not think that the greater sensitiveness of Aus*tralians to smells and offensive odours is due to* the difference in climate between Australia and England. I think it is due simply to the fact that the Australian, taking him all round, is better to do than the Englishman. He is accustomed to a better standard of living. His style *of living is freer, more open, and more hygienic.* To a certain extent the hotter climate of Australia has an influence in making odours more offensive.

119. *To Mr. Finlayson.*—I do not think that *any system of sewage disposal installed in a city,* or near to a population, can be regarded as absolutely inoffensive. I do not know of any such system. On those grounds, I am in favour of the treatment works for Canberra being set outside the city as a point removed from the population. I am speaking quite apart *from the question of* expense, or of engineering difficulties which may occur. I am merely speaking from my point of view on general grounds. I do not think that there is a general tendency towards adopting small installations to deal with various divisions of a city rather than to have one comprehensive scheme which would deal with a large population in one way. I think it is a question entirely for local conditions. In some places, where the local conditions tend in that direction, small multiple installations would be used, but, of course, when you get a number of small installations, you increase the expense very much. All the installations have to be looked after, and it increases the expense of maintenance any way. I do not think that there is any other compensating advantage. I think it depends entirely on local conditions whether the area of land is available. For instance, I can imagine a state of affairs in an inland town where you had, perhaps, four or five small areas of good ground for irrigation situated in different directions round the town, but none of them large enough to deal with the whole sewage of the town. In those circumstances, you would naturally divide the sewerage system up into three or four districts, and deal with sewage by means of three or four installations. In the case of Canberra, I should certainly be inclined to make provision beforehand. I do not think that necessarily you want to make an installation large enough to deal with the whole of the sewage straight away. But there are certain portions as to which it is necessary to exercise foresight and construct the whole of the installation in such a way that it could be increased

from time to time, as the population grew. I think I should prefer that system to a system which would involve the installation of a separate unit for each section of the city as it developed. In connexion with the *biological treatment of* sewage, I should prefer to retain the filter bed and the irrigation area. If it is absolutely essential to eliminate one division, I would eliminate the irrigation area; but I should hesitate very much to do so. If the effluent is going to be discharged into a stream which is likely to be used, within 15 or 20 miles at any rate, for drinking or domestic purposes, I think I should prefer to have the effluent discharged over land as a final process. Eliminating the filter beds, I do not think that the distribution of the effluent from the septic tank over the land would cause much trouble. But, on the other hand, it would require very much more land, and the cost of maintenance and oversight would be very much greater because the sewage would not be purified to the same extent, and the land would tend to become clogged. The land would have to be perfectly suitable for that system. Generally speaking, if those three specific stages in treatment can be arranged for, I should prefer to deal with the sewage of Canberra in that way. I think that, practically speaking, any seepage from irrigated land which might find its way into a stream from the irrigated land would be quite safe. Our Department did not deal with the Bill, recently passed, to authorize the sewering of Goulburn. It was dealt with by the Public Works Department. Usually that Department comes to us for advice on all matters concerning public health and *medical questions.* So far as I know, it did not consult us with regard to the sewering of Goulburn, but I take it that it had data to go upon Probably it adopted for Goulburn a scheme on which we had already advised in regard to some other town. Personally, I do not know what *scheme has been approved of for Goulburn.* It is quite possible that the matter came before our Department before I occupied my present position. I would only have dealt with a question affecting Goulburn during the past two years. I was connected with the metropolitan area until nearly two years ago, and since that period I have been connected with the whole of New South Wales. I would not say that the rapid precipitation of the solids is the only virtue of the chemical treatment. It purifies the sewage to a greater extent than does mere sedimentation by itself without the addition of chemicals. It increases the amount of sedimentation. The increased sedimentation has an advantage, inasmuch as it clarifies the sewage, and renders it less liable to putrefaction, but it is a drawback in that it increases the amount of sludge. I do not think that at Canberra you could adopt the chemical system along with the biological system. It is a question of two systems. You would not have both of them together. I did say that the effluent after chemical treatment was not fit to be discharged into a running stream which might be used for domestic purposes. Perhaps I put that rather strongly, because, as a matter of fact, in many English towns, after chemical treatment, the effluent is discharged directly into the streams. I think I would have spoken more correctly if I had said that the effluent, after chemical treatment, is less fit to be discharged into a stream than is the effluent after biological treatment.

120. *To Mr. Laird Smith.*—Putrefaction sets up in the septic tank. It begins as soon as ever the sewage leaves the house. It is folly to say that it does not set up in the septic tank, because it begins immediately. Putrefaction and fermentation are really one and the same thing, and they begin as soon as the sewage is exposed to the air, or, at any rate, within an hour or two of that event.

121. *To Mr. Sampson.*—I would not like to rely on the possibility of the contact with a larger body of water, such as an ornamental lake, killing immediately any deleterious living organisms which remained in the effluent. I would hardly like to advise a minimum distance from the population at which the septic tank should be established, but it should be located at no great distance The nuisance arising from septic tanks does not travel far, even *with tanks which are* temporarily out of order and causing trouble, the smell does not travel any great distance. It is quite possible that a mile would be a sufficient distance to adopt. In the case of London, and the towns which discharge the effluent into the *Thames, some of them use* the chemical treatment, but most of them employ the biological method. In the first place the adoption of the chemical treatment was due to the restricted area of land available to discharge the sewage upon I think it is quite possible that, in many of these cases, if they had a sufficient area of land at their disposal, they would discharge the effluent on the land. I presume it was really the shortage of land which caused them to direct their attention to some other method of treatment. Raw sewage treated on land only needs a very large area.

122. *To Mr. Fenton.*—Whatever method of closed tanks is used, I think there is bound to be some offensive smell in the immediate vicinity. I believe that that is unavoidable. I do not consider that sewage can be dealt *with without causing* some offensive odour in the immediate neighbourhood. If the tanks were located in the midst of a fairly large population, I think that the residents contiguous to the tanks would complain of the smell. The water from the Thames, London, is subjected to sand filtration before it is allowed to pass into the service pipes. The sand filter beds are cleared very frequently, the sand has been examined as to the presence of organisms very frequently. The surface of the sand becomes quickly covered with a thick mass of micro-organisms, some of them being dangerous, but most of them innocuous. I do not think that there has been any special complaint regarding the effluent from people living on the banks of the Thames below the point of discharge for the city of London. But there is always a certain amount of smell in the lower regions of the Thames. Mud is always offensive, and people down there are used to it. The Thames is a tidal river up to Teddington lock. That is about 10 miles above London Bridge.

123. *To Mr. Gregory.*—A good deal of the offensive smell which is complained of is due to the fact that putrefaction of the sewage sets up. I cannot say what length of time elapses after the sewage leaves a house before it begins to be offensive. Putrefaction, as I said, begins immediately the sewage is exposed to the air I should say that within three hours there would be practically no odour. The sewage would be very free from odour then The more quickly you can get the sewage into the treatment tank under the biological system the less offence there will be.

(Taken at Sydney.)

MONDAY, 15TH FEBRUARY, 1915.

Mr. RILEY, Chairman;

Senator Keating,	Mr. Gregory,
Senator Leach,	Mr. Sampson,
Mr. Fenton,	Mr. Laird Smith.

Joseph Davis, M. Inst., C.E., Director-General of Public Works, recalled, and further examined.

124. *To the Chairman.*—Since I appeared before the Committee, I have had an opportunity of visiting the Federal Capital site, and making myself, in a superficial way, acquainted with the physical and other conditions at the site. Therefore I am now able to speak with greater authority on the question at issue than I was formerly. Perhaps it will be convenient for me to deal with Mr. Griffin's proposal before referring to Colonel Owen's proposal. The Imhoff treatment of sewage is by no means new to myself or the officers of my Department. In 1909, when I was stationed in London, I received a request from the Public Works Department to investigate the Imhoff treatment and a kindred system of disposal of sewage. I did not go to Essen to examine the Imhoff treatment, as I had no opportunity of doing so. But I did go to Norwich, where there is a very similar system, invented by a Mr. Travis, and for the information of the Committee I will read the report I then made:—

Consulting Engineer's Office,
61 Victoria street,
Westminster, S.W.,
16th June, 1910.

Travis Hydrolytic Sewage Tanks at Norwich.

SIR,—I have the honour to report that at the request of the Department of Public Works I have now obtained particulars of the Travis system of sewage tanks as practised at the Norwich Sewage Farm. At the time the request was made for details the tanks were in course of construction, and it is only quite recently, within the last few weeks, that they have been brought into operation.

The sewage at Norwich has been treated since 1868 on a sewage farm at Whitlingham by broadcast irrigation. I understand it gave sufficiently good result until a few years ago, when the sewage was increased from three millions to six millions per day, which showed that the farm was insufficient to efficiently cope with the task of sewage purification.

Mr. Arthur E. Collins, M. Inst. C.E., in conjunction with Dr. Travis, the inventor of the system, decided to supplement the land treatment by the installation of a series of these tanks.

Experiments had been made at Hampton by Mr. J. H. Johnson, the chemist to the Urban District Council at that place, which proved to the satisfaction of the investigators the effectiveness of the system. It was then decided, after the usual local government inquiry, that it should be adopted for supplementing the land treatment of sewage for Norwich.

Mr. Collins, who visited the farm with me, was good enough to very fully explain the operation of the tanks, and also to explain what he regarded as the advantages of the system.

He stated that the special features of the tanks were based upon:—

1. The elimination with rapidity from the sewage of removable suspended solids and colloidal matters with a view to excluding the major portion of the sewage from a prolonged tank operation.
2. The introduction into the tank of self cleansing surfaces which would attract the fine suspended solids and upon which a proportion of the colloidal matters would be deposited.
3. Adequate means for eliminating sludge and scum so as to minimise the carrying forward of depositing matters, and thus maintain the working capacity of the tanks.

Four tanks have been constructed, having a capacity of three million gallons of sewage per twenty-four hours. Each tank is divided into three compartments by a longitudinal arch-shaped structure carrying two walls. The arch has openings at its springings and at its crown. The outlet of the tank is provided with a weir which is common to the three compartments.

The two side compartments are for the sedimentation of the sewage, and the central one for sludge collection and reduction. The latter is wedge shaped in transverse section in order to concentrate the deposit of the sludge and facilitate its removal. The sedimentation chambers are wedge shaped in transverse section, and are fitted for a portion of their length with wood bars 1½ inch x ¾ inch placed three inches apart transversely, and from 5 inch to 9 inch longitudinally, for the purpose of attracting the finer suspended matter and for coagulating as much as possible of the matters in the sewage in colloidal solution. The first and last portions of these chambers do not contain any of these wood bars. It is claimed that 80 per cent. of the sewage entering the tanks traverses their entire length and passes over the weir on to the farm in four hours, whilst the balance, 20 per cent., flows more impregnated with solids, descends into the central portion of the tank and takes twelve hours before it passes over the weir on to the farm.

It will be seen by reference to the attached lithographs that two hydrolyzing chambers are provided at the outfall ends of the hydrolytic tank. These receive the liquid, and it is claimed, as they are fitted with wood bars, that further purification takes place.

Arrangements are promised when several analyses have been made, extending over some weeks, that he will forward these to me. It is too early to say whether the system will be effective, as it has only been, as previously stated, in operation a few weeks. I will, however, keep the system in mind, and should there be anything further to report I will take care to send on further particulars.

Two lithographs are attached.

I have the honour to be, Sir,
Your obedient servant,
J. DAVIS.

The Agent-General for New South Wales,
123-125 Cannon-street, E.C.

That was the position as regards the Travis treatment of sewage in 1910. In an account given by Dr. Imhoff of his system, he refers to the Travis system as being on all fours with his own. I have not seen the Imhoff system but, speaking generally, it is a system for the elimination of the major portion of the liquids of the sewage before decomposition takes place. The clarified sewage is drawn off, and where it is not possible to put that into a running river, it is treated over filters. I have here a photograph of the tank used, which I reproduced from an illustration in *Engineering*, and which honorable members can see. The sludge is deposited at the bottom of the tank, drawn off after septic action has taken place, and buried. By the settling method adopted, about 95 per cent. of the sludge can be removed by sedimentation, and the balance, of course, passes off in the effluent. It is manifest that that must be treated biologically, unless it can be discharged into a very large volume of water, such as a running stream or a tidal arm of the sea. I do not think that I need go further into that matter, except to say that on the occasion of my visit to Canberra Mr. Griffin pointed out to the Committee what he proposed to do. He proposed to put treatment works of the type I have indicated near the present railway terminus, and to discharge the effluent into the circular basin which is indicated on the design for a Capital site at the upper end of the system of basins. Apart altogether from the efficiency of the Imhoff system, of which I have very grave doubts indeed, I think it would be a ridiculous and serious mistake to put sewage works where Mr. Griffin indicated they should be put. I think that they would create a nuisance. I do not see quite how Mr. Griffin is going to dispose of the sludge which, according to Dr. Imhoff, must accumulate, and must be dug into land. Furthermore, I do not think it would be safe to discharge such an effluent as would be got from such treatment works into the lake in such proximity to the city. But apart altogether from that, the levels are such that what Mr. Griffin proposes is out of the question. The level of the lake which is intended to be eventually formed at the base of Parliament Hill is decided upon as 1,825 feet above sea-level. That means that the pipes, in order to reach the outfall works, would be above the level of the railway, so that it would be necessary to pump the sewage from some point on the upper side of the railway, or put in an inverted syphon, which, in my judgment, would be a great mistake. Furthermore to collect the sewage the intercepting sewer would have to go against the fall of the stream which again would be a mistake. So that, apart altogether from the merit of the treatment works such as Mr. Griffin proposes, I have not any hesitation in saying that, from an engineering point of view, his proposal is not sound, and should not be adopted. I shall be prepared later to answer any questions which the Committee may wish to put to me, but I think that I might leave that matter for a moment. Coming now to the proposal made by the Department of Home Affairs, I have prepared a statement, which I will read, so that the Committee may have my views in as brief a manner as possible. The statement reads as follows:—

On the occasion of my visit to the Federal Site, in company with the Committee, on Monday and Tuesday last, when I conversed with Colonel Owen, Director-General of Public Works to the Commonwealth, and Mr. Hill, the local officer in charge, I learned that it was proposed to construct an outfall sewer from the point indicated by the letter "A" on plan submitted to Western Creek, a distance of 3 miles, at which latter place it was intended to construct treatment works. The level of the sewer was, it is understood, fixed at the upper end at reduced level 1,890 feet, and the invert level at Western Creek would be 1,790 feet. The ground level at the latter point was supplied me as being 1,805 feet. The internal dimensions of the sewer would be 4 ft. 6 in. x 3 ft. 8 in.; manholes were provided at 500-feet intervals, and ventilation at intervals of 1,000 feet. The estimated cost was £75,000, or £25,000 per mile. The capacity of the sewer is based on a fall of 3 feet per mile running two-thirds full, giving the mean velocity of 2½ feet per second. Provision is made thereby for an ultimate population of 125,000 persons.

As regards the treatment works, it is understood that no definite decision has been arrived at. Colonel Owen stated that he recommended the adoption of the biological treatment of the sewage, and that thereafter the effluent should be treated on the land. The level at which the treatment works were to be put in relation to the invert of the sewer had not, it would appear from conversations I have had with the officers concerned, been definitely decided upon. This being the case, I have concluded that I am at full liberty to make any suggestions and recommendations to the Committee which my usual consideration of the subject will admit of my doing.

Should the Committee decide that the treatment works are to be established on Western Creek, in accordance with the departmental proposal, then I would strongly advise that sewage be brought on to the surface by extending the outfall sewer down that creek towards the Molonglo River, and, assuming that the land treatment is resorted to in addition to the biological treatment, that the effluent should, after it has passed through the filter beds, be pumped on to the land in the vicinity. I do not favour the idea of placing the treatment works below the surface, as was indicated on the occasion of the visit referred to, as this would mean that they must be put below the invert of the sewer, and then the effluent pumped therefrom either into the Molonglo River or on to the land, as may be decided upon. There was another suggestion made that the septic tank and filter bed should be put on the surface in the vicinity of the sewer at Western Creek, and that the crude sewage should be pumped from the level of the outfall of the sewer to the top of the treatment works, and the effluent again pumped from the outlet from the filters on to the land in the vicinity. As before stated, I do not favour either of these propositions. If it is concluded that an outfall sewer 3 miles in length from the point "A" on plan already mentioned is a necessity, then the treatment works should be fixed in the vicinity of the Molonglo River above flood level. It would be quite easy to do this, as the levels will admit of the outfall sewer being extended down the Western Creek to a convenient site near the Molonglo River, when the effluent from the treatment works could be discharged into the river direct, or, should the necessities of the case demand it, on to the land as hereinbefore stated.

I do not, however, think that it is necessary for the outfall sewer to be extended to Western Creek. If a site is adopted on the Yarralumla Creek in the vicinity of the Yarralumla wool sheds, I am of opinion that the case will be fully met, and thereby, at least, a mile and a half of the outfall sewer be saved, or, approximately, £10,000. I examined the locality, and found there was an excellent site for such works. This I have shown on the plan. To reach the point, however, there would be required a connecting sewer from the line of the outfall sewer to the works. The outfall sewer could be diverted, but I have assumed that the work has proceeded too far to permit of this being done. The levels of the Molonglo River will admit of the treatment works being established on the Yarralumla Creek, so that the effluent would be discharged above flood level. Provision has been made for the treatment of the effluent on the land, but this is suggested to make matters doubly sure; it is thought that for a good many years to come the effluent will be so small in quantity that it could with impunity be discharged into the Molonglo River, where it will be sufficiently diluted to admit of it being discharged into the Murrumbidgee River at a lower level.

Assuming that my suggestion is adopted, and that the invert at the upper end of the outfall sewer is 1,890 feet, and the invert level of the main sewer at the outfall is 1,790 feet, then above flood level there would be 18 feet for gravitation through the treatment works.

In considering the question I have assumed that there will be 15,000 persons resident on the area requiring a reservoir scheme during the next ten years, and while, therefore, it would be proper to provide in the main sewers for an ultimate population of 125,000, it would be unwise and extravagant, in the case of the treatment works, to look beyond the 15,000 persons. I have, therefore, adopted this number in the suggestions which I make hereafter for the treatment of the sewage.

Two land required, when it is brought into use, would be needed at the rate of 1 acre to each 1,000 persons, and in this connexion it has been assumed that when pumping machinery is adopted it would be advisable to lift the effluent about 50 feet. This would command 150 acres of land which, although not highly suitable, might, by terracing, be made fairly efficient. It would not, however, be necessary to lay out any of this land in the first instance, but, as such as required, an acreage capable of treating the effluent might be brought into use.

To provide ordinary septic tanks with continuous filter beds for the earlier population of 15,000 persons would cost, approximately, £22,500. The pumping station, plant, and rising main to lift the effluent, would cost, approximately, £5,880, and assuming that the pumps are driven by electricity from the central power station, the sewage should be lifted for, approximately, ¼d per 1,000 gallons for the 50 feet. The cost of grading the land would probably be £200 per acre or thereabouts.

The intercepting sewer from the upper end of the outfall sewer would be required to be constructed with a capacity equal to the ultimate population to be served. The level of the lower of the ornamental lakes has been taken as 1,825 feet, while the level of the intake to the outfall sewer is 1,890 feet. This leaves a difference of 25 feet, which would be ample to allow the intercepting sewer to be constructed around the lake and serve the population, gravitating at convenient points along its course. It is difficult with the data possible at present, to give an approximate estimate of the construction of this intercepting sewer. Its length from "A" (the upper end of the outfall sewer) to the present railway station will be about 3½ miles, and its cost, assuming the same rate as for the outfall sewer, would be £80,000.

The reticulation would be carried out as required. What the mileage will be for the 15,000 people depents entirely upon the manner in which the settlement takes place. These sewers, including ventilation, should be constructed at £2,000 per mile.

A rough estimate of the works dealt with herein would be as follows:—

Outfall sewer, 1½ miles	£37,000
Treatment works	22,500
Pumping station, machinery, and rising main	5,880
Preparing land, including channels, say, 20 acres at £200 per acre	6,000
Intercepting sewer, 3½ miles	80,000
Reticulation, say, 20 miles, at £2,000 per mile	40,000
	£191,880

(Engineering contingencies up to 10 per cent. included.)

These figures, however, must be regarded as merely approximate, as the information available as to the exact nature of the ground to be excavated is necessarily meagre.

125. *To Mr Gregory.*—In my statement I assumed that a portion of the sewer between B and C shown on the plan here had proceeded so far that it was really too late to make any deviation. But if it is not too late, then I certainly think it would be better and cheaper to put an angle in the outfall sewer at B, and construct it to the treatment works on the Molonglo Creek from B. That would shorten the sewer again, probably by a quarter of a mile. I think that, after passing through the septic tank and beds of gravel, the effluent could be run into the Molonglo Creek without danger of pollution. At the same time, to make matters doubly sure, I have provided for the eventuality, and that is that the effluent, after passing through the filter beds, should be put on to the land in the vicinity. I do not think that that is necessary with a population of only 5,000 or 10,000; but in Great Britain, as I explained to the Committee previously, a Royal Commission has insisted upon land treatment after biological treatment. My view of the reason for that decision is that in Great Britain and several places the sewage is not carried away from the population apart from the storm water. The moment the storm water is mixed with the sewage proper, the problem at the treatment works becomes very much more complicated. With a storm, a good deal of the sewage is carried, notwithstanding the treatment works, into the stream close by. The British Commission, therefore—and very properly, I think—said that, before any of the effluent from treatment works passes into a running stream, it must be put on to land. I would not concur in a proposal to allow the storm water from a city to run through the same sewer as its sewage.

126. *To Senator Lynch.*—I would allow the intercepting sewer to be put at such a depth, and made of such dimensions, as would accommodate the population on the north side of the ornamental lakes at Canberra, but with this qualification, that it would only require to be of sufficient size to take the portion on the north side of the lakes below where the sewage from that portion joined it. In other words, the intercepting sewer would be a decreasing quantity, and would decrease as the sewage from the residential areas joined the sewer at the different points. The connexion of the population on the north side with the sewer would in all probability be across a bridge, which is shown in the city design in the vicinity of what is called the Government Group.

127. *To Mr. Sampson.*—Eventually it might be necessary to run the effluent over the land before it reaches the Molonglo River. I would not do that right away. I think it would be quite safe to allow the effluent to flow into the Molonglo in the first instance, but it is possible, as the population increases, there will not be the same quantity of water flowing down the river below the ornamental lakes as would flow in ordinary circumstances, and for that reason I provided for the contingency of land treatment. I think that the effluent after having gone through biological treatment, would be sufficiently safe to be put into a running stream of fresh water in that way. I do not see how there could be any justification for complaints to be made by persons residing on the Murrumbidgee River. Whether complaints would be made or not one cannot exactly gauge, but there would be no justification for such complaints. I should say it is most improbable that disease germs from the effluent would be carried for a very long distance in a running stream. I can scarcely be expected to speak of pathological questions of that description. But I can remember reading years ago a rather learned treatise by Dr. Koch on the question of filtration of water. I know that, in the case of water taken from the Elbe River at two points, one portion was filtered and the other was not. The water which was filtered was taken from below a city. With the filtered water there were very few cases of cholera, but with the unfiltered water there were very many cases; and this although the two cities adjoined each other. With the septic principle of treatment, I would adopt the biological system. I would not necessarily install a single chamber tank. As you know, there has been a good deal of controversy as to whether the biological treatment, or the plain sedimentation treatment, is the better. So far as I am able to gather, with the latter treatment the sewage is dealt with as early as possible before decomposition sets in. A sedimentation of the solids is brought about, and the liquid is drawn off for treatment in filter beds or through other forms of aeration. Both the system proposed by the Department, and supported by me, and Dr. Imhoff's system, are biological systems. Under the departmental proposal the whole of the sewage, amounting probably to 40 gallons per head, will be put into the septic tank. It will there be septicised, and after it has been in that way liquefied, it will be put through the filters, and a good deal of the solids in the sewage will find their way in a liquid stage on to the filter beds. The action that will take place there has been explained to the Committee. That is the biological treatment, as proposed by the Department. But coming to what is known as the sedimentation treatment, instead of passing into the septic tank for septic action 40 gallons of sewage, a very small proportion of that quantity, and that portion principally solids, is put into the septic tank. The other portion—that is the liquid portion, or what is called in some of the papers the clarified sewage—is immediately put over filters, and therefore the septic action takes place in respect to the balance, so that, as a matter of fact, the only difference between the departmental proposal and Dr. Imhoff's proposal, is that he does not put into his septic tank the whole of the sewage. He only puts into the tank a portion of it, and that portion is solids. The other portion he puts on to the filter without treating it. There is necessarily a certain amount of sedimentation in connexion with the biological treatment. In my opinion, it is out of the question to think of treating the sewage in the vicinity of the Federal Capital, whatever system you adopt. I think that that ought to be very clearly laid down. Whatever system is adopted, it should not be installed in the vicinity of the city or in the city. That being so, the question then is how you should purify the sewage. The orthodox way is by passing the sewage through a septic tank, and then through either a contact or a continuous filter. I suggest that the septic tank should be put sufficiently far away from the population to render any possibility of offence quite improbable. Having settled the position of the tanks, I do not pin my faith to a particular filtration system. But what I do say is that you must adopt an efficient method of treating the sewage, and what is generally favored, and what I favour now, is the ordinary biological treatment

128. *To Mr. Laird Smith.*—I do not know the Neilson system as installed at Goulburn. I have not examined it.

129. *To Mr. Fenton.*—At Goulburn, we are going to install the bacteriological system of treatment. We got the Goulburn Sewerage Construction Bill put through both Houses on Friday,

and we intend to put the work in hand, and establish the septic tanks and filter beds on the river. Boiled down, it is practically the same system as I have proposed to the Committee.

130. *To Senator Lynch.*—I think that a fall at the rate of 3 feet per mile, which is what is allowed by the Department, is quite sufficient to enable this or any system of biological treatment to be operated with success. That fall will give a self-cleansing velocity. The main thing in designing a sewer is to have such a flow that it will be kept clean by its own action. I propose to lay a sewer from the extreme eastern point to the outfall sufficiently large to serve, ultimately, a population of 126,000 persons.

131. *To Mr. Sampson.*—The scheme proposed by me will only serve 15,000 persons in the treatment works, and 15,000 persons in the reticulation, and the only portion of the scheme which provides for the ultimate population is the main outfall sewer, and the intercepting sewer. The septic tanks could be multiplied to any extent as the population increased, but you could not do that in regard to the sewers.

132. *To Mr. Gregory.*—I would not listen for a moment to a suggestion to put down a treatment plant for more than 15,000 persons at the present time.

133. *To Mr. Sampson.*—Certainly eight separate schemes would involve a very much larger expenditure than would one scheme doing the work for 125,000 persons, not only from the stand-point of capital cost, but—what would be very much more serious—from the stand-point of working cost, because, after all is said and done, in these matters you have to look at the annual cost. The working expenses for seven or eight installations at the Federal Capital would be very much more than the working expenses for one installation. I consider, too, that the first cost would be greater.

134. *To Senator Keating.*—I did assume that, under the scheme of Mr. Griffin, the connexion of the sewerage system for the population on the northern side of the ornamental lakes, would be across a bridge in the vicinity of the Government Group, but that is not indicated in the scheme submitted by the officers of the Department, because I understand that what they have submitted is simply an outfall sewer. I thought that the Committee would like to go a little further than that, and see in a comprehensive way just what is involved. I have, therefore, gone to some little trouble to indicate what all this means. It would be quite a proper thing that such connexion should be maintained across a bridge, the sewage could be conveyed across in pipes, which could be put in the structure of the bridge, so as not to appear. Probably there would be an arched bridge there. I do not know what Mr. Griffin proposes, but it would be quite easy to put the pipes there. Probably the water-pipes and gas-pipes, too, would have to go across there. The traffic across a bridge has a tendency to cause vibration. Such vibration does not entail fractures in pipes. Our experience is that it does not materially affect the pipes, but I should think that the tendency would be for the joints to be disturbed. In a case like that you would probably carry the sewage across in a steel pipe, which would have very few joints, or which, if it were sufficiently large, would have no joints. It would be carried across in one continuous tube. When the Imhoff system, 95 per cent. of the solid matter in the sewage is sedimented, and the remaining 5 per cent. goes away in the effluent. It is found by experience that it takes two hours or thereabouts to deposit the solids held in suspension in ordinary liquid sewage. If a contrivance is provided such as the Imhoff sedimentation tank, then you get the effect I have indicated. But it has to be borne in mind that when the solids are got out of the septic tank, which is the lower portion of Dr. Imhoff's tank, as shown in the sketch I have presented to the Committee, 75 per cent. is water, and that percentage of the sludge has to be dried out and evaporated. In some cases, as in the case of Birmingham, before they adopted the biological process, they took out a good deal of the water by means of sludge filter presses. That is the sediment tank of the Imhoff system. The portion of the tank shown in the cross-section marked "A" is clarified sewage. The deposit passes down through two openings indicated on the cross section and marked "G." The sludge proper is indicated by the letter "F." When the sludge is removed it passes by the pipes "B," and "C," but that latter operation is not effected for seven or eight months. In other words, when the tank is full, they take out the sludge by some mechanical operation. The letter "D" indicates openings at the top of the tank to admit of the gases generated by the decomposition of the sewage, and they pass up through "E," so as not to disturb the clarified sewage. You may have noticed in the septic tanks that, as the gas passes up from the decomposing matter, it carries a lot of such matter with it; it bubbles up to the surface. This system is applied to some extent. I will read to the Committee what I have on that subject:—

> A clarification plant of this type was first operated in 1909. In 1910 seven such plants are in use, serving a total population of 220,000. Similar works for ten more municipalities are being built, and it is expected that thirty others will eventually be constructed in various parts of the district.

So that, although there were seventeen then in Germany, there were some more in contemplation. The nearest approach to the Imhoff tank is the Travis plant at Norwich, and that accomplishes the same thing as the Imhoff plant, only it is in a different form. I doubt whether this system would not cost equally as much as the treatment which I have put before the Committee, and which would cost 30s. per head of the population, and I question very much whether this system could be constructed for less. There is very little disparity between the two systems. You must have the filters, it is only a question of the tanks. I have an illustration of the sewage disposal system at Norwich, if the Committee wish to see it. It is very like the Imhoff system, except that the sludge falls down on each side.

135. *To Mr. Sampson.*—In Australia we have in some cases the broad irrigation in operation. We have not in operation the Imhoff or the Exascher or the Travis system, or a combination of the three systems. In the United States there is a contention that the sewage should be dealt with when it is fresh, rather than that it should be allowed to decompose in the septic tank. There may be a good deal in the contention. As I have tried to explain to the Committee, that can only relate to the portion of the liquid which is passed through the filters while it is fresh. So far as the solid matter is concerned, 95 per cent. is treated as we propose to treat the sewage—by means of septic action. The system is precisely the same as the one we propose, only they give it in a different way. The treatment of the sludge is the same as the treatment of the whole liquid with the septic tank system. Under the Travis system the anaerobic action takes place in the sludge at the bottom of the tank, or in the tank underneath. I do not know that there is a likelihood of getting a poorer effluent if the matter is

not allowed to decompose before the solids are extracted Again it is a question purely of experience. I prefer the method I have indicated, but other persons may prefer the other method. As to principle, you can see that there is really no difference between one and the other There is no difference at all as regards the treatment of the sewage except in details, between Mr. Griffin's proposal and the Department's proposal. They are both absolutely biological treatments, covering the same ground, but there is this difference between them, that, while Mr. Griffin wants to treat the sewage in the city, the Department says that it would be unsafe to do so. I agree with the view of the Department.

136. *To Senator Lynch.*—I think that, at the outfall point selected by myself, there is sufficient land available for filtration purposes for a population of 125,000 persons. After some years' investigation, a Royal Commission appointed by the Imperial Government came to the conclusion, purely as a safety measure, that it is necessary to pass the effluent from the filter beds over land, and I have no doubt that their reason was the one which I have already indicated to this Committee The conditions in England are such that, owing to the storm water having to be dealt with in combination with the sewage, it is most difficult to treat it at the disposal works, and therefore, to make assurance doubly sure, the Royal Commission said, "Pass the effluent over the land, and we will be quite sure." They came to the conclusion that, with soil such as we have at Canberra, the effluent from the sewage of 1,000 persons could be treated on 1 acre of land.

137. *To Mr. Sampson.*—It would not have been practicable to turn the channel the other way, and collect the land away from the river instead of close to the river, as indicated on the plan. The levels would not have permitted that to be done The outfall sewer is at such a level, as determined by the officers of the Department, that, while it will serve the Federal site, and admit of all the sewage being drained into it by means of gravitation, at the same time it will admit of the sewage being discharged on to the treatment works and through them by gravitation, and even then the effluent will be above flood-level.

138. *To Mr. Fenton.*—To allow it to run on to the land at the start would mean the addition of a pumping plant.

(Taken at Melbourne.)

TUESDAY, 16TH FEBRUARY, 1915.

Present:

Mr. RILEY, M.P., Chairman;

Senator Keating,	Mr. Gregory,
Senator Lynch,	Mr. Sampson,
Senator Story,	Mr. Laird Smith.
Mr. Fenton,	

Walter Burley Griffin, Federal Capital Director of Design and Construction, further examined.

139-146. *To the Chairman.*—I have little further to add to the evidence I have already given. I feel that the alternative suggestion by Mr. Davis has borne out my contention that we can effect a great saving if the question of sewage treatment is thoroughly investigated as an engineering proposition on the basis of pounds, shillings and pence. Two or three days' work has effected a saving of £45,000, and I think that a few weeks' further work might save a great deal more money in the same proportion. The alternatives I have put forward have been suggestions, based on general principles. Their actual application will require a considerable amount of computation based on a reticulation plan, which I should like to see worked out at the earliest possible moment.

147. *To Mr. Laird Smith.*—In order to put the whole scheme on a sound engineering basis, I suggest that an expert should be called in. I consider Mr. Davis an expert, although I join issue with him on several points, in regard to which I think he might alter his conclusions if he were to take further time to give them consideration. For instance, he refers to the Travis system as being on all fours with the Imhoff system, whereas there is a very wide difference between the two. The Travis system preceded the Imhoff, and was, indeed, a step towards the present stage of the latter. I do not think Mr. Davis has investigated the later opinions and actions of engineers in regard to these matters in Germany and the United States. I noticed the other day a translation by an English house of a German work on the Imhoff system, which would show that the engineers in England are taking an interest in it.

148. *To the Chairman.*—I suggested that the sewage should be treated inside the city as one of the schemes open to consideration, but whether that would be advisable an investigation of the financial considerations would show. There is no doubt that the lines suggested by Mr. Davis are all right from a sanitary point of view. His plan brings the sewerage area within sufficient distance of the city to insure fresh sewage to dispose of. I believe that investigations would show that greater economy could be effected if the treatment were brought even closer to the city. That scheme proposed by him, however, should not be undertaken until a full investigation has been made. There are a number of statements by Mr. Davis which I should like to controvert, but I do not think this is either the time or the place to do that. In spite of his statement that the location of the disposal system which I suggested for consideration was not sound from an engineering point of view, I still believe that my proposal is entirely sound, and that further investigation will prove it to be so.

149. *To Mr. Gregory.*—In regard to the differences between the Travis and Imhoff systems, I have shown the Committee a diagrammatic representation of the latter. In the Imhoff system, the treatment of the sludge has been carried to a much further stage than in the Travis system. The latter was based on the idea that the suspended non-precipitable solids, as well as the precipitable solids, should be separated, and the plant included a lot of corrugated baffle plates, which were immersed in the upper chamber in order to have precipitated on them the colloidal constituents of the liquid. That was the first principle of the Travis system. The inventor in that case desired to separate all solids from the sewage, but that gave rise to a nuisance in the tank, and in consequence that attempt has been abandoned. On the other hand, in the Travis tank of Norwich, there was no attempt to absolutely exclude the flowing sewage from the digestion chamber. At least a third of the sewage continuously flowed through that lower chamber, and that made a radical distinction to the process. In the Imhoff system there has been an endeavour to reduce the sludge in the digestion chamber. I believe that actually in the Travis installations they have now reverted to plain sedimentation.

150. *To Mr. Fenton.*—In Germany they have no call for the biological treatment of filter beds, for the reason that they have not been required by the State to purify the effluent beyond the degree necessary to preserve the *status quo* in the rivers. In only a few cases they have placed the biological treatment secondary. I do not think that the scarcity of land has led to this policy of local treatment. Dr. Imhoff told me that he put the treatment plant in the city because he wanted fresh sewage to handle.

151. *To Mr. Sampson.*—The Imhoff system is not plain sedimentation, which means the precipitation of the sludge and the drawing of it off fresh. That is a disagreeable stage, and requires a mechanical process to facilitate handling. The Imhoff sludge does not require mechanical treatment. If Mr. Davis said that it does, he was not familiar with the Imhoff sludge, because in no case, to my knowledge, has it been found necessary to treat it mechanically.

152. *To Senator Keating.*—The pipe in the diagram of sludge tank before the Committee is the channel by which the sludge is drawn off. The outlet for the sludge is about 3 feet below the water line, and the sludge is discharged from the tank by hydraulic pressure. Nobody touches Imhoff sludge until it is dry.

153. *To Mr. Sampson.*—Plain sedimentation leaves the effluent free from putrefaction, as does Imhoff's precipitation scheme. The liquid enters the tank fresh, and is only retained in the tank long enough to be discharged still fresh; it does not come in contact with the process of putrefaction which the solids are undergoing apart. The liquid remains in the tank from two to three hours, as a rule, but in Essen it is in the tank for only one hour. The precipitation of solids is 95 per cent.—that is to say, 95 per cent. of precipitable solids. That is what Mr. Davis meant when he referred to a 95 per cent. precipitation. There are other solids that are not precipitable and will not drop. Those are what are generally called colloids, and which are treated by the aerobic process. There is no offence caused in the extraction of these solids in this way. They are oxidized without the process of putrefaction coming in at any stage. Whether, in the discharge of the effluent from the tank, there is a greater proportion of suspended matter in the fluid from the septic tank than in the fluid from the sedimentation tank is questionable. Some putrid solid matter is bound to flow out from the former, but the effluent from the sedimentary process is in a condition to oxidize more readily than that from the septic tank, because there is no antipathetic life to be exterminated, as in the other case. In the effluent from the septic tank the anaerobic matter has to be killed before the effluent can be oxidized biologically. In the Imhoff two-story tank the process that takes place in the lower chamber is purely septic. In the drawing off of the solids there is no offence. The matter is drawn off from the bottom of the tank. Sometimes these tanks are made as deep as 40 feet. Only the matter at the bottom is taken away. The liquid in the upper portion of the sludge tank is undergoing septic action, but in the lower part that process has been completed. It is a strange phenomenon that there is no odor in this matter when it is drawn off, except a tar-like odor, which I could only detect by pressing before my nose the matter which was specially drawn off for my observation at the Essen-Nord plant only five months old. This is mainly accounted for by the fact that the colloidal matter, containing a large part of sulphur, is kept free from the precipitable organic matter. I claim that by the sedimentation process—taking off the effluent and submitting it to aeration, which means oxidization—we take away all reaction that generates offensive odors. That refers also to the solid matter as it is drawn off and deposited on the drying beds, not buried, as Mr. Davis said, because it is left exposed, and in sunny weather is completely dry after three days' exposure. These solids contain about 75 per cent. of water, which as drawn off is not only clear, but free of bacteria, and can be discharged into the final effluent. That water is even purer than the effluent from aerobic filter beds. The drying of sludge is a serious operation in the case of ordinary sedimentation, because the solid matter there is eight times in volume that of the sludge produced by the Imhoff process, and it not only requires to be treated mechanically, but holds the water in such a way that it will not readily evaporate. In Birmingham it has been found necessary to leave the sludge for a month, in order to get some degree of dryness. The Imhoff sludge can be disposed of in its fluid form without the process of drying, by just depositing it on the land, allowing it to lie there, and then depositing another layer on top of it. It is a very good soil for the growth of vegetation. In the Essen district there is no agricultural land within several miles, but the sludge matter is sold to the farmers where they are available. Undoubtedly there would be a sale for this matter at Canberra. I do not say the sale would be profitable, but the demand would be sufficient to guarantee the taking away of all the matter which we may wish to have taken away. The soil in that region is deficient in humus, that is its worst characteristic. This sludge might be disposed of by being deposited in trenches. The effluent from the sludge is quite inoffensive, and bacterially pure, which is more than can be said of the effluent from filter beds even. There would be no difficulty in the handling of the sludge. The matter would be of about the consistency of cream, and could be easily pumped. So that, wherever the treatment tanks may be situated, the primary sedimentation process is, in my opinion, superior to the ordinary septic system. When I speak of sedimentation, that applies to the upper chamber, but it is the lower chamber which disposes of seven-eights of the solids in the form of gases. Perhaps it would be more convenient to speak of this process as the Imhoff system. No other system is the same, so that the name will be easily understood. I contend that the chief merit of the Imhoff system is the freedom from nuisance, and the compactness of the scheme. In speaking of freedom from nuisance I mean not only freedom from smell but general hygienic superiority, including freedom from insects, and other means of transmitting disease. The flow of the effluent from the Imhoff system, combined with filters, into a river would be perfectly safe. There would be no chance of typhoid germs being carried down the stream. I do not believe that some typhoid germs would continue for 40 or 50 miles along a big stream. On this point, however, there is a difference of opinion, but I take as my authority John D. Watson's statement that the residual bacteria, the final percentage that comes through the filter beds, could be disposed of, but, financially, that further process is not justified. With the septic system, as generally known, large quantities of sludge are sometimes discharged into the ordinary effluent. That is beyond control, but such a thing cannot occur with the Imhoff system. I should like to add, in regard to the purification of streams, that we cannot count on

a stream which is flowing through country used for pasturage and other ordinary purposes to be pure. If an inland stream is to be used for drinking purposes, the water requires filtration at the source of its use. That is the only economic and safe way of insuring the purity of stream water supply. If we purify sewage and town discharge, there are still several ways by which the water of the stream can be contaminated between the point of its receiving the effluent and the place at which it is used for potable purposes.

154 *To Mr Laird Smith.*—I feel assured that the system suggested by Mr. Davis would permit of the installation of the Imhoff tank. The location is sufficiently near to the city to prevent septic action.

155. *To Mr. Fenton.*—The cost of mere installation there would be the same as at a point closer to the city Any additional cost would be in the intervening line of sewer. My estimate for the installation is £19,000 for a population of 20,000. The figures I had available on which to base my estimate were the average maximum and minimum costs in America. I took the average maximum costs.

156. *To Mr. Sampson.*—I previously told the Committee that I would suggest the establishment of a system to serve a section of the city where the population had gathered, and as the population increased I would increase the units. There would be no objection to having several units in the same city. Whether that would be more or less expensive than to have one system would depend on the time that elapsed before the other systems were brought into use. Having several units does not necessarily mean separate staffs, because in Essen they have two men for the disposal plants to take care of the whole of the sludge. In any case, the system will be divided into units. There are units of reasonable size, below or above which one would not go. Even at Essen they have a series of tanks, instead of one large tank in each installation. My idea is to attach the tanks direct to the reticulation.

157. *To the Chairman.*—I believe that we could establish eight systems at nearly the same price as one large system. The one large system would be eight times as great as the several smaller ones, and would cost approximately eight times as much. It would be built in units in any case, and the cost of the installation would be practically the same, whilst the expense of maintenance would show a very slight difference in favour of the concentrated plant. I obtained that information direct from Dr. Imhoff.

158. *To Senator Keating.*—The Emscher and Imhoff systems are one and the same, Emscher being the name of a place, and Imhoff being the name of the inventor. My contention that the Imhoff system is preferable for the Federal area to that outlined by the Department is borne out by the experience of sanitary engineers in Germany, England, and the United States, with whom I have come into contact, or whose works I have been able to consult. I saw Mr. Hill's report to the Director-General of Works on a sewerage system for the Federal area, and I noted his objection to the Imhoff system and his statement that it is inapplicable to the Capital site, but I have not seen his testimony given before the Committee. I desire to say generally that none of his criticism can be properly directed against the Emscher system. Dealing with Mr. Hill's remarks in detail, as you now cite, he says —

Further, the operation of systems such as the Emscher, Imhoff, or Elberfeld tank systems, which may be said to be modifications of the one principle, would be attended by serious difficulties in the Federal Territory, particularly in the matter of the disposal of the sludge independently of the effluent.

I say that the Imhoff system, of all the systems that have been put into practice anywhere, is the one that requires the least attention and involves the least difficulties. He further says:—

To procure suitable labour for handling same would be most difficult.

That objection does not apply to the Imhoff system, because the stuff is handled automatically until it is finally in the state of humus, when it is so innocuous that in Germany women handle it. Mr. Hill's reference is to offensive sludge such as comes from septic tanks. In the case of other processes the volume of sludge is eight or ten times as great as that from the Imhoff process, and is offensive, whereas in the Imhoff process there is so small an amount of sludge to be treated that it can be dealt with on a small area until it is in a state in which it can be carried off or dumped contiguously. It is practically garden soil. In the Essen Nord plant the sludge is not carried away, but dumped on a piece of ground which is being reclaimed. The process is automatic in all the disagreeable muddy phases, and the sludge is only handled when it is dry, as well as inoffensive. Mr. Hill says:—

and cartage through the city and subsequent disposal by burial in areas remote therefrom would entail the possible creation of a nuisance unless sealed carts were used (in exactly the same manner as now applies in the disposal of excreta in connexion with the pan system).

In the first place, cartage is not necessary. I have suggested to the Committee one low place at hand where this matter could be dumped continuously for many years. There is no nuisance in connexion with it, and if it were taken away by people who wanted to use the matter for garden purposes, it would not involve any trouble to the authorities in connexion with its disposal. There would be no more difficulty in handling the sludge than in digging trenches. I pointed out an area which requires filling up considerably, and it would take all the sludge from the system for a great many years. At the same time, I think it would be cheaper to reclaim that place with soil which is without humus value, and preserve this more useful sludge for garden purposes. Certainly, sealed carts would not be necessary. In the urban districts around Essen, where there are no farmers, the sludge is used for reclamation. But in the Bochum district, which is surrounded by farms, all the sludge is bought by the farmers, and the demand for it is greater than the supply. The farmers not only cart it away, but pay for it. This information is based largely on my reading, but I have had opportunities of verifying that information by personal observation, and conversation with the men in charge of the system in Essen, and men controlling similar plants in America. I say absolutely that with sewage treated by the Imhoff system, there is no nuisance. The statements I am making would not have been justified earlier in the history of this system. The results were the same, but those in charge did not know certainly that elements might not have been left out of their calculations. The system has now been in operation eight years, and whereas the engineers were, in their first reports on it, somewhat guarded in their expressions, each succeeding year has given additional evidence of its efficiency. Mr. Hill continued—

The sedimentation tanks would, I am of opinion, emit an offensive effluvium at certain times of the year, owing to the decomposition of the sewage whilst under process.

In the Imhoff system, that objection does not exist. Septic action takes place in the upper portion of the lower tank from which the sewage is never withdrawn, or allowed to be disgorged. There is no outflow from that tank except at the bottom, where the fully decomposed matter is withdrawn. It is not possible for any solid to float out of the tank. The gases that come from the tank, so far as can be discoverable, are merely methane or marsh gas and carbon dioxide, which are odorless. Again, Mr. Hill stated—

The sludge requires to be removed at frequent intervals to avoid the destruction of much valuable organic matter by decomposition, since, unless so removed, it is liable to affect the sewage effluent by the products of its decomposition.

In the Imhoff system there is no possibility of the sludge affecting the sewage effluent, from which it is kept entirely separate. It is considered preferable to allow the solid to decompose in the manner I have described than to handle it in an offensive state. The value of this organic matter which Mr. Hill says may be destroyed by decomposition is questionable. I think the chief value in the sludge as manure is the humus which the Imhoff system preserves after the matter has been completely treated. It does not require to be removed at frequent intervals. In the first place, it should be retained for almost a year before any of it is drawn off, in order to set up septic action. After that, it is drawn off according to the rate of precipitation. After the sludge has risen to a certain level, portion of it is drawn from the bottom. Mr. Hill said—

Over and above these considerations, there requires to be considered the initial cost of the tanks, of the plant necessary for the removal of the sludge, and of the labour which requires to be constantly employed in maintenance, as against the gravitation scheme suggested, in which the sewage naturally flows to an area on which it is distributed by gravitation channels over the soil, requiring very little attention.

Obviously, the latter alternative pictured is not the Departmental project we have seen under construction. As to ordinary septic *versus* Imhoff process, it is very difficult to compare the cost of the respective tanks on a fair basis. On the basis of same size, the Imhoff tank is more costly, but on the basis of efficiency, the comparison is all in its favour. Per gallon of matter contained, the Imhoff tank is more expensive, but it must be judged by the work it accomplishes. The other tank will not accomplish, under any circumstances, the work which the Imhoff tank accomplishes. The Imhoff tank gives an assured result which the other cannot guarantee, and having regard to that fact, the Imhoff is the cheaper. The plant for the disposal of the sludge is part of the same instalment as the tank. It requires only a very small area as compared with filter beds, which, in this case, would require two or more acres, as against a quarter acre required by the Imhoff sludge disposal system for a plant to serve 20,000 people. The Imhoff plant is a very simple and uncomplicated one. One man could take entire charge of a plant for 30,000 people. I believe that the proposition put before the Committee by Mr. Davis yesterday is near enough to the Capital site to allow of the Imhoff tank being safely installed there.

159. *To Senator Lynch.*—I do not consider myself competent to explain fully the bacteriological action that goes on in the sewage. The sewage enters into that tank, and flows out of it over a weir, but the outlets are not shown in the diagram. As to the evidence of Dr. Hogg, in reference to the Kenmore Hospital, I have to observe, first, that the clarification of the sewage, which is the process that goes on in the tank there, is not by any means complete. The sewage that flows out is not clear, though it is comparatively clear in the Imhoff system. The reason is that in the system of Dr Neilson, an attempt is made to dispose of the sludge, as well as the rest of the sewage, by oxidation in the tank, and the bulk of the sludge, and all passes off in the effluent with the rest of the ingredients. It is a question whether is able to carry this out on a large scale in the case of a city; and I could not say until I had seen it experimented with on a large scale. The old-fashioned septic tank, located close to a house, has been quite satisfactory in small installations. The chances are that the sewage does not remain in it long enough to get tainted, and, on the other hand, the small amount of sludge actually (not relatively) disgorged from each tank is not enough to create a nuisance. A small installation is not a sure test of a large one. No matter how satisfactory the installation may be for this institution, it is not final and completed evidence. I should like to see the installation that Dr. Neilson instanced at Pisa, Italy, before giving a definite opinion.

160. *To Mr. Sampson.*—It is a fact that with a small installation a considerable amount of oxygen remains dissolved in the sewage when treated.

161. *To Senator Lynch.*—When I was in Essen, they drew the treated sludge out in a glass, and I could not detect any odour whatever. This was contrary to the statement made to me that it had a tarry odour. On the other hand, in the case of an ordinary septic tank there, I detected a decided odour in the sludge The reason, as I stated before, is that there is a much more complicated action going on when the whole sewage is going through. It is the partially decomposed matter in the sludge that gives off the odour. The essential difference between the Imhoff and other systems is that the incoming sewage is not allowed to come in contact with the outflowing sludge; they are practically kept apart. The only contact is when you draw off the sludge, when you draw an equal part of the effluent into the chamber beneath. Sludge is drawn at a point at the distance from the top sufficient to give the head required—ordinarily about 3 feet. The hydraulic pressure on the bottom of the tank needed to remove the sediment is obtained in this way. The sediment is drawn from the very bottom of the tank, the sludge is forced from the bottom. The hydraulic pressure is really a feature of the tank. In some cases means are employed to make sure that there is no solidification of sludge at the bottom; a perforated water-pipe is passed through at the very bottom, and flushed with water from the water supply to loosen the sludge, and encourage a flow. At the Kenmore Hospital the other day, it was not a clarified sewage by any means. It is considered by engineers that the underfed contact filter system given off no appreciable odours even right above it, whereas trickling filters, which are twice as rapid as contact beds, sometimes give off sufficient odour to be carried ½ of a mile. There is less odour with the Imhoff system, where the liquids enter the filter beds fresh. Putrefaction is the source of all the offensive odours. There is no putrefaction in the effluent from the Imhoff tank; the liquid sewage is not putrefied at all. There would be putrefaction if it came a long distance; and that shows the importance of having it treated handily to the city. If it is decided to have an intercepting sewer for the entire city, it will have to be of the dimensions as large as shown on the map by Mr. Davis. My idea is an installation in small units, which

would obviate the necessity for this intercepting sewer In any scheme, based on the principles laid down, I should eliminate from Mr Davis's list list the outfall sewer, the pumping station, the preparing ground, and the intercepting sewer. My scheme would require only the second and the last items in Mr Davis's list, viz., disposal plant and reticulation I could not say, without going into the matter pretty thoroughly, whether I should require some collecting drain or intercepting sewer, or some means of taking the sewage to the treatment works, but I am assuming that we could treat all the sewage in connexion with the reticulation itself without appreciably increasing the mileage of the reticulation.

161A. *To the Chairman.* — An intercepting sewer does not discharge at every street, or collect at every street or junction. Sometimes the sewer that picks up the streets and junctions is a separate sewer right above the intercepting sewer.

162 *To Mr. Fenton.*—It must finally enter one sewer, but usually only at definite points some considerable distance apart. My "Initial" plan deals with the east side of the capital. There may be settlement as well on the west side, which is for us to say.

163. *To the Chairman.*—The ideal that I set up would do away with the sewer proposed to be constructed, but how that would do away with any simply discharging sewer could only be told when the reticulation was worked out. I have not had an opportunity to prepare a scheme, but my idea is that it would obviate the greater part, if not, perhaps, the whole, of this sewer. What I am giving the Committee is an indication of the possibilities if they were worked out on an engineering basis to get the maximum results at the minimum of cost. This is the ideal I set up, and how close the engineers will get to it remains to be seen. If the Committee decided to take my advice, and that results in the installation of the Imhoff local treatment, the intercepting sewer would never be constructed. In the case of my system proving a pronounced success, I doubt that the intercepting sewer, if already constructed, could be utilized as a storm-water drain, because it would not be large enough

164. *To Mr. Gregory.*—Of course, it would be a wise engineering principle to construct the sewers according to the formation of the country. It is not appreciably the fact that to have a sewage plant on the east side would be contrary to the formation of the country. I have a plan here which shows depressions, but they are all so uniform that they would have the same level of discharge. The natural fall of the country is not appreciably to the west. The river goes in a gorge. This river is very recent, and as it discharges into the Murrumbidgee it is 400 feet below the surface of the land. Geologically speaking, the river is cutting back rapidly into this area. All the land is remarkably uniform in height; it has not been worked into a matured valley by any manner of means. The line fall applies practically only to the very narrow gorge, and not to the lay of the land on either side.

165. *By Senator Story.*—I could not detect any tarry odour myself in the final Emscher sludge, but I take their word for it that it does exist. I can safely say that the tarry smell is not very pronounced. All the gases that escape are perfectly harmless as well as odourless. Methane is given off from marshes and is popularly known as marsh gas. There is no danger to health from inhaling these gases, and there is a possibility — though whether it can be commercially realized here or not, I cannot say—of using such gases for combustion; indeed, I believe this is already being done in Parramatta.

166. *To Mr. Fenton.*—The patent held by Dr. Imhoff does not apply in Australia, and I do not think it would be necessary to import experts to erect the works.

167. *To Mr. Sampson.*—It would be entirely practicable to pump the sludge up 50 feet, which is the difference between the level of 1,795 feet at the end of a sewer channel, and the 1,845 feet, which is the level at the top of the area set apart by Mr. Davis for filtration purposes, but I would not advise doing this if the idea is to get rid of the sludge most easily, because the pumping of the sludge would drive the bubbles out, that makes it dry very quickly. As to pumping it up to the highest level, and using it in the ordinary way for manurial purposes, I think it would be too heroic a measure to apply the wet sludge to the land. I do not say it would be too strong, but it would be too thick—like pumping on wet mud, which would check the growth. Chemically, it would be harmless.

168. *To Senator Story.*—The sludge could be pumped up into trenches, and be ploughed in; but for this purpose about a quarter of an acre for 20,000 people would be ample. It would soon dry, and it could be ploughed in practically for all time at a gravity level.

(Taken at Melbourne.)

WEDNESDAY, 17TH FEBRUARY, 1915.

Present:

Mr. RILEY, Chairman;

Senator Keating,	Mr. Fenton,
Senator Lynch,	Mr. Gregory,
Senator Story,	Mr. Sampson.

Percy Thomas Owen, Director-General of Works, further examined.

169. *To the Chairman.* — I have been to the Capital Site, and I have pointed out various points of interest in regard to the sewerage system; and during the visit Mr. Davis was with us. I have not had a copy of Mr. Davis' plans, but am prepared to deal with the proposition as it is put forward. Mr. Davis proposes a scheme which evidently would form part of the ultimate scheme for delivering the sewage at Western Creek. The deviation shown on the plan, which, of course, might be lessened by curves, would be 600 feet, and the cost would be, roughly, £8,000. Mr. Davis' scheme shows also an area for the possible disposal of the effluent of 60 acres, but the area shown has not taken into account the area that may possibly be flooded. The site shown for the outfall treatment works is on the bank of the Yarrolumla Creek. It would be necessary to keep these works on the high bank near the creek at the level of not less than 1,820 feet, because of possible floods which occur at long-distance periods on the Molonglo. As to the financial aspect of carrying out the shorter sewer proposed by Mr. Davis, there would be, in addition, the cost of the main outfall sewer and the cost of a deviation to connect with the treatment works. My opinion is that the area shown of 60 acres for treatment works would not suffice for all time, and that the Commonwealth should retain the principle of being able to meet the necessity for the distribution of the effluent over the soil

after bacteriological treatment. The cost of the septic tanks for 15,000 people, at 30s. a head, would be £22,500. The point for consideration from a financial aspect, therefore, is whether, in order to avoid the capital outlay at the present time, it would pay the Commonwealth to spend £30,000 on works which would not form part of the ultimate scheme in the event of a large irrigation area being necessary. I have been working concurrently with Mr. Davis in connexion with the Yarrolumla treatment, and I should like to mention what I have shown on another plan. Whilst visiting the site at the crossing of the sewer line on the Yarrolumla Creek, Mr. Gregory asked me whether it would be feasible to divert the sewer so as to possibly shorten it and obtain an irrigation area on the Yarrolumla Creek. I told him at the time that I thought the Yarrolumla slopes would be too steep, but I undertook to work the matter out. I have prepared a plan showing a deviation which would give about the same length of sewer to the treatment tanks as to where the sewer line is projected by the Department across Yarrolumla Creek. There are, however, one or two disabilities. The first is that to get the sewage to the surface there would have to be a sewage pumping head of 53 feet, and to get the effluent on to the surface there would have to be a total head of 88-foot pumping. There would then be necessity to pump the effluent from 2,500 feet to 3,200 feet, and the areas commanded would be only 35 acres, on the assumption that the irrigation would be by distribution over a natural surface, to avoid the necessity of terracing or preparing the ground. Reverting however to Mr. Davis' scheme, the contour plan shows that the area proposed is partly rocky ridge, although, to the best of my recollection, the lower slopes are probably shale, covered with alluvial from the upper reaches of the creek. In working out the section for Mr. Gregory I chose the easiest one, but it transpires that there would be six shafts of over 80 feet, and all the shafts would be deep except those at the city end of the sewer. Those shafts would cost £5 a foot to construct. There would be a further irrigable area on the Yarrolumla Creek at 10,000 feet pumping distance and a head of 138 feet. After carefully considering the alternative scheme prepared by me for the Yarrolumla treatment, after Mr. Gregory's inquiry, I would recommend that it should not be adopted. First, the lower areas for irrigation come within the boundaries of the city. The upper area is so far away that I think the effluent pumping scheme would be out of the question for anything except a large population. The plan shows a comparison of the irrigable area which could be obtained from the end of the outfall sewer, as proposed by the departmental scheme. In it there would be 15 feet of lift into the tanks, and a distance of 3,200 feet, with a pumping head for the effluent of 45 feet to command 90 acres. That area could, of course, be extended by more pumping, and there are other portions of land close to the treatment works which could be well used for the effluent. The area at Western Creek is one which I consider the Commonwealth could use with practically no surface treatment of the land. As between the Yarrolumla scheme and the one sketched by me, the difference appears to be that I had assumed that the Commonwealth must lay a scheme which will be capable of allowing the effluent to be distributed over a land area. The area shown by Mr. Davis would be insufficient for a large population, and I gather from the remarks which he made at Canberra that he thought the effluent might safely—at present, at all events—be discharged into the Molonglo River His evidence, however, is a matter of which the Committee will have fuller knowledge than I have In regard to the 60 acres, if a flood did come occasionally, it would not matter so much, but I would rather keep away from the flooded area. I do not regard the lower ground, near the bank of the river, as being of much use, except for a very small population. Without apprehending an early recurrence of a maximum flood, there is no doubt that, with a medium flood in the Molonglo, the banks of the Yarrolumla Creek have been recently submerged I pointed out to some members of the Committee a green line on the western banks as an indication of what I have mentioned. As a conservative approximate estimate, I should say that a third of the 60 acres is liable to be flooded. My reason for not concurring in Mr. Davis' scheme is that it does not give a sufficient irrigable area to meet the possibilities of a city of 25,000 people. Secondly, I think that the money which would be spent in the tentative treatment work, and the deviation of the sewer, would be so large that it would be better to carry out the whole scheme now, upon the fixed charges on the capital outlay. The other objection is that I think the sewage treatment works would be still too close to the western boundary of the town; and there is a large area of land which, in the event of any noxious effect from the treatment works, might be greatly depreciated in value, and the value of Commonwealth property at Canberra thereby affected. Without going carefully over the surface of the whole 60 acres, I could not say how long Mr. Davis' scheme would supply the population of the city. It depends on the amount of shale and rock, but, to the best of my recollection, we are inside the shale country at the point shown on his plan. As to the saving to the Commonwealth which would result from the adoption of Mr. Davis' scheme, as compared with that originally proposed by the Department, I can only give it in regard to the sewer. Irrespective of the terraces, the saving on the sewer construction would be £36,000; the treatment tank would be the same in either case. The cost of the terracing cannot be given without a careful examination of the proposed area. After seeing Mr. Davis' plan and again visiting the locality, I still consider that the original proposal is the most effective and would prove the most economic in the end. I think the treatment area chosen by the Department is the best. It is at a reasonable distance from the city, and it is land which you could reasonably apply the effluent to, as distinguished from land which might be used for small holdings or suburban residences To make my point clear, we do not want sewage effluent with the possible occasionally noxious results at the place where a man wishes to conduct a farm or make a home. On the other hand, if you can get a large area which you can irrigate, it may be used for agistment without a man living on it. A member of the Committee asked me whether I thought the treatment area proposed by the Department a good one My view is that it is not the best which one might obtain in some towns of Australia, but I certainly consider it the best that we are going to obtain on the natural drainage of the country for the sewage system of Canberra. The contour plan shows that the grades are easier than the intermediate areas, and the Committee themselves will be able to form an opinion of the nature of the soil for irrigation. As to the question of the difference in the cost of pumping at the site proposed by Mr. Davis, and at the site we propose, the power

for pumping for 15,000 people is about 6 horse-power for every 10 feet. I do not look on the difference of cost in the pumping as vital. It would, however, be further away from our power line at Cotter River, which we propose to tap for electric power for the sewer lifting pump. Mr. Davis' pump well would have to be 25 feet deep, as against the pump well at Western Creek of 15 feet—that is, for the pumping of the sewage into the treatment tank from the sewer. You could not depend on running your sewage at this point into a tank, because the flood level, which must be apprehended, is 1,810 feet, and the outfall invert is 1,795 feet. I may say that it was one of those possible floods which influenced our design. The Chairman has asked me the extra cost of Mr. Davis' scheme. There would be some extra cost for pumping plant, but it is not very material. The saving as between the plan I have brought this morning, as shown by the red line, and the original scheme would be 9,800 feet of main sewer, which would cost over £44,000, but as against that there would be more expense in constructing the sewer, because of the depth of the shaft, which entails £5 per foot run. There is also the extra cost of time in working through such shafts, both for men and material, and the extra cost of pumps for the increased lift. I am sorry I cannot give a close estimate of what the saving would be, but it might be put down at £35,000 to £45,000 less than by carrying out the Departmental scheme The other system would be more expensive, so far as the pumping is concerned, but I do not look on the pumping charges as a very heavy matter; we have the power there.

170. *To Mr. Sampson.*—As to health objections, the scheme which I prepared in response to Mr Gregory's question, I considered the effluent area as altogether too close to the city—in fact, half in it—but I chose that scheme as giving irrigation areas which would be suitable for surface disposal.

171. *To the Chairman.*—There are no suitable areas further out, where we get on too steep ground. At Western Creek we save the initial outlay of terracing, and a lot of expense in getting the effluent all over the surface. As to the difference between the highest point of the area, to which the effluent would have to be pumped under the departmental scheme, as compared with the total height on the area suggested at Yarrolumla by Mr. Davis, the area delineated, or shown grey, on the plan, would entail 45 feet total head, while the total head at the area delineated on Mr. Davis' plan is 50 feet. That would serve 60 acres.

172. *To Mr. Gregory.*—In the absence of any plan, we have never attempted to work out the intercepting sewer. As to the approximate cost of the sewerage of the city, I would prefer to get together some data; it is rather a big thing depending on city plan, and requires some thinking out. The estimate by Mr. Davis of £80,000 for the intercepting sewer is a fair one. I am asking nothing like £5,800 for the pumping station, machinery, &c., but the pumping proposition is a minor consideration.

173 *To the Chairman.*—We have the power installed, and it means carrying wires and putting down the pumps.

174. *To Mr. Gregory.*—I do not think that the land will require a deal of preparing; parts have turned out better than I expected, and, instead of attempting to terrace, we can run ploughed furrows, following the contour. The expenditure in the first few years would amount to about £220 000 That expenditure would be spread over some years, and the main sewer would provide for a population of 150,000 eventually. A stiff loamy soil is the best land upon which to discharge the effluent; preferably a soil which contains enough sand to give it freedom in ploughing. The soil at Yarrolumla Creek is generally better than the soil in the Western Creek area. Mr. Davis has marked an area of 60 acres as being suitable for receiving the effluent; towards the Yarrolumla homestead there is other land quite suitable for the purpose. There is an area of country on the eastern side of the sewer line, but I do not consider it available for this purpose, because a road runs right through it. It is laid down as a maximum that an acre of soil will take the sewage of 1,000 people; but I consider that even 600 to the acre is high. My idea of an irrigation area is that, after using a particular patch for one year, we should turn to another patch, and probably not return to the first area for some years. The departmental scheme at Western Creek contemplates the pumping of sewage into the treatment tank. Every scheme for the Capital area will require the pumping of the sewage into the treatment tank. That is inevitable. When Mr. Davis said that the levels of the Molonglo River will enable a treatment plant to be established at the Yarrolumla Creek, I am afraid that he had not taken into account the flood-levels of the creek. It would be possible to obviate the trouble from floods, but that would involve the building of a retaining wall at least 15 feet deep. If the Committee were to recommend the Yarrolumla Creek scheme, that would bring them back to my proposal to pump the sewage to the treatment tank. The tank would be placed sufficiently high to allow the effluent to discharge well above the flood-level. A deviation could take place from the edge of the lake direct to the treatment works, without the acute angle in the sewer shown by Mr. Davis on his plan; but I see a disability in relation to the carrying on of that sewer; because if it is decided to cater for an ultimate irrigation area at Western Creek for the disposal of the effluent, the sewer must cross Yarrolumla Creek at a point, that would entail the creek being bridged. At that point the sewer is above the level of the Yarrolumla Creek, the bed of the creek being approximately 1,770, and the sewer 1,790. The main sewer would eventually be longer than if carried on the direct route. I do not think that the 60 acres provided for the disposal of the sewage will take sewage in the proportion of 1,000 persons to the acre, or anything like that proportion, because there is rocky ground there. There is enough ground about Yarrolumla to deal with the sewage from 60,000 people, but there will be a danger of bringing it rather close to a residential suburb. My opinion is that it is not feasible to erect treatment works within a mile from the city without risk of noxious smells, it being improbable that you can get treatment works that will not smell during at least some portion of the year. The depreciation of the value of land properties at the point suggested would outweigh tremendously the extra cost of the sewer to carry the sewage further away. I have never come across a septic tank or its effluent that did not smell at some time. I understand that, for the sewage of the town of Goulburn, the biological treatment is to be adopted, and I consider the special aeration treatment at Goulburn is very good; but, on the other hand, Geelong, with a population of about 35,000, is going to the expense of carrying its outfall right away to the sea. That is, to deal with crude sewage Geelong might take the sewage out and have an irrigation area with

the effluent; but the people prefer to incur the expense of carrying the sewage right away to the sea, and I think that, generally, the public will say, "discharge the sewage in the sea if you can, or, failing that, take it as far away as possible, and eventually get rid of it on the soil by way of effluent." That has been my proposition from the beginning. My conviction is that it is not feasible to erect treatment tanks within a mile of the city which will not allow of offensive odours reaching the city at times. I would point out that it is not the strong prevailing wind which is likely to give evidence of a nuisance. It would be on still eventings when there is a gentle breeze that the offence would be most noticeable, because the smell would not then get the same dilution as it does by a fast breeze. It is at night, or late in the evening, that these still conditions are found, and that is the time when the people least want the nuisance of an offensive smell. The soil of Yarrolumla Creek is better for irrigation purposes than that at Western Creek. In fact, I think the soil at Yarrolumla is so good that it could be used for smaller holdings. If that land is to have sewage put on it, its utilization in small holdings would be precluded. There are good areas to the north of the town in the direction of Duntroon, and to the north-west, but Yarrolumla is one of the best pieces of country close to the town. I think that that is better country than the plains the Committee drove through on the way back from Tharwa. I have no personal opinion as to what the population of the Capital city will be in ten years time. I have taken the figures estimated by Mr. Knibbs. He estimated that there would be 15,000 people there now, but that estimate was on the understanding that the city was to be built in six years. The whole scheme has been put back. My own impression is that in fifteen years from the time the land is thrown open for occupation by the people we will have a population in the Federal area of 15,000.

175. *To Senator Keating.*—The deviation referred to earlier in my evidence is that from the main outfall sewer line as proposed by the Department to the treatment site shown on Mr. Davis' plan. The item of £8,000 which I gave as part of the estimated expenditure represents the cost of the sewer, and the amount of £22,500 the cost of the treatment tanks. That is based upon the requirements of 15,000 people. That expenditure of £22,500 would have to be met in connexion with the departmental scheme, presuming that filtration tanks were provided at Western Creek, but my point is that Mr. Davis' plan places the tanks at a point where eventually they will not be needed. It is an interim scheme. If that scheme were adopted as permanent, that £22,500 must be eliminated as an item of added expenditure. There would be a saving of about half the amount of £8,000 if the sewer were taken direct across instead of having the deviation from the point where the mains sewer fringes the artificial water. As to whether that would be a better deviation from the intercepting sewer than the one shown on the plan, depends on the general principle. If Western Creek is to be the ultimate scheme, the route shown on the plan is not as good a proposition as the taking of the sewer direct to the tank. I do not think there has been much work done at the city end of the outfall sewer to prevent the sewer being taken by the more direct route to the place of treatment proposed by Mr. Davis. If Mr. Davis has the idea of ultimately carrying the pipe on to the Western Creek, most certainly it should be carried by the shorter route. My reference to a sewerage pumping head of 53 feet, and a total pumping head of 88 feet, was not in connexion with Mr. Davis' scheme, but has reference to the scheme prepared in order to answer a question put to me by Mr. Gregory. That remark applies also to the further 10,000 feet of pumping distance which I spoke of. Of the 60 acres hatched red on Mr. Davis' plan as a treatment area, I consider that only about 35 acres is suitable for running the effluent on. Everything depends on the extent of rock at that place. I cannot speak with certainty on this point, because I have not examined the locality with a view to ascertaining the area suitable for this purpose. All the hills about the Yarrolumla show shale on the top. The six shafts I referred to as being required are on the drawing I prepared for the Yarrolumla scheme. Assuming that only 35 acres of the 60 acres hatched in red on Mr. Davis' plan are suitable for receiving the effluent, that area would accommodate, theoretically speaking, the non-putrescent effluent of 20,000 people. But to propose to utilize a small area like that from year to year to treat the effluent from 20,000 people is not sound. The effluent disposal should, in course of time, be removed from place to place. Assuming that the whole 60 acres is suitable for the purpose, I would put down 600 persons to the acre as a maximum, but the capacity of the land cannot be assumed on that basis, which I consider is too high. A sewerage system for the Federal Capital area should commence to operate from the time that the workmen commence to go there in aggregation. In my original scheme for construction, one of the "enabling" works provided for was the sewering of a district, so that with the first aggregation of population we would be able to carry the sewage away. I cannot too strongly impress on the Committee the importance of establishing hygienic conditions where workers are concentrated, especially at the time when the workers are semi-nomadic. If they can be provided with water carried sewerage system at the outset, let them have it. My idea was that if we could not have the complete sewerage scheme from the commencement of workers going there in considerable numbers, we should put in a small septic tank as a tentative scheme The main sewer should be available from the time of the first large aggregation of workmen. I do not call 300 people a large aggregation. I am considering 1,500 as an aggregation of workmen, with their families. For 300 people we should put in a little tank as we did at Acton. As to the quantity of sewage requisite for the operation of the scheme over the distance of 3 miles provided for in the scheme, theoretically, a bucketful of sewage will flow to the end of the sewer if it is not absorbed, because the gradient is there. From 1,500 people there would be a total of 60,000 gallons of sewage per day, although I admit that the flow would be variable. There would be a minimum quantity below which we would not get the discharge at the other end of the system, because the whole of it would be absorbed on the way; but the egg-shape section of the sewer designed for the minimum flow. I should say that a total population of 1,000 is the minimum before the main sewer proposed by the Department could be effectively operated. The present population of the Capital City area is negligible. I have already said that if a deviation were made from near the point where the sewer leaves the city boundary, it would not be so suitable for subsequent extension if the scheme were dealt with as an interim one, because we would be encountering unnecessary difficulty in bridging Yarrolumla Creek, and the distance would be greater. The plan prepared by the Department provides for crossing the Yarrolumla

Creek, but at the creek level; whereas in the other case the invert would be from 15 to 20 feet above the bed level of the creek. The bends in the sewer are not of very great importance, but I would rather see a sewerage flow kept on a straight line if possible, because we should avoid increasing the distance if that is practicable. In 1910 I prepared a general progressive scheme of the Federal Capital works, and I gave to Mr. Knibbs an indication of the number of workmen who would be likely to be employed at the time of maximum activity in construction. That programme has been fairly consistently carried out, except that the time has been extended owing to the non-provision of funds, and to the inability to get the land required for certain works, which, again, was due to lack of funds. The main sequence of the work has been adhered to. The Committee may assume that it is essential that by the time there are 1,500 people on the eastern portion of the city, the sewer should be there. As to when we will have 1,500 people there I cannot say, beyond making the estimate that they will be there within six months of the time of the land being thrown open to the public. In regard to the carrying on of works, we shall have to prepare designs on the basis of the city plan—I mean communications, and water and sewerage reticulation. We have not any plans at present, but we should be able to get those plans together sufficiently quickly to make a start very soon after knowing what the definite plan of the city will be. My original proposition in 1906 was that portion of the city should be tentatively thrown open for occupation by the workmen. No charge should be made for the land, but the sewers should be ready, and the workmen could build their own little cubicles or tents. If we get the city plan soon, and are able to make a start, it may be necessary to put in a small septic tank, as we have done at the Cotter River. I have no idea when we may expect to get the city plan which is being prepared by Mr. Griffin. The Department is waiting for the plan from Mr. Griffin.

176. *To Senator Lynch.*—I have not examined the country in the neighbourhood of Yarrolumla Creek in order to ascertain its suitability as a location for sewage disposal, but I have been over the area, and it is very fair country. The main factors which influenced the Department in selecting the Western Creek site were the distance from the town, the general contour of the country, and the fact that it would be a fairly irrigable area. It is land that would improve by having water put on it. I am not over optimistic in regard to that land; but Mr. Hill has a higher opinion of it than I have. I do not look on any of the land near the Capital City site as being gilt-edged. I think that, if by taking account of the increased expenditure, the Commonwealth were to do anything which would place it in years to come in the position that it could not use any irrigation treatment method it would be taking a grave responsibility. I estimate that the population of the Federal Territory will be 15,000 in fifteen years, but I should start with a plant estimated to accommodate 5,000 people at a cost of about £10,000. That would be complete, aerobic and anaerobic. It is a moot point whether we cannot take the effluent from an anaerobic tank, and put it on the land. It is certainly not necessary to lay down tanks straight away large enough for a population of 15,000 people. I would start on a population basis of 5,000, and let the scheme be progressive, eventually building up to meet the requirements of 120,000 people. It is a question of more tanks or of enlarging the treatment works. I do not think it would be feasible to have a plant at the point of deviation shown on the plan, that is, at 1,820 feet above sea-level, which would test the efficacy or otherwise of this form of sewage treatment, and at the same time be sufficiently far away from settlement to obviate a nuisance. The sewage could not be taken to that point without pumping, because it is below flood-level. I would not favour a tentative project of that kind. The amount which I stated might be saved by postponing the construction of the length of sewer from the point of deviation to the location of the treatment works shown on the plan was £36,000. Senator Lynch estimates that that would be equivalent to a saving of £1,600 a year in interest at 4½ per cent., or £16,000 in ten years. He contends that in establishing a plant at the point of deviation, we would be only using up the interest required for the extension of my project to the suggested treatment area, and with that interest on the expenditure thus deferred we would be testing the reliability of a particular form of septic treatment. Sunken tanks would not be possible. The sewage could not be brought to the ground without pumping, because the tank would be below flood level. I would not favour a tentative scheme of that kind, in order to save the cost of running the sewer to Western Creek, and so avoiding all possibility of odours, and starting on the whole outfall sewer. Of course, it is for the Committee to say whether the scheme to be put in hand is to be merely a test, or whether they have sufficient advice to remove from their minds any doubt as to what ought to be done. I think that the experience of sewerage matters generally is that one cannot be certain that the sewage will be innocuous, no matter how treated. The point of deviation from the main out-fall sewer would be a little over a mile from the nearest indicated residential suburb. So far as the disposal of the effluent is concerned, there would be no difference in the two schemes; both would require pumping. In regard to the suggestion that the length of the intercepting and main sewer might be shortened by making the main cross the city boundary at a point further to the south-west, I would point out that the Committee must be guided by the nature and general slope of the country.

177. *To Mr. Sampson.*—It would not be practicable to put the treatment works at the end of the out-fall sewer close to Yarrolumla Creek, because of the levels. There would be nothing in the way of elevation to prevent a new area being added to that shown on the plan for the treatment works, but it is generally fast-falling ground. In regard to the country away from from both creeks the easiest slopes are on the tops of the hills, where, however, there is very often rock. The flat places on the tops of hills are the worst for irrigation. Mr. Knibbs estimated that in 1935 there would be 18,000 people in the Territory. I have said that £40,000, in round numbers, would be saved by not carrying out the extension of the sewer as proposed by me, and establishing instead a tank at the point of deviation mentioned by Senator Lynch, or at the place proposed by Mr. Davis. Interest at 6 per cent. on that £40,000 would amount to nearly £50,000 in twenty years. You ask me, therefore, if it is not a good business proposition to place a tank at one of those points for that period, even though at the end of that time it may have to be replaced by a larger tank further up. You argue that we would save, probably, an immediate outlay of £40,000, and at the end of twenty years, when the population has reached 18,000, we could discard the tank, and

still be £30,000 in pocket on the fixed charges for the larger scheme. In the first place, I would point out that we did not get a start with the Federal Capital works until three years later than was estimated by Mr. Knibbs, and that would alter his estimate of population accordingly. Before there is a population of 18,000 you have to spend for these tanks, which you may have to discard subsequently, £33,700. I do not know that you are right in deducing that, as we would have to make provision for 18,000 people in twenty years, the outlay would be practically the same in both cases. We would have to spend up to £30,000 for the tanks placed there as an individual scheme, and when the population was 18,000 the expenditure would be £33,000; not only that, but there would be the tanks, pumps, and all sorts of plant. Suppose we spend £10,000 straightaway, and gradually raise the expenditure to £33,000, there will be a considerable accumulated fund, and all that expenditure will have to be put aside, and will be worth nothing to the Commonwealth. What we require is a progressive scheme. The Committee wish to save the primary outlay. If we go on to that outfall which has been planned, the only pumping we need do for a good many years will be that into the septic tank. There will be no charge at all for the preparation of the irrigation land, because we can send the effluent direct from the tank to the irrigation area. The land we propose to utilize there will require no preparation. In considering the possible saving mentioned by Mr. Sampson, I think 6 per cent. is on the high side. If, however, works have only a limited life of ten, fifteen, or eighteen years, what rate of interest is to be charged? Perhaps, in working out the cost of the scheme, each portion could be made to bear a rate of interest varying according to its life. The main sewer would have practically a permanent life. For machinery 6 per cent. would not be high enough; 10 or 12 per cent. would be necessary on account of the rapid depreciation. The sewer could be built for £75,000. I would establish, first, one anaerobic tank, and I would take the effluent from it direct to the soil. Only a small 10 horse-power pumping plant would be necessary to take the effluent from the tank to the land. In Mr. Davis' estimate of the prime cost he has provided £5,800 for pumping plant. That would not be necessary. If it were proposed to work on the basis of 1,000 persons to the acre, we could carry on for years without any pumping, except in connexion with the effluent from the septic tank. There would be a saving there in primary outlay. I should like to prepare a return which would show the Committee what the Department estimates to spend from year to year up till 1935, including the prime cost of the tanks, the prime cost of the sewer channel, and the cost of operating, and also the expected return from the land. I should also like an opportunity of getting more evidence in regard to the suggestion of Senator Lynch to put a tank at the point of deviation at the 1,820-feet level.

178. *To Mr. Sampson.*—The area of 60 acres allowed for by Mr. Davis as ground for receiving the effluent can be nothing more than a filter bed. For irrigation purposes, an acre is required for the liquefied crude sewage of each 100 persons. I do not think the land could absorb the effluent on the basis of 600 persons to the acre. I estimate 30 gallons per day for each person; Mr. Hill estimates 40 gallons. Allowing 600 persons per acre, that would give a total of 18,000 gallons according to my estimate, which is a very great quantity to put over an acre of land day after day and week after week. An area so treated is not going to last for a great number of years. In regard to the commercial aspect of sewage farms, I would use land treated with sewage for the agistment of sheep and cattle, but I would never get people to take up such land for vegetable growing. I am not afraid of the effluent finding its way into the Molonglo River after it filters through the land and gets the proper soil treatment; but if it travels in channels, I think we might be at some times confronted with almost the crude effluent.

179. *To Senator Story.*—We could not carry out Senator Lynch's suggestion to place the tank at the outlet of the sewer, because it would be below flood level. The sewage must be brought to the surface. I do not think the smell from the pumping of the sewage, in connexion with Mr. Davis' scheme, would reach the city. The offensive matter is all contained in the pipes until it gets to the tank. There is certainly a little more offence in pumping crude sewage than in pumping the effluent. No matter what spot might be selected for a gravitation scheme of sewerage, it would be necessary to lift the sewage by pumping. I do not think that the objection to the pumping on account of the smell would be very serious. If the sewer were taken in a direct line to the treatment tank, it would be necessary to carry it a considerable distance above the bed of the river, and that would add considerably to the cost of the sewer. A bridge would be required to carry it across the stream. It is a sound policy to keep sewers down and out of sight if that policy is possible. In addition to the cost of the bridge, there would probably be increased expenditure involved in the use of steel pipes at that point. It would cost more to make any deviation than to take a direct line. Mr. Hill will tell the Committee that he has adopted the cheapest route that can be obtained. I propose to prepare for the Committee a statement showing the estimated cost of the scheme from year to year, as far as we can forecast it up to 1935, when Mr. Knibbs estimates the population will be 18,000. That will be shown on a curve diagram, and I should like to work out an inverse curve of the estimated working expenses and interest.

180. *To the Chairman.*—I see what is in the Committee's mind in regard to effecting a saving in the length of the main sewer. A few days ago, I took the men off the extreme end of the main sewer, and put them on to road work. I understand the Committee's suggestion that work on the extreme end of the sewer, indicated by the dotted line, should be left in abeyance for the time being.

~~*The witness withdrew.*~~

John Howard Lidgett Cumpston, M.D. (Melb.), B.S. (Melb.), D.P.H. (Lond.), Director of Quarantine, sworn and examined.

181. *To the Chairman.*—My experience in connexion with the septic treatment of sewage has been in England and on the Continent, where, as an outsider rather than as a person concerned in their administration, I saw some systems of treatment in operation; and in Western Australia, where a considerable number of small installations, belonging to both the Government and private owners, were under the jurisdiction of the Health Department, by which frequent inspections were made. That inspection work was more or less under my control, and in that way I became acquainted with a limited range of septic

tanks in Western Australia. I think it is generally accepted that some form of treatment in tanks, all of which have certain essential features in common, is necessary for the proper disposal of sewage. I have rarely found a tank that was absolutely free from smell. Many tanks are sufficiently smellsome to be a nuisance. I would most certainly hesitate about placing septic tanks close to a city. One may take it as a cardinal rule that, where the treatment of putrescible substances has to be undertaken, it should be undertaken at as great a distance from population as is possible, consistent with other considerations. That applies more particularly to the treatment of human excreta, which is an important ingredient of city sewage. As a broad question, there can be no doubt that the discharge of effluent, no matter how treated, into a body of water, pollutes that water. That, I think, is accepted by all the authorities who have given any attention to the subject. Not only is there a discharge of decomposible organic refuse into the water, but there is also the possibility of the discharge of micro-organisms which may be disease-producing. To a very large extent, that objection can be overcome by putting the effluent on the land. The fineness of the filtering substance which the land offers, the fact that the fluid has to pass through a very fine mesh of soil, arrests all solid material, and in so doing arrests a great majority of the organisms contained in the effluent. There would certainly be less danger from effluent after passing through the land into a stream than if it passed into the stream direct without soil filtration I have no experience of septic tanks having a bad influence in the spread of disease, nor can I recall any occasion in my experience where there was any definite effect on health. There have been complaints of an alleged effect upon health For instance, there was a septic tank at the Kalgoorlie Hospital, and it worked so very badly for some months that there was a considerable discharge of objectionable gases. Certain residents in the neighbourhood did object, and complained that they suffered from sore throats, and deteriorated health. Nobody had direct evidence that such illness was the result of the gases discharged by the septic tank, but the two facts did exist side by side, namely, that people were ill, and that there was a discharge of objectionable smells. Of course, that tank was not working properly, and it gave us a great deal of trouble. We had to empty it by hand on several occasions.

182. *To Senator Lynch.*—I do not know very much about the Emscher system of septicization. I think I know the principal features of it, but I have never seen it at work, and I have only text-book knowledge concerning it. I have seen most of the systems in England and on the Continent, but I do not remember having seen one of the Emscher type. The essential feature in septic treatment is to get a tank content of as large a dimension as possible so as to give a period of sedimentation sufficient to remove most of the organic material. One of the great features of Australian sewage, as differentiated from European sewage, is that there is a much greater degree of what is known as scum There seems to be a greater amount of fat in the city sewage of Australia, for what reason I do not know. That creates a scum on the surface of the septic tanks, thus causing a difficulty which is not experienced in Europe to the same extent. On the other hand, we do not have in Australia the same difficulty in regard to sludge, the heavier matter which is precipitated in the bottom of the tank, and which the Emscher system is primarily designed to treat, so as to make it readily disposed of without any nuisance. The district of Essen has peculiar characteristics, inasmuch as it has a large industrial population with a great number of factories, giving a highly decomposible form of sewage. The Emscher system of treatment, therefore, goes a considerable length to overcome that difficulty. I do not think that the sewage in Australia is less amenable to treatment than that in the Old World. It requires some modifications of the system, providing for larger tanks to give greater accommodation. There are many systems in Australia which are working very satisfactorily. One of them is that in operation at the hospital for the insane at Claremont, Western Australia. It is a generally accepted experience that septic tanks are not to be relied upon alone, and that their processes have to be followed by land treatment. All big towns have adopted either land treatment or filtration on a large scale. There is no particular variant which, from my limited knowledge of the subject, I would favour. I am not sufficiently acquainted with the engineering side to give a reliable opinion. Apart from my Kalgoorlie experience, I have not become aware of any ill effects of the septic treatment. The Perth system had not started when I left that city; but I did hear that it was not working satisfactorily. The working of the septic system, generally speaking, does not come under my supervision, though in Western Australia it did to a certain extent. We have a small septic system in the Quarantine Station, and so forth, but it is negligible from this point of view.

183. *To Senator Keating.*—In Western Australia, I was Assistant Medical Officer in the Health Department. In Western Australia, we found that it was not infrequent for a tank to get out of order; and when tanks do so they have to be dealt with in various ways according to the particular case. In most cases the cause is that the tank is not large enough. I do not think that climatic conditions have anything to do with the matter. When the tanks went out of order the defect was in some cases removed by the addition of a large quantity of water to dilute the sewage. In other cases the tank had to be dug out, and the contents removed with shovels and buckets. In Kalgoorlie the tanks were, I think, generally made of reinforced concrete. There the tanks were near the city, alongside the railway station—in the hospital grounds about a quarter of a mile away. I should say that it is very undesirable to have the tanks in or near the city area, and, further, that it is dangerous or potentially dangerous. If the tanks be in the city area, what is to happen to the effluent? Presumably the effluent has to be carried out of the city and disposed of in some way as a final stage.

184. *To the Chairman.*—If the effluent has to go into a stream, it is essential that it should do so as far from the population as possible.

185. *To Senator Keating.*—And after filtration as far away as possible.

186. *To Mr. Fenton.*—At Kalgoorlie there were no contact beds, and the effluent was disposed of by a species of land irrigation in a large vegetable garden. This was in a fairly thickly populated part—right in Kalgoorlie itself. It is rather difficult to say how far away the effluent should be disposed of to be considered safe, taking the climate into account; I should say 3 or 4 miles, perhaps, although it is not easy to answer the question. I should not think that the climatic conditions have any influence on the increase of the scum in Australia; that is rather a chemical question. I am not sure that anybody quite knows why the scum should be greater here. I cannot think, generally speaking, why the climatic conditions should affect the effluent here in this way.

187. *To Senator Story.*—Given a properly constructed tank, I should say that it was hardly possible for the effluent to escape from the tank itself into the river without being filtered from the solids. There is a possibility, however, that it may run into the river without percolating through the soil, and I see a possibility of that occurring if it is not properly managed. On general principles, I should say that it is desirable to have the treatment works as far as possible from the river. But in the case of land filtration there must always be a fall of some sort, and that fall will naturally be in the direction of the ordinary water-course, which it will ultimately reach. On general principles, however, it would be better to have the treatment works as far as possible from the main water channel. I should think it would be better not to have the works within a quarter of a mile.

188. *To Mr. Sampson.*—As to the systems which have been before the Committee, and as to treating the sewage at an early stage, and separating the organic matter from the fluid so as to have a better chance of obtaining a pure effluent, I take it that an essential part of the proposition is that, having come through the tank, the effluent should pass into a contact filter bed before discharging at the final point. That necessarily presupposes an effluent which is non-decomposible, an effluent which is free from the possibility of further decomposition. I should think that there is hardly any system working which does its work continuously and so satisfactorily as to give that result—that is, that the effluent can be guaranteed at all stages to be non-putrefiable, which it would have to be if it had to be discharged into any body of water within the residential area. It also presupposes that the septic tank process, and the contact filter bed process, are each of them free from nuisance; that is, they are so managed that no noxious gases are evolved. If, as I take it, you are suggesting that the sewage is to be treated at once as nearly as possible to the city, then the treatment works will have to be guaranteed to be free from any offensive gases. There is a potential danger that the gases will be a menace to health, and, secondly, as the authorities of the city would not allow any trade or corporation to discharge an offensive gas into the atmosphere, it should not permit such gases to escape in its own installations. Any process in which there is even the possibility of the discharge of any putrefaction gases should not be considered. The authorities on the question are sufficiently agreed that there is no system which works continuously and regularly without the possibility of something going wrong. The fundamental point of the system under discussion is that the sewage should be treated at the earliest possible moment, but I do not think that that should be regarded as a *sine qua non*, because the decomposition of the sewage, on which all systems depend, for the putrefaction of the sewage does not commence to any important degree until the period of rest, which begins when the fluid enters the tank. So that, whether it be 100 yards from the tank, or 3 or 4 miles, I do not think it makes any important difference; and the authorities are, I think, sufficiently agreed on that. Professor Dunbar, in his book, "The Treatment of Sewage," expresses the same idea—

> It can only be assumed that the dissolved organic matters are first separated from the sewage during its passage through the filter, and are retained in the filter to be decomposed and oxidized by the micro-organisms during the succeeding period of rest.

I think it is more or less readily accepted that that is a fundamental of most systems—that the period of decomposition only begins when the sewage has come to rest for the time being. I cannot see, from what I know of the subject, that it matters very much whether it is 100 yards or a mile or two away. It has been suggested that certain processes of putrefaction go on immediately the solids find their way into the liquids, and I point out that it might take place even further back than that, seeing that putrefaction begins before the excreta leaves the body But the decomposition on which the treatment process relies does not, I think, commence to any extent before it reaches the tank. If it is a properly graded channel, with a proper invert, giving a self-cleansing flow, the flow is so rapid that I do not think there can be much material decomposition taking place. As to the possibility of typhoid and other germs finding their way into streams and being carried a considerable distance, some very good work has been done in this connexion by the London Water Board. The chemist of that body, who is a medical man, has shown that with a storage of what he calls raw Thames water —that is, water taken out of the River Thames, the Lee, or some other stream that supplies London—both typhoid and cholera germs persist for comparatively long periods. Some little time ago he demonstrated that they persist for, I think, about seven days—I am speaking from memory—at any rate, they persist for at least several days. As to the danger of typhoid fever being carried into the streams, and thence into the Burrinjuck scheme, it is to be remembered that with a good treatment process there would be few, if any, typhoid germs escape, and, in the second place, that they die out with a certain amount of storage—I think about the seventh day. With an immense volume of water, as at Burrinjuck, I should think that the danger at the distance would not be appreciable.

189 *To Senator Lynch.*—I should say that these germs would not reproduce in the streams to any extent, in ordinary water they do not reproduce beyond the first generation, and then only to a small extent.

190 *To Mr. Greyory.*—In my trip to Great Britain and Germany I only cursorily examined the treatment plants. I was not in Essen. In Germany the treatment plants were generally fairly close to the cities. I do not think that with a properly graded sewer there ought to be less noxious smell and better results in a small plant than in a big plant. Of course, in a badly constructed sewer, with pockets, you do have decomposition in the pockets, as in the London sewers to-day, but with a properly constructed sewer I would say you should not. This, however, is an engineering question. I do not see any reason why, while the sewage is in the sewer, the bacteria should set to work and septic treatment start, owing to the darkness; I do not see any reason why they should operate to such an extent as to produce an appreciable amount of gas, if there are proper ventilation pipes at intervals. It is a fact that the sewage or effluent from the sewage plant in Oxford and many other towns on the Thames flows into that river, and that the water is used for drinking purposes by the people of London; but all the Thames water so used is filtered through sand filters and stored for a week before. I should say that below the lakes there should not be much danger, with an efficient plant and filter beds, in allowing the effluent to flow into the Molonglo, because it is a fairly long stream before it reaches the Murrumbidgee, and the Murrumbidgee goes a long way before reaching the

reservoir. I would not allow the effluent to flow into the lakes on the eastern portion of the town in the city boundary, because there is always a prospect of some green vegetable scum. This was a difficulty experienced at Belfast, where the sewage discharged into the river. There the authorities had a great deal of difficulty with the seaweed which grew along that portion of the river where the sewage was discharged. There would undoubtedly be a greater danger where the water was to a great extent stationary.

(Taken at Melbourne.)

THURSDAY, 18TH FEBRUARY, 1915.

Present:

Mr. RILEY, Chairman;

Senator Story,	Mr. Finlayson,
Senator Lynch,	Mr. Gregory,
Senator Keating.	Mr. Sampson.
Mr. Fenton,	

Robert Boan, Engineer-in-Charge Sewerage and Drainage, and Head of Railway Laboratory, Victorian Railways, sworn and examined.

191 *To the Chairman.*—I have control of the sewerage systems in connexion with the Victorian Railways. Under my supervision are various installations, large and small. There are installations at Hamilton, Korumburra, Leongatha, Servicetou, and Ballarat, for instance. Ballarat is now being sewered. There are two septic tanks at the Newport Railway Shops, and these have been in existence for a good many years. At Newport I suppose there are about 4,500 men, but all these are not accommodated by the septic tank, because we have the pan system as well. At Newport we are waiting for the Melbourne drainage system to be connected. The two tanks at Newport were designed originally for about 1,000 men each, and, as I have said, there are now about 4,500 men there. At Newport is the largest system we have, and we have found it perfectly satisfactory unless the tank becomes overloaded. The system could not be called satisfactory in every sense. There is no nuisance, nothing can be seen nor any smell detected—indeed, you would not know the work of purification was going on. There is no complaint from the men about any smell. When the work was first started, and not finished, there were complaints, but the moment the tanks were covered the complaints ceased. The biggest septic tank will accommodate 1,000 men, for which number it was nominally designed. It is used only during working hours, and at night time is scarcely used at all. This discontinuous use of the tank has no effect; it means that when not in full work the material is having a longer period of decomposition. We have prepared aerobic filter beds, and the difference between the aerobic treatment and anaerobic treatment is that the work of dissolving is in the one case done by organisms working without air, and in the other case by organisms working with air. The work of the septic tank is to dissolve into solids that are in suspension. After passing into the septic tank the organisms that do the most work in the septic tank proper dissolve the solids. The liquid flows from the septic tank half purified, and is then distributed by various means on the aerobic filter bed. The organisms draw oxygen from the atmosphere, and hand it on to the liquid, so as to purify it; they really oxidize the solids that are in solution. The natural method of oxidizing the sewage is the correct one, though there are other methods. There are various ways of getting rid of the nuisance temporarily, but in the natural bacterial treatment it does not matter whether the sewage is discharged on the land, buried in the soil, or treated on filter beds. The latter simply means that you bring the sewage into a specially prepared cultivation bed, where the same process goes on as goes on in the land, only, in the latter, the organisms that do the purification are very many at the top, and at 12 feet down there are none, whereas in the artificially constructed filter the whole of the depth can be employed. At Newport the effluent goes into an open drain, and then flows to the sea, for perhaps half-a-mile. It flows in a brick drain, then a pitched drain, then into a swamp, and finally into the sea. There are only a few houses, and not much population, along the route. There has never, to my knowledge, been any nuisance created, though from other points of view the locality is not very savoury. There are refrigerating and other works, and there is a swamp, practically land-locked, without any proper outlet to the sea. There are abattoirs and other works, and these drain into the swamp, which is known as the Kororoit Creek swamp. As an engineer who has given a good deal of time and attention to sewage questions, I would have no objection to building a house close to where the fluid passes. The liquid coming from the railway works has no offensive smell whatever. The water is the waste water from the blacksmith forges, the washing of engines, the effluent from the filter beds, and so forth; and although it is dirty and discoloured, there is no nuisance. You could stand over the water, and unless you were told what was going on you would not know anything about it. The effluent, if it is properly treated, can be rendered perfectly innocuous. We have no other system of putting the effluent over the land; in every case it simply flows away down gullies and into creeks. In the case of Serviceton it simply flows into a cutting alongside the north of the station. Except at Hamilton, where only there is a stream of any size, the effluent runs usually into dry creeks and so forth. At Ballarat we are putting in a septic tank and an aerobic filter bed, and the effluent will be passed into the Gnarr Creek. The water from that creek is not used for domestic purposes; the creek is practically the main sewer of Ballarat, and is quite close to the station. From our previous experience we do not anticipate any trouble with this tank.

192. *To Mr. Fenton.*—We have many times analyzed the effluent which would pass the standard of the Royal Commission on Sewage Disposal in England. Of course, it is not quite up to the standard of ordinary drinking water. The destruction of sewage means, briefly, the liquefaction of the solids by bacterial aid—not all of the solids, but the bulk of the organic matter. Assuming all the work to be properly carried out, the final product is water, carbonic acid, and nitric-nitrogen or nitrates. I have studied the new German and American systems, and I have full particulars of the Imhoff system. When we started at the Newport workshops, we had nothing but the pan system, and it was grossly offensive, though the best was being done. At great expense, the pans were cleaned every day, but as the population began to grow rapidly better arrangements had to be made. I put in the

first septic tank on what is known as the East block, and another on the West block. At that time, the men would number 500 or 600 on each block. It was then supposed that the Metropolitan Board would not sewer the place for, perhaps, twenty or thirty years; and when the population rapidly increased, I was called upon by the Railway Commissioners to suggest a remedy for the inadequate accommodation provided by the existing tanks. I designed the tank somewhat on the lines of the Imhoff process, but nothing was done beyond producing the drawing. The works are now being connected to the metropolitan system.

193. *To Senator Story.*—It is rather hard to answer straight away whether, supposing I had to arrange for the disposal of the sewage of a city of 20,000 inhabitants, I would put the treatment tanks in or close to the town, or would further go to the expense of building a sewer to a point a mile or two away. The conditions might be imperative—there might be only one outlet for the effluent. It must be remembered that, by the most perfect system of bacterial treatment, we have to destroy the solid matter; and the sludge problem has always been the great difficulty. It was thought in the beginning that the tank had solved this problem, but it had not. There are certain mineral and other matter present which the bacteria cannot touch; and to get over that difficulty, the sludge has to be taken away somewhere. Various methods have been tried. It was first of all thought that 100 per cent. of sludge would be treated by bacteria; and I may say that I delivered a lecture at the University on the subject "The Purification of Sewage." In it I show the percentages of liquefaction obtained in various septic tanks. I think it was reckoned that 50 per cent., and, in some cases, 80 per cent., of the sludge is finally disposed of, and goes away in the effluent, but it is then in a perfectly inert condition—its danger is gone. It is not sewage, and it has no power of secondary putrefaction. There is no danger of this matter putrefying if it has gone through the proper treatment. But it is very difficult to make the matter clear. If you want to get perfection, it is possible to have as a result nothing but perfectly pure water, in the sense that it is clear water, though containing nitrates in solution. I am afraid I am not making this quite clear; and, perhaps, I had better refer to the lecture I gave at the University. That lecture is illustrated; and in one of the drawings, which shows a septic tank, you will see on the left-hand side the words "Anaerobic tank"; and on the extreme left is shown the inlet for the sewage. Then you will observe that there are two baffle plates, one vertical and one inclined. The object of the inclined baffle plate is to deflect floating particles like paper and so forth; the heavier matter drops to the bottom of the anaerobic tank, and is dissolved there by bacteria. The liquid flowing between the vertical wall and the inclined baffle plate is partly dissolved liquid and water running away. The liquid is now going into the next chamber, which is really a sedimentation tank. The object of the baffles in the tank is to turn the water—to make it take a circuitous course and empty the tank as far as possible. The water reaches the right-hand side of the septic tank, and it passes through a submerged inlet into a channel called a supply channel. From there it passes out by various small pipes into tipping troughs. The tipping troughs are emptied first to the right and then to the left, as the compartments fill with the liquid, and are tipped into the aerobic filter-beds. In its passage through the aerobic filter-bed, the effluent is oxidized by the aerobic organisms which are in the filter-beds. The liquid then drains out into small channels, and the effluent from the filter-beds goes to wherever it is to be discharged. In order to get a perfectly clear effluent, the members of the Committee will see, in the right-hand corner of the drawing, that there is a small tank called a chlorination tank, or final sedimentation tank. There is a small amount of solids present in the effluent, but when the process is completed the effluent should be perfectly clear; though, of course, it will contain, probably, a large number of bacteria. A great many experiments have been carried out to see whether it is possible for pathogenic organisms (disease organisms) present in the sewage to survive the treatment; but it has been found that this can be prevented by a comparatively cheap and very effective method of sterilization known as the calcium hypo-chlorite method Calcium hypo-chlorite is allowed to flow into the effluent as it leaves the septic tank, in the ratio of ten parts in one million; and this has been found to disinfect the effluent, leaving it clear of bacteria. The liquid being dosed by this calcium hypo-chlorite, passes through the filter-bed, where it rather assists than hinders the organisms to nitrify the effluent. When the effluent reaches a chlorination tank, or sedimentation tank, the dosed liquid, oxidized by the bacteria in the filter-bed, is further kept in contact with the solution for, perhaps, two hours, in which time the effluent is absolutely disinfected The water flowing away from the little tank shown is cleared of solids in suspension, and it is disinfected or sterilized of its bacterial contents—it is practically sterile water. The addition of the calcium hypo-chlorite has the further advantage of destroying any odour in the liquid coming away from the septic tank. Of course, the septic tank liquid contains gases; the solids are turned into gaseous matter and water. I do not think it would be necessary to have this purifying if you were going to dispose of the effluent on the land for irrigation purposes. I think it would be better to use the water for irrigation rather than make it absolutely sterile, on which process a certain amount of money is spent. Of course, if the effluent had to be taken a mile away, the other system might prove cheaper; it is a question of which is the cheaper I think that we can get a perfectly sterile, clear liquid that can be discharged with impunity into a creek, oven in or near a town, without causing any offensive odour. At Newport the tanks are overloaded, the population being greater than that for which the tanks were designed; but, still, the system does its work without nuisance, although the tanks are immediately alongside the closets and the main buildings. I think that the Imhoff system is on better lines than the ordinary septic tank; and, according to authorities, it has been adopted by high-class sanitarians in America. On page 23 in the lecture to which I have already referred; there is another illustration showing the sewage influent coming into the two chambers, which are called sedimentation chambers. You will notice that at the bottom of those two chambers there are inclined partitions, one on each side of the centre, extending further than the right and left-hand sloped walls. The openings between the two inclined walls are slots through which the sludge or solid matter falls out of the sewage as it passes over the tank. The water flows from one side of the tank to the other; and, flowing across these divisions, the sludge drops out, falling into a large tank of circular shape. When it reaches that stage, the sludge goes on being dissolved. When the water that comes in on one

side of the tank passes over—it goes over slowly, taking about two or three hours—it is then practically clear of all solids which have been dropped through the slots into the lower chamber, which might be called the septic tank. The liquid from the sedimentation chamber, now free of solid matter, is practically dirty water only; and it flows away on the circular weirs. At this point, the following might be quoted from my lecture:—

At Bochum, for example, where the sewage from a population of 145,000 is treated, the sludge-drying beds cover an area of only half an acre.

The water which drains out of the sludge while on the drying beds is clear and odourless. The effluent flowing off from the Emscher or Imhoff tanks, though containing practically no suspended matter, is still highly charged with soluble organic matter. At Emscher the effluent runs into a canal, where the dilution is sufficiently great to prevent nuisance. But under ordinary conditions the effluent must be further purified by bacterial treatment on aerobic filter beds.

The first part of my lecture is really descriptive of a lecture by, I think, Imhoff himself. In May, 1909, Imhoff wrote a paper to *The Surveyor and Municipal and County Engineer*, describing his new method of treating sewage; and what follows in my lecture is taken very freely from him. I have seen the plans made by the American engineer who went over to study Imhoff's process; and they provide for aerobic filter beds, practically on similar lines to those shown in the sketch I have described. The Imhoff process shows decided improvements over other tanks. First of all, at the beginning of the septic-tank process, it was thought by Mr. Cameron, one of the first to suggest the idea, that if the tank were made large enough to hold, say, twenty-four hours' supply, the solids would all dissolve away, and the water would be perfectly ready to be ultimately disposed of in the filter beds. That was a mistake, because you cannot liquefy all the sludge; but you can easily see that, if you make a tank so large that the water coming in has to flow through in twenty-four hours—that is to say, an isolated drop, if that were possible, would take that time—the material is in actual contact with the putrefying matter. The action of putrefaction means the manufacture, so to speak, of gases, and this results in an evil-smelling liquid. In the case of the Imhoff tank, only about three hours, instead of twenty-four hours, are occupied. The water does not drop because it is flowing over other water; only the solid matter drops. The difference between the septic tank and the Emscher system is that, in the one case, the solids are separated quickly, and allowed to go away to the lower chamber, while the freed water flows fairly fast across; it is not in contact with the polluted matter, and is practically clean water. No doubt, of course, it contains certain organic matter in solution, but it is in a pretty clear condition, and is inodorous, or nearly so. Consequently it is in a condition to be rapidly passed over a filter bed. Soapy water presents one of the difficulties of the treatment. I think it has been necessary, in small installations of the septic-tank system, to divert soapsuds, but I do not think it would very much matter in the case of a large installation. The sludge, which is still an existing difficulty, has to be got rid of. No doubt large quantities of soapsuds must cause trouble, but this can be combated by precipitating the soap. On this point I may quote further from my lecture:—

Speaking generally, an average water carried sewage from a residential town will be composed as follows (Rimmicut):—

Solid matter, 200 to 800 parts per million.
Mineral, 50 per cent. In solution, 75 per cent.; in suspension, 25 per cent.
Organic, 50 per cent In solution, 60 per cent.; in suspension, 40 per cent.

The mineral matter present consists chiefly of sand, clay, iron and aluminium oxides, the chlorides, carbonates, sulphates, and phosphates of the alkalies (soda and potash) and alkaline earths.

The vegetable and animal (organic) substances may be divided into compounds which contain nitrogen and compounds free from nitrogen. The nitrogenous compounds are principally urea, proteids, amines, and amido acids. The non-nitrogenous compounds are carbo-hydrates (sugar, cellulose, &c.), fats and soap.

The organic matters, chiefly through the action of bacteria, undergo more or less decomposition, and to follow these changes it is necessary to have a knowledge of the composition and properties of these substances.

Urea—the chief constituent of urine—is a compound $CO(NH_2)_2$, is readily converted into ammonium carbonate by the urea fermentation, and is due to several *organisms* ubiquitous in nature, *i.e.*, the Bacillus Ureæ and the Micrococcus Ureæ, which have the power of producing the fermentation, and which is a typical hydrolysis, *i.e.*, decomposition. It is this decomposition of ammonium carbonate into ammonia and carbon dioxide which gives rise to the characteristic odour of urinals, stables, &c.

The proteids or albumenoid substances form the principal constituents of the animal organism—they all contain carbon, oxygen, and nitrogen—some contain sulphur, such as cabbage stalks and the like, some contain iron and phosphorus.

The carbohydrates include starches, sugar, cellulose, and wood fibre.

The fats are more stable than the other organic matters, and are not easily broken down by bacteria.

In the Imhoff system there would still be the difficulty caused by the soap, which is common to every system. These fats are not acted on by the bacteria, and they have to be gathered up and disposed of. If a large amount of soap flows in, say, on a washing day, it can be precipitated by lime or magnesia, which results in a form sufficiently solid to be collected. This could all be made part of the system. In large towns they do not have those difficulties with the soap. They have to collect a certain amount of floating matter, such as cabbage stalks or scrubbing brushes and cloths, which people find convenient to put into the sewer; these are collected at the screens before the sewage goes into the septic tank. If there is a great amount of fat, it will have to pass through a chamber dosed with lime and precipitated—not exactly precipitated, but so mixed as to form a thick hard curd. It is rather a complicated question to answer straight off whether precipitating the soap would leave any odour in the water.

194. *To Mr. Gregory.*—The biggest population which any of the railway septic tanks are serving is about 1,000. It must be remembered that these tanks deal with pure fœcal matter, which is hardly comparable with ordinary sewage, because it is so much stronger. It is better to have a septic tank some distance away from the place where the sewage is collected if that is possible, because the treatment cannot proceed without the production of odour at some time. The tank itself might be quite close to a residential quarter without causing any nuisance, but the filter beds would require to be some distance away. In my opinion, it is a decided advantage to have the sewage carried some distance before treatment. If the sewage is allowed to get stale in the pipes, bacterial action takes place during its passage to the place of treatment. I suppose that, from the extreme outside areas of the Melbourne sewerage system, the sewage has to travel some 25 miles to the farm at Werribee, which means that it is about twenty-four hours in transit. All the time it is passing through the sewers it is being attacked by bacteria, and is getting partial treatment. When it reaches Spotswood it is pumped and agitated to a great extent, then sent for some miles through a rising main, which is really a huge septic tank, and then the sewage flows on to the farm in the form of a black soup-like liquid. All

that time putrefaction has been going on, and increasing the liability to offence; but, of course, if the sewage is travelling in closed sewers there would be no offence until it reached the tank. You tell me that, for the purpose of saving expense, it is suggested that a treatment tank should be placed in the eastern portion of the Capital site, if necessary another in the western portion, another in the north-eastern portion, and still another to the north-west of the lake. In order to avoid offence to the residents, it would be better to carry the sewage away from the city. I would not take the risk of placing a tank there if I could keep it away. The aim is to treat sewage in such a way as to obtain finally an effluent which will be above suspicion. I would not allow the effluent from the tank to run into the stationary water of the lakes without first giving it soil treatment. There are cases where the effluent is allowed to go direct into bodies of water, but I certainly would prefer to pass the effluent over the land. It is possible to get a perfectly innocuous effluent which is inodorous, but the expense involved in obtaining that result has to be considered. It might be better to carry the sewage further away from the town rather than incur the extra expenditure of such very complete treatment. I notice that there is a proposed railway station near one of the suggested sites of the tanks, and, as a railway engineer, I would say that the tank should be kept away from that locality if possible, but if the expense of taking the tank elsewhere is enormous, I would take the risk of placing it at that point.

195. *To the Chairman.*—If I were preparing plans for a perfect city, and had not to consider the question of expense, I would use every endeavour to get the works away from the population.

196. *To Mr. Gregory.*—If it is proposed to have a sewage farm, that farm should be kept away from the city as far as possible. At the Newington Asylum, Sydney, the filter beds are in the open, and when I have been there there has been absolutely no trace of a nuisance. The effluent is finally discharged into the Parramatta River. Parramatta city also has a septic-tank scheme, the effluent from which flows into the river. I have also visited the Balmoral and Mosman systems, and there has never been any nuisance when I have been present. With the best possible plant obtainable I should be quite satisfied to have the tanks 1 mile away from the city. An effluent of anything like the purity that can be obtained by a good system has a lot of valuable nitrogen in it, and it can be used on the land with safety. It is much better than a sewage farm effluent, and is cheaper to use. From what you tell me of the alternative schemes of carrying the sewage 3 miles from the city, or treating it only 1 mile from the city, and so saving £35,000 to £40,000 in sewer construction, I cannot conceive that there would be any difficulty at all in placing the treatment works a mile from the city.

197. *To Mr. Sampson.*—The Sewerage Commission in Great Britain require only that sewage which is to be delivered into a stream shall conform to a certain standard of purity. The Commission at first said that the effluent should be passed over land, but in places it was found that the land could not be obtained, and so I believe the land treatment is not insisted upon. With a proper system of treatment there would be no danger of the effluent carrying bacteria into a stream. Care would be taken to insure that the effluent was perfectly harmless. Before expressing any definite opinion upon the alternative schemes suggested for the Capital Site, I should like to look into the details. There are hundreds of places where the only treatment is the septic tank, and the effluent goes direct into streams which are afterwards used for water supply. I believe that in the Emscher district the tanks are so disposed that the sewage is fairly fresh when it reaches them. I am not prepared to say whether that is necessary. The object of every engineer is, first of all, to do the work; and secondly, to do it economically. I would not advise putting an Emscher tank at the end of the rising main at Werribee, for instance, because by the time the sewage reaches there it has been already smashed up, so that it is soup-like in consistency, and sedimentation would be difficult. The very essence of the design of the Emscher system is that they wish to free the water as quickly as possible of its solids. If the sewage has to run for several miles before reaching the tank it gets broken in its passage, some bacterial action takes place, and when sewage is in that condition it is not necessary to pass it through even an Emscher tank, because, in the first place, it would be extremely difficult to get the solids to settle. If the sewage at Canberra were carried to Western Creek it would travel a distance of 3 miles, and by the time it reached the tank it would be to some extent attacked by bacteria. I am not prepared to say whether at the end of 3 miles sewage would be in a condition in which the solids would separate easily in the sedimentation tank, but I do say that when sewage has travelled 25 miles, and been vigorously stirred up by pumping, sedimentation would not be possible. The effect on the sewage in a 3-mile passage would not be appreciable. There would still be the grosser solids in it, and an Emscher tank would be effective at that distance. Just at what particular distance the Emscher tank would not be suitable, I am not inclined to say. The designers of the Emscher tank no doubt had in mind the odorous liquids that come from the ordinary septic tank. They saw the tanks in operation in England, and they decided that instead of allowing the sewage to travel horizontally in the tank, they would make it go down, so that the solids would precipitate before they decomposed. The water from the sedimentation tank would thus flow off free of solids, and without coming in contact with the offensive gases which are the products of decomposition. From the illustration I have seen of Emscher tanks, some of them are quite close to large residences. Whether the Emscher treatment would be as effective when the sewage has been travelling for some miles as when it is gathered fresh, I cannot say, but the very principle of the system seems to be to separate the water from the solids at an early stage before any decomposition sets in. The water so liberated is more easily oxidized, and during the process of oxidization it does not emit any offensive odour, because it has not had time to gather up gases from the process of septicization. Although, in small installations, an odour is just noticeable, it may be that in a much larger scheme such as would be required for the Capital City, special treatment of the effluent would be required. At the Newport Workshops the filter beds are covered, and the visitor does not know that anything is happening. The plant is doing the work effectively, and there has been no nuisance. With a large population to cater for, and only 3 miles of sewer to pass through before reaching the tank, I think that the Emscher principle would do the work effectively. The effluent could be discharged straightaway on to

land without treatment in filter beds. If a septic tank has to be designed for a twenty-four hours' supply, and an Emscher tank for only three hours supply, practically only an eighth of the tank capacity is required for the latter, and consequently the work must be very much cheaper. The Emscher tanks, being very deep, are not so costly to construct as the ordinary septic tank. In regard to the aeration of the effluent, in some cases, it is spread on the filter beds, and in other cases it is sprayed on by jets similar to a lawn sprayer. But there is not very much difference in regard to the efficiency of the respective methods.

198. *To Senator Lynch.*—My proposal for establishing the Imhoff system at Newport was not accepted by the Department for these reasons: We were just finishing the sewering, and were about to commence the construction of the tanks, when the people of Williamstown approached the Board of Health, and asked to have cleared the big swamp which receives the drainage from the town as well as the workshops, and is offensive. As a result of that deputation, the Minister for Public Health, the doctor of the Board of Health, and the Council of the Melbourne and Metropolitan Board of Works met on the spot, and inspected our tanks. It was alleged that the tanks were offensive, but the visitors were standing on them without being aware of their presence. Dr. Burnett Ham said that the sewerage system of the place should be connected with the metropolitan system. The Metropolitan Board had said that there would be no work done in that district for twenty-five years or more, but it was subsequently represented that a sewer would be carried out there, and we discontinued building our tanks for the reason that they would be of no further use when the sewer was constructed. As to the respective merits of the Emscher and other varients of the septic tank, each has its advantages, but I think that, on the whole, the principle of the Emscher is right, inasmuch as it gets rid of the water quickly. I would prefer that the sewage should be taken to the treatment tanks by gravity, and that the effluent should then be pumped to the filtration area. As to whether there is any engineering advantage in excavating the ground in order to get the sewage into the tanks by gravitation, when the effluent has to be pumped from the wells to the highest point of the distributing area, I would point out that the work must be carried out with the least amount of nuisance and disturbance. If you are to get the advantage of rapid sedimentation, and have the water running from the tank well oxidised, and not offensive, I should say that it is better to pump the effluent than to smash up the untreated sewage by pumping it into the treatment tank. I would certainly advise the installation of filter beds for aerobic treatment. The effluent from the Emscher tank might be in a condition which would allow of its being passed over the irrigation area without aerobic treatment. Of course, that effluent would require less ground than crude sewage.

The witness withdrew.

Elwood Mead, Chairman of the Victorian State Rivers and Water Supply Commission, sworn and examined.

199. *To the Chairman.*—I have had a good deal of experience of irrigation, and I consider that for irrigation purposes the effluent of a septic tank is more valuable than ordinary water. It is not so valuable as sewage which has not been subjected to biological treatment. I have seen a number of large sewage irrigation works, amongst them that at Milan. The whole of the sewage of that city is used in irrigation, and it is not subjected to any septic treatment. It is simply diluted to a great extent. They mix it with a large quantity of water, so that its use throughout the year does not entail any unpleasant result. There is very little odour from the sewage, and the wells in the irrigated country are used for ordinary domestic water supply. That scheme caters for probably 800,000 people, because some of the suburban towns are included. The sewage irrigation area is about 11 miles from the city, and the sewage is carried in open channels. A number of springs flow into the channel, and there is further dilution by the surplus water from the canals. The sewage is used winter and summer for the irrigation of fodder plants. No complaints are made by the people of offensive odours from the sewage. In the upper portions of the channel some evidence of offence is noticeable, but the smell is more from paper and matter of that kind than from sewage proper. Although the odour along the open canal was perceptible, it was not sufficiently noticeable to be disagreeable. I also visited the sewerage works in Paris about ten years ago, and at that time a considerable portion of the sewage was used for irrigation without any treatment. It was simply pumped about 14 miles from the city, and diluted in much the same way as it is diluted at Milan. The method of disposal at Milan and Paris are similar to that at the Werribee farm, but at Werribee the odour is more pronounced, because the sewage is carried a considerable way in a closed channel, there is more putrefaction, and gases seem to accumulate. In addition, there is no dilution as there is at Milan and Paris, and that fact is responsible to some extent for the odour being much more disagreeable. Sewage in this form certainly enriches the land to a great extent, although I doubt if the increased yield of crops would pay for the use of the sewage. In considering its commercial aspect, you must take into account, together with the results from the irrigation, the fact that you are getting rid of your sewage. In Italy, the sewage is turned on to the highest part of an irrigation area, and from there it flows on to the lower portions. It is a noticeable fact that the part which receives the sewage first is decidedly more fertile than that which receives the clearer water. That shows that the crude sewage has a marked fertilising value. The increased fertility is not due to the greater saturation of the upper portions, because there is practically a continuous flow over the whole area. In adopting a scheme of sewerage for a new city, I would prefer to adopt the septic tank system, even though I used the effluent for irrigation. I would not take the precaution of putting the effluent through filter beds; that would not be necessary. I have seen the effluent of a number of septic tanks used for irrigation, and I am of opinion that there is no need for filtration if the effluent is to be placed on the land. In those circumstances the odour ought to be almost eliminated. There is usually some odour in the tanks, but it is not very noticeable, and it is not unpleasant in the water carried in open channels. I do not think there has been any difficulty on account of flies carrying microbes from land watered by the sewage effluent.

200. *To Senator Lynch.*—Sewerage in this State is quite in its infancy. There are no sewerage works in any of the irrigation areas controlled by my Commission. That at Werribee is

the only sewerage irrigation scheme in Victoria. I have heard of complaints from settlers along the main aqueduct to Werribee of the offensiveness of the odour, which, I admit, is quite strong, but I have not heard of it affecting the health of the settlers. Families living along the main seem to get quite used to the odour. As a moistening agency for land, the sewage effluent is certainly equal to an equivalent amount of water, and it is somewhat better for purposes of irrigation. I know of two or three systems in America where the effluent from septic tanks is used in irrigation, and it is certainly preferable in appearance and in its freedom from odour to the crude sewage. So far as the effect on the growth of plants is concerned, I cannot say that there is any perceptible difference between the sewage effluent and clear water. I should say that the results from the use of the sewage effluent for irrigation purposes have been favorable from an economic point of view. If I were given the choice of turning the effluent on to the land, or running it into an adjacent creek, I should certainly adopt the former course. The practice of turning the effluent into creeks will disappear in time as the water, which is necessary to dilute the sewage in order to prevent the nuisance, is required for other purposes. There must be dilution of the sewage, or the stream becomes so impure that the water cannot be used for household purposes. I should say that it is a bad policy to run away water that can be used on the land, and it is also inadvisable to discharge sewage into streams if that course can be avoided. There have been a great many cases to support that opinion. In portions of America, as population became greater, and the contamination of the streams became more pronounced, the running of the sewage effluent into streams has been the cause of spreading infectious diseases, and the practice has had to be discontinued. I have no doubt that with a strong wind blowing the odour from the Werribee farm could be smelt at a distance of 5 miles.

201. *To Mr. Sampson.*—I estimate that there would be 60 gallons of water and sewage per head of population, and that 30,000 gallons per annum would be required for the irrigation of an acre of land. That means that an acre would take the sewage from 50 people. Even with a rainfall of 22 inches per annum, the land would absorb that quantity, because, I understand, there is a warm summer in the Canberra district. Clay soil is not the best for the absorption of a large quantity of water. For sewage irrigation, of course, the greater quantity you can put on the land the better, because the problem is to get rid of the water. A clay subsoil will enable the irrigation of more territory with a given quantity of water than will a sandy subsoil. There might be some difficulty in utilizing profitably the full quantity coming to hand day by day, but the surplus could be turned into the stream, especially if the sewage has been treated in the septic tank. There would be times in the winter months when the soil could not be irrigated at all, because it had no further capacity of absorption. At Werribee they have a sandy land on which to turn the sewage in the winter months. If the land at Canberra is as good as the land in the Goulburn Valley, irrigation will increase its productive capacity fivefold or tenfold. As to whether it would be better to carry the sewage to Western Creek, or to treat it at Yarrolumla, I would say that it is preferable to carry the sewage the greater distance. We must anticipate that the Federal city will grow, and if the treatment works are established at Yarrolumla Creek, it may eventually be necessary to move them further away. I do not think 3 miles is too distant, although I do not believe there would be any danger of the odour penetrating into the city if the works were established at a distance of 1 mile. It is difficult to forecast what the growth of the city will be, but I should say that if the sewer empties at Yarrolumla Creek, it will be necessary to remove the works from that point within the next fifty years. I do not apprehend any difficulty from the odour if the nearer site is chosen for the treatment works, but as a final scheme I would certainly prefer to have them further away from the city. The running of the effluent on to the land for broad irrigation would undoubtedly pay. There can be no question that farmers could pay a good price for the water. An irrigation scheme close to a city such as the Federal Capital would be very valuable, especially for the growth of fodder crops in connexion with dairying. Even under some of our Victorian irrigation schemes, we get a maximum of 1d. per 1,000 gallons for the water, and that price pays the full cost of pumping On an area irrigated with the effluent from a septic tank I would rather grow fodder crops and fruit than vegetables. Such an area could be used for annual fodder crops, such as millet, oats, and amber cane. Lucerne is the most profitable of the fodder crops where the soil is suitable, and I suppose it would grow in that district.

202. *To Mr. Finlayson.*—The absence of complaints in connexion with the Milan and Paris systems is not due to the fact that the people have become used to the smell; there is no smell. Occasionally the odour may be noticed near the outlet, but it is not disagreeable. The odour at Werribee farm is more pronounced than that at any sewage irrigation works I have ever visited. The Milan sewage is considerably diluted, not by storm water drainage, but by the waste which is continually flowing in from two canals. I do not think the interposition of filter beds is necessary in the case of effluent from the septic tank. The additional treatment would tend to decrease the manurial value of the effluent, but the main consideration is that the further treatment is not required There would be no danger from any seepage getting into a running stream if the effluent had passed through the soil for some distance. I understand that the effluent from the Canberra system would ultimately go into the Molonglo, and I do not think there would be any danger of contamination of the water after the soil treatment. The only danger of seepage would be from river floods. I cannot say that there is any particular tendency in regard to sewage treatment to either adopt the septic system or sewage from irrigation farms; each scheme is governed by local conditions. Land with easy contours is much the easier to irrigate. The contour map of Canberra shows that the proposed irrigation area at Western Creek is rather steep, but neither there nor at Yarrolumla Creek, nor at the suggested site at the south-western end of the city boundary, does there appear on the map to be any great difficulty in the way of irrigation. The main requirement is that the land shall have regular slopes.

203. *To Senator Keating.*—In Italy the sewage is used continuously for the growing of fodder crops all the year round. It is spread over the meadows, and the grasses have a capacity for absorbing large quantities of water. At Werribee, however, the sewage cannot be used for irrigation proper for portions of the year, but has to be turned on to sandy ground. In my opinion, there is nothing offensive in a system of irrigation with the effluent from a septic tank. In expressing a

preference that the treatment works should be at Western Creek rather than at Yarrolumla, I am having regard only to the possible growth of the city. If the population grow to 100,000, the works at Yarrolumla Creek would be in the suburbs. In making that choice, I was not influenced by any consideration for possible offensiveness.

203. *To Mr. Gregory.*—For irrigation I would prefer a light loamy soil, because the lighter and sandier it is, the greater the opportunity of using the moisture in the rainy weather. On clay, the water must be used sparingly. In saying that I thought that it would be better to carry the sewer the full 3 miles to Western Creek, I was not aware that the extra cost was estimated at £40,000. I was considering only an open channel, costing not more than a quarter of that amount. I do not think there would be any risk of anything disagreeable, with a population of 18,000 or less, in having the treatment tanks at Yarrolumla, provided they are good tanks. I cannot see any danger of such a scheme becoming unpleasant or unsightly.

The witness withdrew.

(*Taken at Melbourne.*)

FRIDAY, 19TH FEBRUARY, 1915.

Present:

Mr. RILEY, Chairman;

Senator Keating,	Mr. Finlayson,
Senator Lynch,	Mr. Gregory,
Senator Story,	Mr. Sampson,
Mr. Fenton,	Mr. Laird Smith.

Percy Thomas Owen, Director-General of Works, further examined.

204. *To the Chairman.*—Mr. Sampson asked me a question on Wednesday about the financial aspect of the respective schemes suggested by the Home Affairs Department and Mr. Davis. I thought I would be able to prepare the information in diagrammatic form, but I have, instead, prepared a table (*vide* Appendix B) which shows what we estimate we should have to expend from year to year. I have taken as a basis the forecast that at the end of twenty years, that is, in 1935, there will be 18,000 people in the Federal Capital. I have taken into account the expenditure and interest charges on the out-fall sewer, the treatment tanks, the pumps, power line, &c., and the treatment area. I had also worked out the figures for the pumping charges, but they are very small, and their addition would only complicate the information. I have charged for interest and sinking fund 5 per cent. on the sewer and the treatment tanks, and 10 per cent. on the pumps and power line, they being machinery. Then I have calculated at 3 per cent. sinking fund on the prime cost of the treatment tanks. I cannot see any other way to get over the fact that if we do not do that, we shall have to wipe off a large sum at the end of the period for which those tanks are used. If money has been spent, and the sinking fund has not wiped it out, the charge stands on the books for all time. For that reason I have provided a 3 per cent. sinking fund. I am assuming, of course, that any intermediate scheme must be merely tentative. On the ordinary hydraulic works I have allowed a sinking-fund charge of ½ per cent. I am assuming that the intermediate septic-treatment works will be of very little value at the end of twenty years, and that is why I provide the 3 per cent. sinking fund. I have taken as the prime costs £75,000 for the departmental scheme, and £40,000 for Mr. Davis' scheme. I have run out interest on those amounts, and the return shows the total of the whole of the years from 1915 to 1935 of the prime and annual costs for each scheme. I have divided the calculations into five-year periods, regarding that as a convenient way of advancing the plant to meet the increasing demand as time goes on. I have also gone on the assumption that we would not put in the Yarrolumla deviation suggested by Mr Davis, but would adhere to the line of the main sewer, because we should be able to get better tanks there. I have provided in Mr. Davis' scheme for the prime cost of the extension of the sewer to Western Creek in 1930. The prime cost of the treatment tanks I have assumed to be the same for both schemes. That is really conservative, because I believe that the sewage treatment for the same number of people will cost a good deal more at Mr. Davis' site than at Western Creek. I have put down the prime cost for the pumps at the same figure for each scheme, although Mr. Davis' pumping head is greater than that of the Department, and I have allowed £1,000 for a power line to go across. For the tanks I have calculated £9,000 in each scheme, and I have divided them into three units. We would not construct straightaway septic tanks sufficient to cater for the next twenty years, but with the provision which has been made for the term up to 1935, we would have enough tank capacity for 33,000 people, which gives the margin which we ought to have in any scheme of septic-tank treatment. For the preparation of the treatment areas I have provided £750 for the Home Affairs scheme; that is not the cost of ploughing, which would be a set-off against the cost of maintaining terraces under Mr. Davis' scheme. The cost of ploughing is a working cost which I have not accounted for here. That amount of £750 is merely for a small treatment of the surface. Turning to the total for the whole 20 years, we find that the expenditure of capital on the out-fall sewer will be for the Home Affairs scheme £75,000, and for Mr. Davis' scheme £80,000. The reason for the less cost of the departmental scheme is that if you construct part of the sewer now, and some years hence continue it, you must bring in all the plant afresh, and nothing less than £5,000 can be allowed for getting the plant and works under weigh again. The total cost for the treatment works up to 1935 is £27,000 for the departmental scheme, and £48,000 for that of Mr. Davis; and for the pumps, power line, &c., £2,000 as against £5,000. I have gone so far as to assume that we could use, for the final scheme, some of the pumps that have been already installed at the intermediate station. But it is doubtful whether we could do that, because we should require to have the two systems running concurrently for some time until the later scheme got thoroughly under weigh. I have not made any provision for a duplicate system, although, of course, we would have spare parts. I have allowed for the expenditure of £750 on the treatment area at Western Creek, and of £6,500 under Mr. Davis' scheme. The various charges added together give a total outlay at the end of twenty years of £104,750 under the Home Affairs scheme, and £139,500 under Mr. Davis' scheme. On the other hand, the interest on the capital outlay on the Home Affairs scheme will have been £87,535, as against £80,410 for Mr. Davis' scheme. Analysing the two schemes from period to period, it is found that for the years 1915 to 1920 the capital outlay of the departmental scheme is £65,250 as against £54,000 for Mr Davis' scheme, whilst the annual costs are £14,215 and £10,340 respectively. The figures continue in somewhat the same proportion—except that there is less increased prime cost on the Home affairs scheme from year to year—until 1930 is reached. In that year we shall have to commence moving away from the intermediate scheme, and we shall have to meet the additional charge for extending the sewer and putting down treatment works at Western Creek. In that year the Home Affairs Department would incur £6,000 more capital expenditure on the tanks, but under Mr Davis' scheme we should again have to launch out with an expenditure of £69,500. His scheme involves that extra expenditure at the end of fifteen years. Whilst I have prepared this return on the basis of treatment tanks at an intermediate spot for the service of a population up to 8,000, I am not prepared to advise any intermediate scheme. Mr. Davis informed the Committee that he had 60 acres for a treatment area at Yarrolumla Creek. After giving evidence before the Committee on Wednesday last, I had the following telegram sent to the Supervising Engineer at Canberra:—

> Area about 60 acres, bounded on east, north-east, and north by Yarrolumla Creek, beginning opposite woolshed near shaft 18, thence to junction Yarrolumla Creek with Molonglo, thence bounded on west and north-west by Molonglo, thence bounded on south by line running east to shaft 19. Contour plan shows rocky ridge and steep banks. How much of area is suitable for sewage effluent irrigation if terraced? Inspect with Brilliant if available and reply this morning, very urgent.

To that the following reply was received:—

> Yarrolumla Creek could only be terraced in northerly direction along ridge. Could not make available for sewage more than 20 acres except by expensive works: if terraces put in on slopes 10 feet wide could get another 10 acres, but would be expensive both to construct and maintain.

A population of 10,000, estimating 40 gallons of sewage per head per day, would give a total of 400,000 gallons per day to be spread over 30 acres. That means that, day in and day out, there would be nearly an inch of water over that area.

205. *To Mr. Fenton.*—It might be possible to get another 30 or 40 acres to the east of that area, but we are getting away from the idea of broad irrigation. Are we going to take pipes from place to place to pump the effluent wherever we can find suitable paddocks? I think that Mr. Davis' idea was that the effluent might be discharged into the Molonglo stream, but my opinion is that we must not do that. Over the 30 acres of suitable land in the area he has chosen there would be nearly three-quarters of an inch of water every day, and in addition it must be remembered that during portions of the day there would be big discharges which would result in a rapid flow over the area.

206. *To the Chairman.*—The grand total of added capital and interest charges for the 20 years ending 1935 would be, for the Departmental scheme, £192,285, and for Mr Davis' scheme, £219,910. Separating the principal from the interest, the capital cost of the Home Affairs scheme from 1915 to 1935 would be £104,750, as against £139,500 for the alternative scheme. On the other hand, the interest charges on the Home Affairs scheme would be £87,535, as against £80,410 under Mr. Davis' proposal.

207. *To Mr. Fenton.*—That calculation is contingent upon the intermediate scheme being merely a tentative one.

208. *To Mr. Sampson.*—Up to the beginning of 1930, when the extension of the works would commence, the capital cost of the Home Affairs scheme would be £98,750, and the interest £61,340, making a total of £160,090, and for Mr Davis' scheme the capital charge would be £70,000, and the interest £47,975, or a total of £117,935.

209. *To Mr. Gregory.*—I have allowed £75,000 for the prime cost of the outfall sewer. It must be remembered that there is a lot of initial cost in getting the work under way, and I have assumed that the first portion of the sewer, from A to C, would have to bear the whole of those charges, which otherwise would be distributed over the whole sewer if it were completed to Western Creek in the one job.

210. *To Mr. Laird Smith.*—I have not made any provision for any expenditure in the grading of the treatment area. I have merely allowed £750 for the necessary improvements to the ground, and I think that sum would be enough. I would simply trench the ground for the conveyance of the effluent, as is done in orchards.

211. *To Mr. Finlayson.*—My contention is that any scheme at Yarrolumla must be regarded as tentative. If we are to have a city with a large population, it would be wrong to place the treatment tanks at Yarrolumla Creek. In providing in that return for the treatment works at Yarrolumla lasting until there is a population of 18,000, I think I have gone further than such a scheme would last. Any Australian town with a population of 18,000 is a big place. I have endeavoured to see into the future what the Federal Capital and its suburbs will be when there is a population of 18,000 there, and I take the view that by that time we should have to move our treatment works from Yarrolumla.

212. *To Mr. Laird Smith.*—I consider that after a year's operations a large proportion of the effluent from Mr. Davis' scheme would reach the Molonglo River. The filtration ground would be so saturated by having three-quarters of an inch of water over it day after day that a great portion of the moisture would simply run into the stream. I am speaking now, of course, of a time when the population has reached, say, 10,000.

213. *To Mr. Fenton.*—There is a considerable catchment area on the proposed irrigation site at Western Creek which flows into the Molonglo, but I do not think there would be any trouble through the rain helping to carry the effluent into the stream. We would keep away from the creek. I do not mind the soakage into the stream; all I fear is the effluent running over the surface into the stream. Of course with heavy rainfall there would be a considerable dilution of the effluent by the time it reached the stream. The Western Creek treatment area would be capable of catering for 150,000 people eventually.

214. *To Mr. Finlayson.*—There would be no difficulty in connexion with the Western Creek site on account of its adjacency to the road. With an extra 5 feet of pumping head on the sewage we could keep the works a considerable distance back from the road, because the land is comparatively level. It is only a matter of pumping the effluent further, and we can keep it a long way from the road. In the intermediate scheme the site would be on the western side of the road, from which the pumping plant would not be very far distant. The pumping of the crude sewage into the tank involves only a small lift. I do not think there would be any nuisance from the

pumping, because the pump would be of centrifugal type, and the whole of the sewage would be enclosed.

215. *To Senator Lynch.*—I do not think that a population of 130,000 will be included in the city boundaries. The city contains 16 square miles, of which about one-third is occupied by lakes. I take it that the Federal Capital will be a garden city, with abundance of parks and shrubbery. Even a settlement of 10,000 people is a big town in Australia, and a garden city with a population of 18,000 would spread over a considerable area. The city will require more space per head of population than other Australian towns, because of the model character of its design.

216. *To Mr. Laird Smith.*—At Western Creek we could eventually get a sewage treatment area of 3,000 acres. Such a large area would involve more pumping, but the expense of that would be justified by the big population. The best portion of Yarrolumla Creek area for irrigation is in the valley. The tops of the hills show shale outcrops, and it is hopeless to think of putting the effluent in the valleys of the Yarrolumla lying to the west of the intersection of that creek with the Urayarra road.

217. *To Mr. Sampson.*—I disagree with Mr. Davis' scheme because of the restricted area which is available, the situation of that area, and the possibility of the effluent getting into the Molonglo. There is no additional area in that locality for treatment works without transgressing the city boundary. In the financial statement I have put before the Committee I have not made any allowance for the value of the effluent for irrigation purposes as a credit against the expenditure on the larger scheme. I have pointed out that we will be getting an effluent which we will be able to put on the land at a cost of 2d. per 1,000 gallons, and the water at that price in an inland settlement would be cheap.

218. *To Mr. Gregory.*—The length of the main sewer from the point of intersection with the intercepting sewer to Yarrolumla Creek deviation is about one mile. You are doubtless considering whether the amount allowed for the first section of the main sewer is excessive. It must be remembered we would have to go to the far side of the Yarrolumla Creek to establish our tanks. In the Department's suggestion for the intermediate treatment works we carry the main sewer further than Mr. Davis, so that we bring it direct to Molonglo Creek, instead of deviating at a sharp angle, as he proposes. We would have to load the first section of the main sewer with the whole of the initial cost, which would be distributed over the entire length if the sewer were carried to Western Creek at once; the motors and other plant used on the first section would be carried along the sewer as the job proceeded, whereas if the second section were undertaken some years later the initial cost would have to be charged afresh.

219. *To Mr. Sampson.*—Twopence per 1,000 gallons for pumping is a conservative estimate; the cost would be more like 1½d.

220. *To Mr. Gregory.*—The sewage in every case would require to be lifted from the sewer to the treatment tank; but the pumping head at Western Creek would be less than at the other sites. We could arrange to only pump the sewage into the treatment tank. I should like to consider whether it is advisable to raise the pumping head on the sewage or to have just a simple lift into the tank, and then raise the pumping head for the effluent. The evaporation of 3 feet per annum mentioned by Mr. Hill refers to the lakes; on land the evaporation would probably be double that. Even in the winter months the 60 inches of effluent would evaporate in that climate, except when there is rain. Of course, when there is rain, there is a considerable dilution, so that there is no trouble from the non-absorbtion of the effluent then.

221. *To Senator Lynch.*—You ask me whether, instead of having to lift the sewage from the bottom to the invert sewer, a distance of 50 feet, it would be better to place the disposal tanks 10 feet from the bottom to the invert covers, and pump the effluent 40 feet. As an engineering problem, it would be difficult to pump the sewage 10 feet, and then pick it up as effluent. A cardinal principal of sewage handling is to break the crude sewage as little as possible, and to have the tank as near as you can to the invert. The pumping of crude sewage is not as simple a problem as the pumping of the effluent.

222. *To Mr. Gregory.*—With a population of 10,000 people, there would be a continuous flow of sewage. Mr. Hill agrees that from a population of 1,000 there would be a very satisfactory flow through the sewer. Perhaps the sewage from even 500 people would flow through all right. I will endeavour to have prepared a return showing approximately what the annual cost per head will be in fifteen years' time, assuming a population of 15,000, with capital at 4 per cent. interest, and 1 per cent. sinking fund, adding annual working expenses.

The witness withdrew.

Thomas Hill, Engineer, Department of Home Affairs, further examined.

223. *To the Chairman.*—I still adhere to the Department's original scheme.

224. *To Mr. Gregory.*—I prefer the area at Western Creek as a place for receiving the effluent, and for irrigation work generally, because it consists of a sandy loam, and it is better filtering country than that on the homestead side of the Molonglo Creek to the south of Yarrolumla Creek.

225. *To Mr. Sampson.*—I regard the 60 acres marked on Mr. Davis' plan as a site for a treatment area as insufficient for the purpose, even though the whole 60 acres were fit for use. An area of 100 acres would be required to receive the effluent from 10,000 people, and utilize it for broad irrigation. We generally reckon the effluent of 100 people to the acre. I base that calculation on the estimate that an acre of land in that climate will properly filtrate the discharge from 100 persons, and that discharge is sufficient for the proper irrigation of the land. Reckoning 40 gallons of sewage per head, and 100 persons to the acre, each acre would receive 4,000 gallons per day, equal to 1,460,000 gallons, or about 60 inches per acre per annum. That would be a fair quantity for irrigation purposes. The land would readily absorb that quantity without any undue seepage into any water-course. That has been our experience at Duntroon, where, so far, we have not found any evidence of the effluent in the streams. The land on the east side of Yarrolumla Creek is too close to that valuable homstead site to be utilized for sewage irrigation purposes; whilst that on the south side would be too close to the road. The areas on the western boundary at the interception of Yarrolumla Creek were inspected in the first place, but were abandoned as being too close to the city boundary. For a population of 18,000 people, an area of 200 acres would be required. I do not think that 60 inches per acre per annum, considering the great

evaporation in that climate, would be more than the land could absorb. In ordinary irrigation, only about 12 inches, in addition to the ordinary rainfall, is used; but, of course, the irrigation water is put on at the period when it is most used. In the Federal area; the evaporation on the lakes is equal to 3 feet per annum.

226. *To Mr. Finlayson.*—I think that if the effluent found its way into the Molonglo River *vid* Western Creek, it would be pure after passing over the large treatment area there. I do not think that the quantity of water that may be used by the residents in the Capital City for garden purposes will affect the sewage discharge. Water so used will be absorbed by the garden, so that there is no need to alter our calculations because of any possibility allowed for by Mr. Griffin of people using 80 to 100 gallons of water per day.

227. *To Mr. Sampson.*—I consider that water in that area is unwastable. Sewage irrigation farms, as a rule, just about pay expenses. I should consider that the running of the effluent into a stream would be an economic loss. By utilizing the effluent on the soil for irrigation purposes, there is an economic gain, even though a fair amount of expenditure is incurred in so doing. I do not say that the earnings from a sewage irrigation farm at Canberra would more than pay actual expenses.

228. *To Mr. Finlayson.*—I do not think that it is necessary to establish filter-beds in connexion with a system of septic tank treatment and irrigation; but, if any nuisance were caused by the effluent, filter-beds could be established later.

229. *To Mr. Sampson.*—Compared with the Emscher tank, I would prefer an anærobic tank, and the running of the effluent on to the land.

230. *To Senator Lynch.*—The main sewer and intercepting sewer shown on the plans follow the contour of the country, and take the direction which any sewer must take if the sewage is to be carried by gravitation. The plan is not absolutely rigid, however; there is a little margin to allow for any necessary amendment of the line shown on the plans. The sharp angle shown at the junction of the main with the intercepting sewer has been adopted in order to avoid a high rocky spur. I indorse the Director-General's contention in regard to the placing of the treatment works for the intermediate scheme at the Yarrolumla Creek in preference to the point to which Mr. Davis proposes to deviate the main. The creek is the natural site for the tanks.

231. *To Mr. Gregory.*—The creek-bed level at Western Creek, where we propose to put the treatment tank, is 1,790 feet. The sewage would then be lifted about 15 feet, which would mean that the level of the tank would be about 1,805 feet.

The witness withdrew.

Dr. Edward Robertson, Chairman of the Victorian Board of Health, and Permanent Head of the Health Department, made an affirmation, and was examined.

232. *To the Chairman.*—My practical experience of septic tanks is very limited. As the law stands at present, there is no obligation on the part of any one about to construct a septic tank to inform the Department of his intention. The result is that the Health authorities only step in when a complaint has been made. The complaints have been very few. I cannot say off-hand how many septic tanks there are in the metropolitan area, because only those of which a complaint is made come under my notice. From a health point of view the Department has objections to allowing the effluent from septic tanks to run into streams. We do not consider that any effluent from any septic tank is sufficiently pure to be allowed to flow into a stream used for domestic purposes. I refer to an effluent coming direct from the septic tank or the filter beds; we require land filtration. In regard to the plan showing the alternative sites suggested as a treatment area for the sewage of the Federal city, I should say that, from a health point of view, treatment works a mile from the city would be perfectly safe, so far as concerns any likelihood of a nuisance arising. As to the effect of sewage effluent being discharged into streams used for domestic purposes, pathogenic germs entering a stream will not multiply, but remain in a state of suspended animation. But when they get into a medium favorable to propagation and multiplication they would become dangerous. I would regard a running stream into which sewage effluent flowed as being potentially dangerous. Typhoid is the principal danger. I do not think you could be certain that typhoid germs had been entirely destroyed in a distance of 2, or even 5 miles. It is frequently suggested that a stream running quickly will purify quickly. On the other hand, there is a great danger of the germs being hurried on in a state of suspended animation, and they may be then taken into a dairy vessel, for instance, and when they come in contact with the milk, they may multiply. The water itself would probably do no harm, but it is when the germs get into a medium in which they may develop and become virulent that they are dangerous. If the water had passed through the septic tank and filter beds, and was then placed on the land from which it seeped into the stream, that land filtration would be a great protection. Of course, I am assuming that the septic tank is working properly, and that the effluent is purified to a great extent. All septic tanks do not do that. I am also supposing that the land filtration is superimposed upon the bacterial purification in the bacterial beds. By such treatment, it is quite possible to get an effluent which could be discharged into the stream after passing through the land, provided, of course, that the land has not been allowed to become sick. The quantity of sewage which can be safely put on land depends on the nature, depth, and porosity of the soil, and the amount of humus in it. I do not think it is possible to lay down any definite quantity which can be discharged on the land with safety. In the Old Country they have in parts taken ashes from the various factories, and worked it into the land with a view to providing a land filter bed. In those circumstances the land would deal with an infinitely greater amount of sewage than soil which had a large amount of clay in it. Clay soon becomes muddy on top, and the sewage then passes over the surface. Under those conditions the land would require to be continually worked and treated in sections so that each part would in turn get a spell. I would prefer to also grow a forage crop on the area which is being rested. I would not suggest the growing of vegetables.

233. *To Mr. Laird Smith.*—I would prefer the broad irrigation at Western Creek to the soil filtration at Yarrolumla Creek, because irrigation is a further stage of bacterial treatment in all cases. The bacterial bed in which purification takes place works in quite a similar manner to broad irrigation. The latter is practically the same process on a bigger scale, so that the sewage is receiving biological purification in the soil. No matter what sanitary measures you may adopt, you will have objections from the public. When the health-

authorities are about to declare a cemetery area, if that area is within a mile of a creek there is a tremendous outcry, notwithstanding that the soakage from a grave, if it ever reached the creek, would have passed through a mile of soil.

234. *To Mr. Finlayson.*—There is no big septic tank system in Victoria that I am aware of. Most of the tanks are small plants in connexion with hotels, houses, or institutions. The tank at Newport workshops does not allow of bacterial treatment in the way that is desirable because of the difficulty of keeping out some substances which are inimical to the process. The complaints we have had of septic tank installations have been merely because of the odours, not because of any disease experienced. In regard to the effect of odours on public health, one must take into consideration the personal equation. Some persons become ill because of these odours, and anything that causes people to be ill is detrimental to health. I do not know anything about septic tanks from an engineering point of view. They are firstly the consideration of the sanitary engineer, and secondly of an analytical chemist. The doctor is called in only when there is a nuisance. Where properly constructed and controlled septic tanks are not a nuisance from a public health point of view, they may be a nuisance, to some extent, at first, when they are ripening, but subsequently they work without causing any nuisance. In my opinion, land treatment is a necessary part of sewage disposal.

235. *To Senator Lynch.*—The only place in Victoria that is sewered is Melbourne. The big inland towns do not treat their sewage. In the majority of them the drainage runs into the streets, and on the northern plains, where the ground is quite flat, they have to depend on evaporation and soakage to get rid of the drainage. In some places, when nuisances are complained of, the council issues an order to the offending owner, to the effect that the drainage must not be allowed to go into the public streets, but must be provided for on the owner's land. Several councils are desirous of sewering their towns, and they will undertake that work as soon as the Local Government Bill empowering them to do so is passed by the State Parliament. Sewage should never be allowed to putrify. Fermentation may go on, but not putrefaction. Putrefaction occurs when the sewage is allowed to remain too long in the tank or sewer. Fermentation may set in to some extent from the moment sewage enters the pipes, but putrefaction is a secondary result from ordinary fermentation. Fermentation takes place when complex products are broken into simpler products, but putrefaction does not commence until gases are formed by some of the elementary forces set free by the fermentation process. I am not sufficiently acquainted with the Imhoff system to say whether it would be applicable at the Federal Capital. The Committee would require to get information on that point from places where tanks of that type have been actually in use. Mr. Hoan, of the Railway Department, has probably done more practical work in connexion with septic tanks than any other engineer in Melbourne. He is, perhaps, the only man in this State who has designed tanks, and controlled them afterwards. Such a valuable fertilizing material as the effluent from the septic system should be converted to the greatest economic use in the growing of fruit and fodder crops. I do not doubt that there is a possibility of getting some return for that material. Some people say that it repays the outlay when used on a small scale on their own gardens. I certainly think it would be a pity to waste the sewage effluent. There would not be enough room for soil filtration at a distance of a mile from the city. Land filtration is a necessary supplement to the bacterial bed. I would suggest the aerobic form of treatment as well as the land filtration. There would be a fairly perfect filtration of the effluent by pouring it direct on the soil. If the effluent is to be used for irrigation purposes, it could be taken direct from the septic tank, but if it is to be discharged into a stream, I should say that in all cases land filtration is a necessary supplementary work to the septic tank, and bacterial beds. That, I think, is the best form of treatment, I have no knowledge of the Werribee Sewage Farm. The only time the Board of Health was called upon to intervene in connexion with Werribee was when somebody suggested that the mutton derived from the sheep which ate the forage grown on the farm was unhealthy. We examined the mutton, and found that it was about the best on the market. If you are going to dispose of sewage direct on the land, a great deal depends on what state of division that sewage is in when it arrives. If the treatment area is close to the city there will not be the necessary disintegration of the solid particles when the sewage is placed on the land, and probably there will be a nuisance. A septic tank helps disintegration. The fact that the adoption of the more distant Western Creek treatment area would involve an additional cost of £40,000 for a sewer would not influence my preference for it from a sanitary point of view. I think, however, that the area indicated at Yarrolumla Creek would be sufficient to cater for the Federal City for the next twenty years, and the sewer could be extended afterwards when the city became greater. The Yarrolumla site could be utilized until then without any nuisance being caused.

236. *To Mr. Sampson.*—Complaints in regard to septic tanks have been comparatively few, and when we have inquired into them, we have found that the owners have not been taking care of their irrigation beds, and have allowed them to become sick.

237. *To Senator Story.*—When septic tanks are neglected, they fail to act properly, and cause a nuisance. If a tank were to receive a considerable amount of antiseptic drainage, it would be thrown out of working order, and then a nuisance would arise. Although people are given strong injunctions that they must not put disinfectants into the system, they still get there. Soapsuds tend to decompose, but they have very little disinfecting action. It is found that sewage which is devoid of fœcal matter will smell just as badly as fœcal matter; even soapsuds will do that. At Coode Island, the drainage of the whole establishment goes to a tank, but that tank receives no fœcal matter. We have to pump the drainage from that tank into big pans, where it is sterilized by steam, and the smell from that matter is infinitely worse than from any septic tank that has ever come under my notice.

238. *To Mr. Gregory.*—I do not know of any method of septic treatment of sewage which would allow of a safe discharge of the effluent into a stream such as the Molonglo River. It is true that the water supply of a portion of London is taken from the upper reaches of the Thames, into which I believe the drainage from Oxford and other settlements flows; but it must be remembered that the whole supply of London is filtered. I do not think that the harmfulness or otherwise of the effluent could be determined by an analysis of the water as it flowed from the tank, because no method of chemical analysis will disclose the presence of pathogenic germs. Looking for them is like looking for a needle in a haystack. If the land filtration is effective, the septic treatment will be fairly complete. In many places, especially in Germany and America, the effluent is treated with chlorinated lime as it leaves the bacterial bed, in order to kill the germs. That is about the best treatment of the effluent that I know of. Chlorinated lime is so cheap that it can be used fairly extensively. The effluent is run in channels in which chlorinated lime is placed. The quantity varies in accordance with the volume of the effluent, which has to run a certain distance before it can discharge. No public body has adopted the septic-tank system in the metropolitan area. Water carriage of sewage is certainly preferable to the pan system. One reason is that it mitigates the danger of typhoid, because the typhoid is all gathered into one receptacle instead of being in perhaps 50 per cent. of the pans in a township, and affording access to flies. The sewage effluent certainly contains organic material which water does not contain, and it is valuable to the extent of the organic material in excess of the natural amount in ordinary water. Moreover, that organic material is in a condition in which it can be taken up readily by plants, because a certain amount of nitrification will have taken place. The value of effluent from a septic tank depends on the industrial nature of the community from which it comes. Its origin in a manufacturing town, and the character of the factories in that town, would have its effect on the value of the sewage. The amount of flush has also an important bearing on its value. In Sydney they have a 2-gallon flush; here we have a 3-gallon flush, with the result that Melbourne sewage is much more diluted, which is an advantage in some respects, but not from a manurial point of view.

239. *To Mr. Laird Smith.*—As to whether there is any need to be so careful about the danger of typhoid arising from the sewage effluent, having regard to the success of inoculation, there is no doubt that the inoculations to date have demonstrated that those inoculated have had less incidence for typhoid than those not inoculated. I have seen a paper which states that immunity can be acquired by taking a preparation in a certain form into the mouth. Persons can carry this preparation, and immunize themselves from day to day. If that is so, such treatment must be very advantageous. One objection in connexion with septic tanks is the use of a spray for spreading the effluent from the tank over a bacterial bed. A smell is caused, inasmuch as, by spraying the effluent into the air, gases are liberated and carried to the surrounding districts. There is also the danger of a strong wind lifting the spray bodily, and it has been known to be blown a quarter of a mile. Such wind-blown spray may carry germs with it. Therefore I think that, in adopting any septic-tank system, the use of sprays should be avoided.

The witness withdrew.

APPENDICES.

APPENDIX A.

Commonwealth of Australia.
Department of Home Affairs,
151 Collins-street, Melbourne,
23rd February, 1915.

The Commonwealth Public Works Committee,
Wool Exchange, Melbourne.

GENTLEMEN,

In submitting citations herewith from the authorities in sanitary science, complying with your request of the 3rd inst., I instance chiefly general conclusions, and costs, because nothing is really required additional to facts already submitted to establish beyond controversy among those fully qualified and informed the necessity of following the whole *sanitary engineering policy* I have outlined for Canberra to obviate vast waste, ultimate dissatisfaction, and replacement.

However, it seems proper to again remind the members, and record the fact pointed out by me at Canberra, that *all operations and works contemplated* below the 1,825 level in the Molongio and Murrumbidgee Valleys within the Territory (embracing all the alternative suggestions for sewage disposal as well as features of the waterworks to which exception is taken) will be rendered a *total loss* in the event of creating the 33 square miles of water which my investigations have demonstrated to be practicable. This will be demanded at a certain stage of the city growth when an expenditure of a million pounds to take advantage of a providentially natural opportunity, will secure a mountain lake of constant level coinciding with the city basins, extending therefrom *continuously 50 miles through rugged* gorge and mountain scenery, making available directly by steamers from the heart of the Capital, several hundred miles of deep water frontage, and an infinitude of water view sites, establishing not only a continental attraction, *scarcely if at all to be matched in the world*, but contributing to the Capital Territory the one climatic amelioration and elemental feature needed *to raise mere* existence there on dry land to full rounded life associated with unlimited water facilities.

Yours truly,
W. B. GRIFFIN,
Federal Capital Director of
Design and Construction.

[EXCERPTS.]

DESCRIPTION OF THE WORKS OF THE BIRMINGHAM TAME AND REA DISTRICT DRAINAGE BOARD, 1912.

RE BIOLOGICAL BEDS VERSUS SEWAGE FARM.

John D. Watson, Engineer to the Board.

"In the spring of 1903 the Board instructed me to construct several bacteria beds on more permanent lines than the experimental beds which had been at work for *the previous two or three years. The excellent effluents* obtained, the large quantities of sewage purified on the limited area of the bacteria beds as compared with land, and the obviously hygienic advantages possessed by these beds, together with the fact that for irrigation it was *necessary to lay out nearly* 1¼ acres of land every week in order to keep pace with the population, all contributed to induce the Board to advance *along the lines* of biological treatment, and this notwithstanding the fact that the works sanctioned by Parliament in 1897 were all but completed."

"The Board have since constructed a biological plant, including *upwards of 54 acres of bacteria beds*, storm water tanks, sludge disposal works, &c., at the actual total cost, exclusive of land, of £386,350. This has been done, not because they regarded the principle of purification by land irrigation as bad in itself, nor *because they were dissatisfied* with any part of the engineering works required to utilize the land for that purpose, but because they felt it to be their duty, as representing the public, to see that their works were made as good as it was possible to make them in the light of modern discoveries, without an unreasonable demand upon the purse of the ratepayer, even though it should be necessary *to superimpose a new work upon* one which had so recently been characterized as the best available."

"The much-maligned sewage farm still may be allowed where the conditions are favorable) to rank as one of the best *methods of sewage disposal.* Diverse opinions may be held as to what are favorable conditions, particularly as conditions are sure to vary widely with *locality; but it may be assumed that where there is* 1 acre of land of a suitable kind per 100 persons, as *in Berlin and several other important cities, the* efficiently-worked sewage farm, when judged solely by the standard of the effluent produced, is still in the *front rank.* Effluents from such a farm are remarkable for their paucity of micro-organisms, their low *albuminoid ammonia, and their unvarying character.* These are advantages which obtain more or less over what may be termed the modern, *more hygienic, more* economical, and, in other respects, better method of purification advocated under the name of biological treatment."

"A sewage farm may be ideal in theory, but it is difficult, *if not impossible, to obtain the ideal on a farm* of large size. Nuisance need not necessarily arise, and the general conditions need not give rise to sickness or disease, but a process which fulfills the functions of oxidation and nitrification, with the least surface of *filtering area exposed to the atmosphere*, is (other conditions being equal) probably the process that should be adopted in the interests of the general public. Judged by this standard, a percolation bed possesses more than fifty times the value of the same area of land, indeed, nearly 100 times in the Tame Valley. Under ideal climatic conditions, sewage farming may fulfil the wishes of its most ardent *supporters; but in England* those conditions obtain in very rare instances only. Frequent rushes of storm water sewage flood the fields and upset all farming calculations. Wind and rain storms during darkness render the work of distribution *impossible, and, as the Irrigable land* is never perfectly level, the small earthern embankments or sluices are broken, and the sewage flows to the lowest ground, and sometimes from there to the adjacent river."

"The entailment of farming operations and the ex*tension of the area* used exclusively for sewage treatment, of what the late Mr. Bailey-Denton called downward intermittent filters, over the *major portion* of the Board's lands, turned a once smiling valley into an evil-smelling swamp, and brought reproach upon the *citizens.*"

"The policy adopted by the Board is to let such arable land *as is not required for their own* immediate purpose. At present the Board is farming 285 acres at Tyburn, 43 acres at Minworth, 80 acres at Colehall, and 14 acres at Acock's Green. At Tyburn the farm just pays. At Minworth there is still a loss, due to *the cost of redeeming the land* from the poisoned condition in which it was left after a period of irrigation with sewage containing metal salts. The position at Yardley has not been accurately ascertained."

"I have been asked whether the work of sewage *purification* has been carried as far as science is capable of carrying it, and my answer has been "No." We effect, by our works, a *purification equal to 93* per cent. on the oxygen absorbed basis; in other words, there still remains 7 per cent. of the impurity originally added to Birmingham drinking water to make that water into sewage, and, in my opinion, the cost of *removing that 7 per cent. would be absolutely pro*hibitive; indeed, the cost of increasing the purification figure from 93 per cent. to 98 per cent. would be out of all proportion to the benefits to be obtained, and under present conditions would be an unwarrantable *expenditure of public money.*"

THE AMERICAN MEDICAL ASSOCIATION.

REPORT OF THE COMMITTEE ON THE PURIFICATION OF SEWAGE, 5TH DECEMBER, 1911.

THE BIOLOGIC ASPECT.

By Arthur Lederer, M.D.

"Small communities, as a rule, pay attention to their sewage only when they begin to smell it. Their usual procedure in such a case is to have the engineer, who, in most cases, is a civil engineer by training, draw up *a design for a septic tank* or the like. Right here is where we need most enlightenment."

"Few people realize that ordinary domestic sewage in reality is very dilute as far as the solids in suspension and in solution are concerned. A content of 0.1 per *cent. of total solids* would be representative of a strong domestic American sewage, and more often it is likely to be considerably less. Of *this amount, a small portion* only on the average, about 25 per cent.—represents the solids in suspension. The odour of fresh sewage is not repugnant, as is commonly supposed. In small

bulk it appears as a slightly yellowish liquid, containing a varying amount of finely divided as well as coarse, suspended matter. The layman invariably pictures sewage as the dark putrid liquid found in stagnant *sewers or septic tanks.*"

"The aim in modern sewage disposal is to get rid of the small amount of *suspended matter present* as quickly as possible, and then to oxidize the fresh liquid on biologic filters should additional treatment be required. This view has been the result of a thorough study of the nature of the liquid. The only feasible method of *removing suspended matter* on a large scale is by allowing it to settle."

"During storage a goodly portion of the *finely divided* suspended matter will precipitate and black ferrous sulphide will be formed."

"As has been pointed out before, the modern tendency in sewage disposal is not to permit septic action previous to *biologic treatment such as takes* place on sprinkling-filters. The septic tank has been hailed as a panacea of sewage disposal for the last decade, and has been eagerly taken up by the small towns. The idea of eliminating the sludge question was an attractive *one. The actual digestion* of sludge in a septic tank has been found to vary in different places a great deal. There are very few cases in *which complete liquefaction* of sludge has occurred. Unlike septic tanks, as a rule, are not sources of putrefactive odours, as the layman *ordinarily* assumes, they unfound during the warm season a great deal of the lighter sludge. As a consequence, *the effluent is very often a great deal worse* than the raw sewage entering it, something which will never be the case in a well-operated settling tank. A happy combination of the principles both of settling and of sludge digestion can be found in the Emscher or Imhoff *tank. This tank permits* the escape of a fresh effluent, while the suspended matter settles, dropping into a separate sludge digestion chamber. Thus, the *upper* part acts as a plain settling tank. In the lower part, sludge digestion goes on distinctly separate from the *liquid portion* above. We can therefore classify the tank properly neither as a septic tank nor as a settling tank. The *principle of this form of tank is sound,* and seems to have met with great favour in the sanitary engineering profession."

AMERICAN MEDICAL ASSOCIATION, 1911.

REPORT OF THE COMMITTEE ON THE PURIFICATION OF SEWAGE.

THE ENGINEERING ASPECT.

By Rudolph Hering, Consulting Engineer, New York.

Sewage Purification to Prevent Disease.—"The engineer who is *called on to design works of this character* assumes from evidence furnished by the medical profession that excrementitious matter, laundry water, general wash water, &c.—in short, that sewage, as it is now generally produced in cities—may carry pathogenic *germs. He further assumes* that these germs may be destroyed by exposure to death, desiccation or sufficient aeration. He also assumes that they can be directly destroyed by contact with certain oxidizing materials, such as hypochlorite of lime and sodium. He finally assumes that most, and probably all, such germs will perish by convention if the easily putrescible liquids and the *solid organic matters in the sewage* are removed, or so far reduced that they no longer furnish sufficient means for sustaining germ life."

"The first practical result derived from these assumptions is that sewage should be divided into two parts: *the coarse liquids or solutions, carrying the finest* suspended particles, for which the name "colloids" is now used."

"The second practical result is that both of these parts must be specially treated if the destruction of the pathogenic bacteria is to be ascured. This treatment may be similar for both parts, but it is usually different. In all *cases, however, it depends on the physical and* financial opportunities for treatment."

"The solids that readily putrefy must be rapidly decomposed and converted into liquids and gases, and the liquids must be oxidized and converted into mineral *matter.*"

Sludge.—"The solid organic sewage matter should be further divided into two parts; that which is easily decomposed, such as animal and vegetable fluids and the softer cellular matter, and that which resists de*composition for some time, such as bones, hair,* epidermis, and the harder vegetable cellular matter. Disease germs are more likely to be nurtured by the non-resistant organic matter, or that which more easily breaks down or putrefies. It is highly probable that pathogenic bacteria perish as the non-resistant matter of sewage decomposes, and is converted into mineralized *liquids and gases.* There is no evidence at hand that the more resistant organic matter, such as forest or garden mold, old manure, *river or lake deposits,* retain or nourish the bacteria of disease."

"Therefore, with our present knowledge, the engineer should endeavour to cause as rapid decomposition of the non-resistant solid matter as practicable, so as to remove as *quickly as possible* the most favorable conditions for the survival of pathogenic bacteria."

"When discharged on land at *purification works there* are several methods available for dealing with the sludge."

"When sewage is at once turned on land for filtration, the solid particles remain at or near the surface. The *pathogenic bacteria may perish by* contact with sunlight and sufficient air, or by air alone, should they be washed into or penetrate the soil."

"When sewage is first allowed or caused to deposit its solid matter as sludge before it is further treated or discharged then the pathogenic bacteria contained therein may perish, *pari passu*, as the non-resistant *matter is decomposed, and all favorable nutriment dis*appears."

Liquids.—"The oxidation and *conversion of liquid or* dissolved organic sewage matter into mineral matter is accomplished by low organisms, ranging from insects *down to bacteria, which bring about* changes that remove the conditions of a suitable media for pathogenic germs. With sufficient time they will *perish. But such* sufficiency is not always available, and it is not always certain that all the germs are destroyed."

"If the necessity for their immediate destruction is paramount, then the effluent should be treated with *hypochlorites. This* can now be done in the same manner as destroying the pathogenic germs in potable water-supplies, which has recently *become quite common* because of the much larger quantity of organic matter contained in sewage than in potable water, the expense of such treatment will be much greater. On account of the greater expense, however, it would be cheaper, and, in fact, *safer in most cases, to treat the water supplies,* should they be taken from sources of questionable purity, than to treat the sewage effluents instead, beyond what would be required to prevent nuisances and a reasonable protection against propagating disease."

"This conclusion is proper for the reason that even were the sewage of a town sufficiently treated to wholly remove all *pathogenic bacteria there would still remain* the possibility—in any open water-course or lake—of a pollution with excrementitious matter from shipping, as from cases of "walking typhoid," or from shores, due to rain-water washings of the land, should a water *supply be taken further down the stream* for another community."

Sewage Purification to Prevent Nuisance.—"Most of the efforts made to purify sewage were made because of the desire to prevent the nuisance that results from its *rapid putrefaction.* This nuisance, further, is less one of sight than of odour. The offensive odours arise from a number of ill-smelling gases which are produced by bacterial decomposition of the non-resistant organic matter. The principal offender is hydrogen sulphid. Others are butyric acid, mercaptan, &c."

"A successful effort, there, will be that one which *succeeds in allowing decomposition of sewage to take* place without developing ill smelling gases. Therefore, we endeavour to secure it by oxidation or by the production of marsh gas (CH_4), carbonic acid (CO_2) and other inodorous gases."

"*As before*, we can find that this result can be best obtained by dividing sewage into two parts: the course solids or sludge, and the liquids, including the fine suspended matter. Each part must be specially treated, the kind of treatment also here depending on the physical and financial opportunities."

Sludge.—"The sludge, as mentioned above, consists of resistant and *non-resistant solid matter. It is the* latter alone which causes a nuisance. Animal and vegetable fluids and soft cellular matter as flesh or pulpy leaves, when life has ceased are rapidly attacked by bacteria. When decomposition is rapid, oxygen com*pounds are soon displaced by hydrogen compounds and* oxidation is supplanted by putrefaction. Under ordinary conditions hydrogen sulphid and other foul gases are produced. Until quite recently success was only moderate in preventing these foul odours which are due *to putrefaction.*"

"In the Emscher district of Germany, at Essen, it was found that with a deposition of the solids for one or two hours, the remaining sewage, thus relieved, could be satisfactorily discharged into open water-course It was also found, unexpectedly, that the decomposition of

the sludge in specially-made tanks resulted in the production chiefly of marsh gas and carbon dioxid; therefore, of non-odorous gases."

This discovery, made by Dr. K. Imhoff, chief engineer of the Emscher sewage works, was later tested at numerous places in Germany, and recently in two cities in this country. When the apparatus to accomplish this end received proper design and operation, the same non-odorous sludge and gases appeared in every case, although it is not yet clearly understood why the sulphur compounds are no longer produced in offensive quantities."

"The chief conditions required to obtain this result appear to be the passage of the sewage through a tank having a sedimentation chamber, which at the bottom is provided with sloping surfaces forming a slot, through which the solid particles can pass into a lower chamber for storage and decomposition, but so that the sloping surfaces project over each other sufficiently to prevent bubbles of gas which arise and bring up suspended matter from again entering the upper chamber."

"The sewage passes through the upper chamber in one to two hours. This short time does not allow it to become foul or septic, yet it is sufficiently long to allow practically all of the objectionable solid matter to settle out, the amounts being estimated at from 90 to 100 per cent. of such matter that is capable of settling within the time of passage. The sewage leaving the upper chamber is fairly fresh and non-odorous."

"The sludge is stored in the lower chamber for several months. It has fresh particles constantly depositing on the top. Throughout the mass there is a continual decomposition going on, indicated by bubbles of inodorous gases which are constantly rising. There is no circulation of liquids within the lower chamber. The rising gases keep the sludge sufficiently stirred up so that toxins do not accumulate to reduce the activity of the decompositions."

"At the bottom of the lower chamber, and under a depth of 20 to 30 feet of water, the sludge, after a sufficient time, is found to have lost practically all of its original non-resistant or putrescible matter. It has lost its slimy and gluttinous consistency, and has become friable and porous. In this condition it can be withdrawn from the bottom tank under the existing water pressure. When it issues, the compressed gases expand and lighten the sludge, so that it easily drains, and can be dried within a few days. It has a slight odour resembling burnt rubber, but this soon disappears, and the sludge resembles vegetable mould or garden soil, although hair and other resistant animal matter is often still seen therein."

"The first experiments in our country with this inodorous sludge decomposition effected in Imhoff tanks were made in Philadelphia and Chicago. Although our American sewage is much more dilute than European sewage, the results with the sludge obtained in both of these cities were practically the same as those in Europe. We, therefore, have every reason to believe that this new method of sludge treatment will have a pretty general application in our country, and will at last make it possible to prevent the present nuisances where sewage sludge is handled.

Liquids.—The liquid sewage, after about two hours sedimentation, still has a large amount of fine colloidal matter in suspension. It has been found, however, that this fine matter can be best treated together with the liquids containing organic matter in solution."

"Near its origin, sewage contains very little organic matter in solution other than urine. Nearly all of the organic matter is practically in suspension. But after it has been flowing for hours in a sewer a large amount of the suspended matter is dissolved, so that analyses after indicate about equal quantities of organic matter in solution and suspension."

"In that condition the liquid sewage soon becomes foul unless it is treated. The only satisfactory and economical way of treating it inoffensively is by oxidation. This can be secured by bringing the sewage into contact with sufficient air under conditions favorable for bacterial life."

"When liquid sewage must be purified on land, the oxygen is obtained from the atmosphere. To have sufficient contact with it it is necessary to cause the sewage to be spread out over a large surface as a thin film, in which the bacteria abound, and to which the air has ready and thorough access. Experience has shown it necessary to have on an average from 300 to 600 square feet of bacterial surface per inhabitant. This condition is obtained by intermittent filtration through grains of sand, by the sewage spreading over and wetting the sand grains, so that the above required bacterial surface per inhabitant can be obtained within a few square feet of filter surface."

"Oxidation is also obtained by sprinkling filters made of coarse-grained material. The sewage is spread over it by a sprinkling process, and the oxidation proceeds as above. The coarse-grained filters utilize, in addition to bacteria, the activity of insect life that abounds in them."

"Finally, oxidation is obtained also by so-called coarse-grained contact beds, in which the liquid sewage is allowed to fill the entire bed and wet the surfaces of the material. After each dose the surplus liquid is drawn out, so that the retained liquid may be oxidized by the penetrating air. Several repetitions of this process may finally oxidize all the non-resistant organic matter contained in the liquid."

"All these oxidizing processes can effect an inoffensive purification of the liquid when it has not been allowed to become septic. It is, therefore, now greatly to be desired that sewage be delivered to the works as fresh as practicable."

REPORT ON SEWAGE DISPOSAL, 12TH OCTOBER, 1911.

George M. Wisner, Chief Engineer, Sanitary District of Chicago.

"*Sewage Farms.*—Although farming has been practised for the last fifty years abroad, and for thirty or more years in the United States, it is a method which is being rapidly discarded for other more economical means of treatment. The area of land required is very large. The character of the soil must be just right, and the climate favorable. At best the process is expensive, except where the sewage has a cash value for the water contents for irrigation. In Chicago none of the elements are present for success. The soil is poor. The sewage farm at Pullman was a failure. The rainfall here is sufficient to irrigate the land for all ordinary crops. Winter weather interferes seriously with, and may stop altogether the work of purification, particularly in long continued freezing weather. In Chicago, the cost would be prohibitive. Abroad, Berlin and Paris, for many years the leaders in sewage farming, are seeking biological means of treatment, and Paris is gradually abandoning the older sewage farms."

"Quiescent sedimentation with three hours' duration, will remove practically all of the settling suspended matter. The reduction in putrescibility is marked, but the indications are that the reduction in putrescibility is marked not nearly so great as the reduction in suspended matter, the amount varying with the proportion of volatile and fixed matter as well as the relation of suspended matter to the total solids and their respective compositions. Tests on various scales indicate from 12 to 100 per cent. removal of the suspended matter."

"From tests 15 to 20 per cent. improvement may easily be expected. Of the means available to-day for sedimentation, in combination with sludge disposal the Emscher type of tank is believed to be the most effective. Sprinkling filters dosed at a rate to yield from 2½ to 3 million gallons per acre per day (approximately, 1,000 people to the acre), will give a very stable effluent containing sufficient oxygen to effect its own self-purification. If this liquid be settled quickly in an Emscher tank the sludge can be easily removed. Secondary settling basins are important in the case of the sanitary district, with limited dilution, to remove sludge which would otherwise settle behind dams, &c., which tend to hold back the settling suspended matter."

"As a basis for comparative estimates, the installation of Emscher tanks for settling the sewage has been selected for the larger sewer districts. The population has been estimated from the ward divisions and precincts, the growth being extended from 1910 to 1930 at the same rate as the growth from 1900 to 1910. The year 1930 has been selected as a suitable year to design to, since whatever goes into service around 1920 should be capable of serving for ten years thereafter. It will be entirely possible to extend this design to a date beyond 1930, but it is not thought advisable to do so at this time. For the purpose of these estimates the costs have been made on a *per capita* basis. The tanks taken as a unit have a nominal settling capacity at a two-hour period of about 300 gallons *per capita* daily, and a volume available for sludge storage for a period of six months. This is essentially the same basis as that used at Atlanta Ga., which agrees very closely with the results obtained in our experimental tank and allows a desirable leeway in flows."

"Comparative figures of an approximate nature are submitted here on the different types of settling tanks. The quantities are based on the design used for Emscher tanks at Atlanta, and the vertical settling tanks of the Dortmund type used at Gloversville, and the rectangular straight flow settling basins, comparatively shallow as used at Columbus, Ohio, in order to see how much greater is the cost of the Emscher type of tank. Excavation is included from the top of the tank down.

Comparative Cost of Tanks.

Type of Tank.	Nominal Period of Settling.	Gallons per Capita Daily.	Cost per Capita.
			s. d.
Emscher ..	2 hours (a)	200	1.44=6 0
Dortmund ..	4 hours (a)	200	.84=3 6
Straight Flow ...	8 hours	200	.77=3 2½
Straight Flow ..	6 hours	200	.58=2 5

(a) In both these periods the sludge storage is not calculated in determining the nominal period of settling.

"Although the first cost of the Emscher type of tank is considerably higher than of the others, the amount of sludge removed to be handled is much less, and it is our opinion that this type of tank is the most suitable and inexpensive in the long run, when the cost of handling the removed sludge is taken into consideration. It also causes less of a local nuisance. For the purpose of this report, therefore, the Emscher tank has been taken as the desired standard in estimating the relative costs for the various sized plants that are considered.

Plant to Handle Population.	*Cost Per Capita.*
10,000 to 100,000	$1.50 = 6s. 3d.
100,000 to 500,000	$1.40 = 5s. 10d.

"In the larger plants, however, certain allowances will have to be added for a main system of distribution and return conduits, which are not required in the small units, the unit distribution and effluent system being ample. In addition, allowance must be made for excavation from the ground surface to the water line of the tanks. Excavation below the top of the tank is included in the round figure *per capita*.

"*Areas required.*—From a study of the plans of various types of settling basins, I find that an allowance should be made 0.5 to 1.1 square feet *per capita* with the flows to be expected in Chicago. For the Emscher tank of the design in mind 0.63 square feet *per capita* is a reasonable net area, and an allowance of 1 square foot *per capita* is a reasonable gross area to cover the tanks and appurtenances, but not the sludge drying or sludge disposal.

"*Sludge Drying Bed.*—From a study of the designs abroad, the Atlanta design, and our experience at Thirty-ninth-street testing station, I am satisfied that an allowance of 0.3 square feet *per capita* net area is reasonable for the sludge drying bed. For the gross area to include tracks, dykes, distribution, &c., about 0.5 square feet *per capita* is required. The cost may be taken in round figures at 15 cents *per capita*, including appurtenances."

"The Emscher tank offers the best advantages, giving a thoroughly digested sludge, in less quantities than from other processes. It dries rapidly, and is practically odourless.

"*Sprinkling Filters—Cost.*—Sprinkling filters are estimated to average 6 ft. 4 in. in depth of crushed stone. In general, they can be built for about $28,000 per acre, and will handle 2.5 million gallons per acre of sewage per day.

"This is the equivalent of a population of 10,000 people. It therefore means that the cost of the sprinkling filters will amount approximately to $2.80 *per capita*. On large plants this would be somewhat reduced. The incidental cost of appurtenances will be about $1.00 *per capita*, making a total of about $3.80 *per capita*, which is considered reasonable for first-class construction.

[Note estimated total cost *per capita* $1.50 + 2.80 + 1.000 = 5.30 for 200—250 gallons *per capita* per day. Or for 10,000 population £11,000.]"

REPORT FROM THE SEWERAGE DIVISION OF THE EMSCHER ASSOCIATIONS.

Dr. Ing. Fr. Spillner, 1910.

"*Decline of the Septic Method.*—"Large plants are constantly being converted from the septic tank process to plain sedimentation. In Manchester, *e.g.*, whole rows of septic tanks—one-third of the entire installation—have been changed to sedimentation tanks, and, in Birmingham also, which has the largest plant in the world, the greater number of the former septic tanks have been changed to tanks for plain sedimentation, in spite of the objectionable characteristics of fresh sludge.

"Former advocates of the septic principle are now constructing sedimentation plants, *e.g.*, Travis, at Norwich, in which not only is the sewage to remain fresh, but by which the sludge is to be removed at short intervals, as in the process of plain sedimentation."

"*Emscher Tanks—Action in the Sludge Chamber.*—The sludge flows from the sedimentation chamber into a well-shaped compartment below, in which it remains, on an average, two or three months."

"The processes which go on in this sludge chamber, so far as they have been ascertained, are essentially different from the putrefaction in ordinary septic tanks with currents passing through them; for the gases escaping in large quantities, unlike those in septic tanks, contain very little hydrogen sulphide. They consist mostly of methane and carbonic acid. The apparent cause of this phenomenon is the fact that the liquid covering and surrounding the sludge is renewed to but a very slight extent. It becomes accordingly thoroughly septic very quickly. The albuminous matters that have been set free in it are decomposed, and can form no more hydrogen sulphide. In septic treatment, on the other hand, fresh sewage is continually brought into contact with the putrefying sludge and decomposes, so that the suspended as well as the dissolved albuminous matters are continually being acted upon, developing hydrogen sulphide."

"The sludge is drawn off through iron pipes which reach to the bottom of the tanks, and lead out through the side of the tank about 3½ feet (1 m.) below the surface. When the valve closing the end of the pipe projecting into the tank is opened the sludge is forced out by the weight of the liquid. This does not interrupt the process of clarification."

"*Odour.*—The odour of wet Emscher sludge can only be detected near by, and is only noticeable when it has been warmed to 158° or 176° F. (70° or 80° C.). It smells like rubber, or sometimes like tar or peptone. No disagreeable odours can be perceived a few feet away, even when the sludge is being drawn off."

"Decomposed sludge does not clog the beds."

"*Drainage Water.*—It shows that the drainage water meets the demands of a biologically pure water, for the nitrogen is almost entirely mineralized and the liquids show no sign of putrefaction (H. S. reaction) even when kept for ten days in a closed bottle."

"*Removal of Drainage Sludge.*—At one of these plants (Hocklinghausen-Ost) the drained sludge is sold as a fertilizer to the farmers at 12 cents (50 pfg.) per cart load (at the dumping ground). In the three years during which this plant has been in operation, the demand has exceeded the supply, so that the sludge is usually sold long before it is prepared."

YEARLY COSTS.

Cost of Operation and Maintenance.

	Name of Plant.		
	Recklinghausen.	Bochum.	Essen N.W.
Tributary population ...	30,000	145,000	60,000
Dry weather flow of sewage mill ... ... gallons per day	2.88	13.92	12.60
Total annual expenses $	2,355	10,188	6,155
Total annual cost per head of population ... $	0 0785	0.0803	0.1026
Total annual cost per mill gallons ... ... $	2.71	2.11	1.33
Annual expense for operation and maintenance .... $	750	3,600	2,200
Annual expense for operation and maintenance per head $	0 0250	0 0248	0.0367

SLUDGE TREATMENT IN THE UNITED STATES.

Kenneth Allen, 1912, Engineer Metropolitan Sewerage Commission of New York.

"The quite common use of the septic tank has, in a measure, simplified the sludge problem, and with the anticipated adoption of the Emscher tank by many towns within a short time another step forward will have been taken.

From the marked advantages in sedimentation processes carried on in conjunction with a special sludge chamber it seems probable that the Emscher tank, in its present or a modified form, is destined to play an important part in sewage treatment in America for some time to come."

RE EMSCHER SYSTEM.

Kinnicutt, Winslow, and Pratt, 1912, Sewage Disposal, pp. 101-2.

"Whatever the explanation may be, practical experience in the Emscher Valley, extending in some cases over a period of five years, indicates that this process may, under proper conditions, be operated so as to yield a reasonably clear and inoffensive effluent and a compact and inodorous sludge with no local nuisance even in the immediate vicinity of the plant.

"If the expectations of the friends of the Imhoff tank are justified with other sewage, it will indeed prove to be 'the greatest step in advance that has been taken in the field of sewage disposal during the past five years.' (Fuller, 1911.)"

"An experimental tank of this type at Philadelphia (1911) has already yielded excellent results with regard to inoffensiveness of effluent and sludge, and American engineers will soon have an opportunity of seeing the process in operation on a practical scale at Atlanta, Ga."

Chas. Sarlle, Consulting Sanitary Engineer, Journal of the Association of English Societies, 1911.

EMSCHER SYSTEM.

"The dried sludge is less than 10 per cent. of the volume of the fresh sludge as originally deposited in the tank. One square foot of (drying) area is ordinarily provided for every three persons, and it has been found that one man (the caretaker of the disposal works) can handle the sludge from 30,000 people. The sludge, when removed from the drying beds, is so unobjectionable that the wives of the peasants who buy it for fertilizer help to load the waggons."

1912, SEWAGE DISPOSAL.

George W. Fuller, M.A.S.C.E., A.M.C.E., A.S.M.E., &c., Consulting Engineer, New York.

"Each project should receive the cheapest method of treatment that will regularly give adequately suitable results.

"Highly septicized sewages may be nitrified only with difficulty.

"In filtration processes in general it is apparently something of a handicap for the influent to possess the results of bacterial activities along anaerobic lines, because it is necessary for the filter to maintain these functions on an aerobic basis, thus calling for more or less of a re-establishment of the mode of bacterial life. Furthermore, some decomposition products are of a toxic nature with respect to the bacteria that it is destined to cultivate. Hence, there is no question about septic action being capable, if carried too far, of doing more harm than good.

"The formation of toxins by over-septicization should be guarded against in designing a plant as far as practicable.

"It is regarded in America, by those best informed, as the device affording by far the most advantageous conditions not only for the clarification of sewage, but also for the digestion of the sludge, so that the latter may be disposed of economically and without odour.

"Plants of this type have been recommended in several dozen instances, so that it may be fairly said that this device has established for itself a well-recognised standing as embodying the most successful steps in the process of preliminary treatment of sewage by means of clarification, and particularly as to the disposal of the sewage sludge in an inoffensive condition at minimum expense and with a minimum likelihood of odours.

"The dry sludge is porous, more or less, resembling garden soil, and supports vegetation. It may be used for filling or fertilizing purposes.

"The effluent of the sludge bed is found to be non-putrescible and free from objectionable bacteria, so that it may be discharged directly into a stream.

"Especially it is to be pointed out that the automatic removal of the deposit by its gravity flow through the slot into the lower compartment minimises the effect of scouring velocities, and there is noted in the effluent practically no gas-lifted particles of sludge.

"The preponderance of evidence from experimental plants at Philadelphia and Chicago, as well as the observations as to the operations on a practical scale in the Emscher district, indicate that freedom from odour is one of the marked advantages of this treatment."

Broad Irrigation.—Professor Williams, in his statement, in the *Engineering Record* of 24th February, 1912, says that broad irrigation is wasteful of water in arid regions, and that, with few exceptions, the irrigating duty of the sewage is reduced as compared with what would be obtained with clear water. He states that raw sewage seldom serves more than one-third to one-half as much area as the same quantity of clear water or well-filtered sewage.

From a financial aspect it means that where water is scarce than land raw sewage so reduces the duty or irrigating power of the liquid that it continues a serious drawback to the method.

Manurial Value.—"How far sewage is of practical fertilizing value is a matter upon which we are not informed. Some of the constituents may be only partially available for manurial purposes. They may pass quickly with the effluent beyond the reach of growing crops. Others may be retained at or near the surface under conditions where they are only of limited value. Still, again, it is to be pointed out that when sewage, with its enormous dilution of fertilizing elements, is applied to land as a regular procedure, its value as a fertilizer may become practically nil."

In the *Engineering News* of 24th November, 1910, Professor J. A. Voelcker, consulting chemist to The Royal Agricultural Society of England, states in a paper "the manurial value of sewage, as it is now generally met with, and whether it be in the form of crude sewage, of sewage deprived of its solid matters, or of sewage sludge, is but very small.

"Perhaps 100 persons connected with the sewers for each acre of land is as fair a figure as can be given as to the ordinary loading. With clay soils serious surface clogging may result when the load is one-fifth, or even one-tenth, of this figure.

Résumé.—"In America broad irrigation or sewage farming is not practised to-day, even in the arid regions, so as to give satisfactory results for the sanitary disposal of sewage. There may be scattering exceptions to this statement, but an examination of the present facts does not bear out earlier reports that broad irrigation is really used regularly and carefully in numerous places.

"Objections to the method have increased rather than decreased in recent years. These relate to objectionable odours, prejudice against the use of sewage in growing vegetables, and to the transmission of disease germs by flies and other insects.

"Experience shows that only nominal aid financially has been received from the use of sewage in broad irrigation. The present outlook is that broad irrigation or sewage farming is decidedly on the wane with little prospects of adoption even in the arid districts, except, perhaps, for an occasional project where local conditions are unusually favorable."

Contact Filters.—"Contact filters, however, have certain distinct fields of usefulness. This is partly on account of the smaller head which they require for their operation as compared with sprinkling filters, thus allowing in some instances a gravity flow through the plant, where pumping would be required for sprinkling filters. Their standing is also partly accounted for in small installations by the desire to avoid the odours incident to filters of the sprinkling type. This feature causes them to be viewed with less prejudice by neighbouring property-holders than sprinkling filters, this is particularly true where double contact filters are filled from below to within some 4 to 6 inches from the surface, thus preventing in a suitably-designed plant the sewage from being exposed to view until it has reached an odourless state.

"General evidence now available in America shows that contact beds will give a non-putrescible effluent when on an average they treat from 125,000 to 150,000 gallons per acre daily for each foot in depth of effective filtering material.

"Well-managed freedom from odours can be maintained in a manner satisfactory to the most fastidious, and to an extent not afforded by any other method of filtration available for fairly sizeable plants.

"Exclusive of land, outfall sewers, pumping stations, &c., contact filters by themselves cost per acre 16,000 to 35,000 dollars depending upon the amount of excavation, the size and design of the individual filter units and the cost in place of suitable filtering material.

Sprinkling Filters.—"Sprinkling filters, by themselves, are not normally a complete working process, yet they constitute the greatest step in advance during the first half decade of this century in the field of sewage purification in America. Highly important work has since been done, and is being now done, in adapting them for most

advantageous use with other steps in sewage treatment, all with a view to minimizing odours and securing reliability of performance at least cost. They are far more economical than intermittent sand filters or contact filters. Unless the sewage is fresh they are likely to produce more odour around the plant than are contact filters, and hence they are usually isolated to a greater extent than contact filters.

"The practice of the author recently has been to specify for average conditions a 6-foot filter at an average rate of about 2,000,000 gallons per acre daily. This would be for a sewage flow of separate sewers approximating 160 gallons *per capita* daily. Where it is necessary to secure a high grade of purification during the winter months in a severe climate, the recent tendency has been to lower this rate somewhat, depending on local conditions.

"Compared with contact filters, it may be said that sprinkling filters give approximately equal efficiency with a rate of filtration three to four times as high as those described in the preceding chapter on contact filters.

"*The Odour Question.*—When sewage that is fairly fresh is applied to sprinkling filters there is no noticeable odour more than about 100 yards away, according to Harding experiences. With fresh sewage the odour resembles a laundry odour, or that of a raw turnip. It is not the odour of 'putrefaction.'

"When sprinkling filters receive sewage that is in an advanced stage of anaerobic decomposition so-called putrefactive odours are conspicuous at some distance from the plant.

Speaking generally, a sprinkling filter plant of small or moderate size should be located not nearer than 0.125 miles from built-up streets."

Appendix B.

CANBERRA SEWERAGE SCHEMES.

Forecast of Capital Expenditure and Interest on Basis of 18,000 People, in the Year 1935.

Engineering Projects.	Respective Schemes.	Cost Per Five Year Periods.								Total for Periods.		Grand Total Capital and Interest.
		1915-1920.		1920-1925.		1925-1930.		1930-1935.		1915-1935.		
		Prime.	Annual.	Prime.	Annual.	Prime.	Annual.	Prime.	Annual.	Prime.	Annual.	
Outfall Sewer, 5 per cent	Home Affairs	75,000	*12,500	..	18,750	..	18,750	..	18,750	75,000	68,750	..
	Mr. Davis ..	40,000	*6,600	..	10,000	..	10,000	40,000	10,000 *6,000	80,000	42,600	..
Treatment Tanks, each unit, 5 per cent.	Home Affairs	9,000	*1,350	6,000	2,250 *1,000	6,000	3,750 *1,000	6,000	5,250 *1,000	27,000	15,600	..
	Mr. Davis ..	9,000	*12,020	6,000	13,370 *1,500	6,000	15,625 *1,500	27,000	17,900 *4,050	48,000	25,965	..
Pumps, Power Line, &c., 10 per cent.	Home Affairs	1,000	*300	..	500	1,000	500 *300	..	1,000	2,000	2,600	..
	Mr. Davis ...	12,000	*600	..	1,000	1,000	*1,000 300	2,000	1,500 *600	5,000	5,000	..
Treatment Area, 5 per cent.	Home Affairs	250	65	250	130	250	125	..	125	750	585	..
	Mr. Davis ..	3,000	1,120	..	1,120	3,000	2,240	500	2,240 125	6,500	6,845	..
Period Totals ..	Home Affairs	85,250	14,215	6,250	22,630	7,250	24,125	6,000	26,125	104,750	87,535	192,285
	Mr. Davis ..	64,000	10,310	6,000	16,000	10,000	29,625	69,500	32,415	139,500	80,410	219,910

* For three years. † Including sinking fund at 3 per cent. ‡ Including power line.

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