1923-4.

THE PARLIAMENT OF THE COMMONWEALTH OF AUSTRALIA.

PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS.

REPORT

TOGETHER WITH

MINUTES OF EVIDENCE

IN REGARD TO

CONSTRUCTION OF SOUTHERN INTERCEPTING SEWER, CANBERRA.

Presented pursuant to Statute; ordered to be printed, 2nd September, 1924.

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MEMBERS OF THE PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS.

(Fourth Committee.)

The Honorable HENRY GREGORY, M.P., Chairman.

Senate.	*House of Representatives.*
Senator John Barnes.†	Arthur Blakeley, Esq., M.P.
Senator Hattil Spencer Foll.‡	Robert Cook, Esq., M.P.
Senator Patrick Joseph Lynch.†	David Sydney Jackson, Esq., M.P.
Senator John Newland.‡	George Hugh Mackay, Esq., M.P.
Senator William Plain.*	James Mathews, Esq., M.P.
Senator Matthew Reid.†	

* Ceased to be a Member of the Senate, 30th June, 1923. † Appointed 5th July, 1923. ‡ Resigned 28th June, 1923.

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LIST OF WITNESSES.

EXTRACT FROM THE VOTES AND PROCEEDINGS OF THE HOUSE OF REPRESENTATIVES.

No. 91 of 31ST JULY, 1924.

15. PUBLIC WORKS COMMITTEE—REFERENCE OF WORK—FEDERAL CAPITAL CITY—SEWERAGE EXTENSION.—Mr. Stewart (Minister for Works and Railways) moved, pursuant to notice, That, in accordance with the provisions of the *Commonwealth Public Works Committee Act* 1913–1921, the following proposed work be referred to the Parliamentary Standing Committee on Public Works, for investigation and report, viz. :—Federal Capital—Southern Intercepting Sewer—Extension of Main Intercepting Sewer within City boundary from Commonwealth Avenue to Eastlake.

Mr. Stewart having laid on the Table plans, &c., in connexion with the proposed work—

Question—put and passed.

SOUTHERN INTERCEPTING SEWER, CANBERRA.

REPORT.

The Parliamentary Standing Committee on Public Works, to which the House of Representatives referred for investigation and report the question of the construction of a southern intercepting sewer at Canberra—being an extension of the main intercepting sewer within the City boundary from Commonwealth Avenue to Eastlake—has the honour to report as follows :—

INTRODUCTORY.

1. In March, 1915, the Parliamentary Standing Committee on Public Works submitted to Parliament a report on a proposal to construct a main outfall sewer from the western boundary of the City of Canberra to Western Creek, a distance of approximately 3 miles. After exhaustive investigation of the project, involving also the question of the treatment of sewage and the disposal of the effluent at Western Creek, the Committee recommended that the work be proceeded with. Work on this project was suspended from 1917 to 1922, but its construction is now approaching completion.

2. In April, 1922, the construction of a main intercepting sewer to connect the main outfall sewer with the centre of the City was similarly approved, and its construction is well advanced.

PRESENT PROPOSAL.

3. It is now proposed to proceed with the next stage, viz., the southern intercepting sewer leading from the end of the main intercepting sewer in the vicinity of the centre of the City towards the eastern boundary, that is, from Commonwealth Avenue to Eastlake. This development is in conformity with the scheme prepared by the Federal Capital Advisory Committee in its First General Report.

4. It is represented that it is necessary that the work now proposed be put in hand at an early date in order to collect sewage from Blandfordia and the Power House districts, in which settlement is rapidly increasing. It will thus replace local treatment works, which have been so arranged that the reticulation thereto may easily be connected to this intercepting sewer when completed.

ESTIMATED COST.

5. The estimated cost of the section now under consideration is set down at £47,000, and the time fixed for completion nine months from date of commencement.

COMMITTEE'S INVESTIGATIONS.

6. As the Committee had visited Canberra and examined members of the Federal Capital Advisory Committee in connexion with the report on the main intercepting sewer already presented, and as considerable evidence was then taken embracing the whole sewerage scheme for Canberra, the present inquiry has been restricted to such details as concern only this section.

7. The main intercepting sewer is of a size 5 ft. 6 in. by 3 ft. 8 in. This section is a reinforced concrete pipe of 21 inches diameter, constructed of suitable lengths, and with a concrete surround.

8. The gradient of the section will be 1 in 550, which the evidence shows is suitable for an intercepting sewer of this character. The length of the section is given as 6,721 feet, or about $1\frac{1}{3}$ miles, and it will be laid at an average depth of 50 feet below ground level.

9. Man-holes are to be provided at an average distance of 420 feet apart, and vent stacks for the purpose of carrying off dangerous or offensive gases will be provided where considered necessary.

10. It was stated in evidence that the class of material likely to be met with in the course of construction included clay, sand, schist, and limestone rock, while much water would be encountered in places.

11. Computed on the basis of a prospective population of 100,000 for Canberra, this section is designed to serve 40,000 of that total, made up as follows :—

Between Commonwealth Avenue and Waratah Parkway ..	22,000
Above Waratah Parkway (Interlake Avenue Valley)	8,000
Outside City area—prospective population	10,000
	40,000

Running at full capacity, however, it could provide for a maximum population of 80,000.

COMMITTEE'S RECOMMENDATION.

12. After giving the matter due consideration, the Committee is satisfied that for the general development of Canberra the southern intercepting sewer proposed is necessary, and recommends that the work be proceeded with as early as possible.

P. J. LYNCH,
Vice-Chairman.

Office of the Parliamentary Standing Committee on Public Works,
Parliament House, Melbourne, 21st August, 1924.

MINUTES OF EVIDENCE.

(Taken at Melbourne.)

TUESDAY, 12TH AUGUST, 1924.

Present:

Senator LYNCH, in the chair;

Senator Barnes	Mr. Jackson
Senator Reid	Mr. Mackay
Mr. Cook	Mr. Mathews.

Thomas Hill, Chief Engineer, Department of Works and Railways, sworn and examined.

1. *To Senator Lynch.*—The proposal now put forward provides for the further development of the main sewerage scheme for Canberra, portions of which have already been investigated by the Public Works Committee, and approved by Parliament. In 1915, the main outfall sewer from the city boundary to Western Creek—a distance of 3 miles—was approved, and its construction is approaching completion. In 1922, the main intercepting sewer connecting the main outfall sewer to the centre of the city was similarly approved, and its construction is well advanced. It is now proposed to proceed with the next stage, viz., the southern intercepting sewer leading from the centre of the city towards the eastern boundary, that is, from Commonwealth-avenue to Eastlake. This development is in conformity with the scheme prepared by the Federal Capital Advisory Committee in its first general report. It is necessary that the work be put in hand at an early date to collect sewage from Blandfordia and the power-house districts in which settlement is rapidly increasing. The area shown in pink on the plan exhibited is that portion of the Capital which is shortly to be offered for sale on lease. It will thus replace local treatment works which have been so arranged that the reticulation thereto may easily be connected to this intercepting sewer when completed. Plans and details of the proposed work are submitted herewith. Its construction would be carried out with local materials. The length of the section is about 6,721 feet, or about $1\frac{1}{3}$ miles, and its estimated cost is £47,000. Particulars of the proposed sewer are as under—

Length	6,721 feet.
Diameter	21 in.
Slope, or fall	1 in 550
Average depth below surface ...	50 feet.
Maximum ,, ,, ,, ...	66 feet.
Minimum ,, ,, ,, ...	22 feet.

Capacity.	Cub. feet per min.	Velocity.
Full 4,000,000 gals. in 24 hours ..		3·4 ft. per sec.
$\frac{3}{4}$ full 3,500,000 ,, ,, =	420	3·7 ,, ,,
$\frac{1}{4}$ full 600,000 ,, ,, =	71	2·6 ,, ,,
$\frac{1}{10}$ full 100,000 ,, ,, =	12	1·7 ,, ,,

Maximum distance apart of manholes—630 feet.

Average distance apart of manholes—420 feet.

Penstocks or Valves—Two in number, cast-iron frames, gunmetal faces.

Material in Sewer.—Reinforced concrete pipes, suitable lengths, to lay and to handle. ("Monier," 3 ft. 7 in.; "Hume," 6 feet), butt joints, concrete surround, 7 to 1.

The pipes will be simply butted together and surrounded with a little hessian, and then concrete about 6 inches thick will be placed around the pipes. The remainder of the excavation will be filled in with the excavated material.

Manholes, concrete, in proportions of six to one.

Nature of Ground to be met with.—Clay and sand, schist, limestone rock. Much water in parts.

We have put down bores as shown on plan 166A. From those trial shafts, and from the surface indications, we have learned the nature of the ground. In the low-lying portions we expect to meet with clay and sand, and in other parts, schist and limestone rock, while in other places a fair amount of water will be encountered.

Population to be provided for computed on basis of diagram of prospective population of Canberra (total, 100,000).

This sewer would serve 40,000 of the 100,000, made up as follows:—

Between Commonwealth-avenue and Waratah-parkway	22,000
Above Waratah-parkway (Interlake Avenue Valley)	8,000
Outside city area—prospective population	10,000
Total	40,000

I shall deal first with the estimated population. The plan before us shows the city area—the square dealt with in the original competitions. It is a square commencing at Ainslie and running westerly to near Black Mountain, thence due south to a point not far from Red Hill, thence due east to a point known as Interlake, returning in a northerly direction to Ainslie. Each side of that square is approximately $3\frac{1}{2}$ miles long, and in that area the population is estimated to reach 100,000 people. Each of the areas, A, B, C, D, E, F, G, H, I, J, K, and L is a valley, which will have a pipe running down the centre to meet this intercepting sewer. The pipes in the valleys will be about 9 inches in diameter. The estimated population in each valley is shown, and varies from 14,000 in valleys K and F to as low as 1,000 in the small area H. Area A around Black Mountain is devoted wholly to forestry. For the purpose of this particular work we have to deal with area K, with an estimated population of 14,000, and area L, whose population is estimated at 8,000, and, in addition, a section outside the square extending from near the power-house towards Queanbeyan, for which we have estimated the future population as 10,000 people. The total population to be served by this intersecting sewer is therefore 40,000 persons, whereas the capacity of the sewer running three-fourths full is 3,500,000 gallons in 24 hours, which, at 50 gallons per head of population, would be sufficient for 80,000 people. The grade is one in 550 feet, which allows for any possible future development. In dealing with the first main sewer we provided for a population of 100,000 people. Now we are dealing with one

of the first branches into that main sewer. Provision is made for a population varying from 14 to 17 or 18 to the acre. The cottages already built at the Civic Centre work out at about $2\frac{2}{3}$ houses per acre, including roads, which at five people per house, represents about fourteen people to the acre. On the locality plan (800 feet to 1 inch) is shown the main outfall sewer, the main intercepting sewer, which has already been decided upon, and also the 21-in. proposal now before the committee. The plan also shows the northern branch intercepting sewer, which will commence at the same point as the 21-in. sewer, and will run north-easterly across the Molonglo, and break into two branches, one of which will run along to near the Military College, and the other will take a north-westerly course serving the country towards the slopes of Black Mountain. Any other sewering beyond this will be in the nature of ordinary reticulation with 6 inch or 9 inch pipes laid in the streets in a simple manner as the population extends in any direction. Reticulation is comparatively simple work, the average depth being from 6 to 10 feet only. The northern extension, with its branches, will be about 16,000 feet, or a little over 3 miles, and a rough estimate of the cost is £125,000. With the exception of the small pipes that will complete the main sewerage for Canberra, £125,000 is the estimated cost of the northern portion, and £47,000 the cost of the southern portion. On plan 166A there is a longitudinal section showing the depths at various points, and also the levels. The plan shows the route, commencing at the manhole in Commonwealth-avenue, near the Parliamentary Hostel, running north-easterly to the road in front of the provisional Parliament House, thence easterly by Federal-avenue and across allotments—on account of the depth there is no need to follow any particular road—to Waratah-parkway, near the Power House. It is kept at such a level that any building which may in future be erected can be dealt with. The sewer is laid as flat as possible, while retaining a sufficent grade for flushing purposes, and that, to a large extent, determines its size. The level of the sewer will be 1,812 feet, and as the surface at that point is 1,835 feet, the sewer will be 23 feet below the surface. There will be no difficulty in sewering any future buildings which may extend towards Queanbeyan in the future, although that is not contemplated. We generally allow a 10-ft. depth to the sewers, but in rights of way 6 feet only is provided. The nature of the construction in this case will be different from that of the main sewer. There we bored through the rock and lined the sides of the excavation with concrete and formed an egg-shaped sewer. Here, because of the smaller size, we propose to adopt a different method of construction. The actual drive will be made as small as possible, sufficient only for reasonable access to the men working in it to lay the pipes. The pipes will be made on the surface, lowered into the drive, and laid on a concrete bed. The pipes will be sufficiently reinforced to enable them to be handled. Before being used, they will be at least three months old, and, therefore, well seasoned. Concrete 6 inches in thickness will then be placed around the concrete shell. We shall then have a pipe 6 inches in thickness, with a high class internal finish. The remainder of the excavated space will be filled with the material taken from it which will be carefully packed. This is the most economical, as well as the most efficient way, to carry out the work in this case. I also submit a number of detailed drawings, showing among other things, the method of constructing the manholes. They will be circular in shape, and made of concrete, 9 inches to 12 inches thick, according to the depth, and will be fitted with ordinary iron ladders. They will provide access at reasonable intervals for purposes of inspection, or for cleansing, if required. In two places we have made provision for penstocks or valves. They will enable the sewage to be banked up in one section to permit of a ready inspection in another place. Plans showing the details of the penstocks, ladders, tunnels and the manhole covers are also exhibited. The estimated cost is about £7 per foot, or a total of £47,000. The pipes will cost about 12s. 6d. a lineal foot, the balance of the expenditure being represented by excavation, refilling, and concrete. From the conditions which were met in the shafts which have been sunk, we expect to meet with a considerable quantity of water which will have to be pumped out during the progress of the work. Most of that water makes its way from the surrounding ranges to the river. It does not come from the river. The sewer will be placed in a low position to enable the lowest portions of the city to be drained into it. The pumping, of course, will add to the cost, as we expect to find much more water in this section than in the main sewer. The nature of the country is different. We shall drive beneath the surface from one manhole to another. The soil will be taken out and up to the surface, and afterwards be replaced. The estimated cost of £47,000 is based on the present cost of material and our knowledge of the work required. The estimated time for the completion of the work is nine months. The work is urgent. The sewer will serve the governmental group and all the development on the south side, including that area which is shortly to be offered for sale on lease. It includes Parliament House, and all the other government buildings will be well within the area to be served. The grade in this case will be nearly 10 feet to the mile, as against 3 feet to the mile in the main sewer. That is because of the smaller pipes which will be used. For the main intercepting sewer tenders were twice called, and received. The lowest tender was for £145,000. The work is being done departmentally, and will be finished at a cost within the estimate of £120,000, although extra wages due to awards made since the work was commenced, amounting to £4,000, were incurred. The work will be finished within the estimate, and the department claims to have saved £25,000. I do not say that we have necessarily done a better job than would have been the case had the work been let by contract, but a good job has been done. Engineering work is different from building, and must be well done. The tender of £145,000 was for the main intercepting sewer, from in front of Parliament House to the city boundary. The pipes for the southern intercepting sewer will be of reinforced concrete, in lengths of 6 feet or 3 feet 7 inches, according to whether Hume or Monier pipes are used. The plant is capable of making either length. The Hume pipe is spun on a cylinder, while the Monier pipe is manufactured on a frame. We do not mind which kind is used, as no trouble is experienced with the joints. The pipes are so well made, and they fit so well together, that the joint is not perceptible. The shorter pipes would be more easily handled, and the additional number of joints would not present any difficulty. We propose in this instance to use pipes rather than set the concrete *in situ*. I am not wedded to any particular system, but look for the best job. In this case pipes are undoubtedly better. In the case of the main intercepting sewer, pipes were not used, because of their much larger size making them impossible to handle. In that case the lining of the walls of the excavation was much cheaper. The difference between the cost is largely due to the different size of the sewers, the main sewer being 5 feet 6 inches and the proposed sewer 1 foot 9 inches in diameter. In the southern intercepting sewer, pipes are better than massed concrete, but in the case of the larger main sewer, pipes would not have been the proper method to adopt. The deciding factor is the size of the main. The cost of £7 per foot includes everything—manholes, penstocks, &c. The proposed extension when running at full

capacity, namely 4,000,000 gallons in 24 hours, would, on the basis of 50 gallons per head, provide for a maximum population of 80,000. That point will not be reached for a great many years, if at all. This sewer is to deal with a portion of the city only—about two-fifths of the population—the balance will be dealt with by the northern intercepting sewer. The northern sewer will provide for the full requirements of 60,000 people, and the southern intercepting sewer for 40,000 people, making a total of 100,000 persons to be served. Although this sewer would be sufficient for 80,000 people, to make it any smaller would mean an increase of the grade, and that could not be done because it would mean getting too near the surface. A fall of 10 feet to the mile is all that we can spare, and that, to a large extent, determines the size of the pipe. The southern intercepting sewer is intended to serve the area south from Parliament House and including Blandfordia—that is, the southern and south eastern portion of the city. The south-west side is not thickly populated, as reference to the population plan will show. A population of 18,000 people only is estimated in that area. They would be dealt with by pipes running directly into the main sewer by branches down the respective valleys, as shown in the plan. They would probably be 9-inch pipes, with 6-inch branches feeding into them. This sewer, being in the lowest part of the area it will serve, was referred to by the Federal Capital Advisory Committee in its report some time ago. They did not deal with the size of the main, or the manner in which the work should be done, but they realized that the position in which we proposed to construct it was the position where it naturally should be placed. As far back as 1912 I showed the position on a plan in approximately the same place as that on the plan before the committee. This sewer will meet any developments in population which are likely to arise, and is capable of expansion to meet the needs of a much greater population than 100,000 people. The manner of constructing the junctions of the mains is common to all sewerage systems, and no difficulty is anticipated. At the manholes it will be possible for inspectors to look into the pipes in each direction. The flow is generally more rapid through the manholes than in other portions of the main. Plans are now in course of preparation to deal with the treatment of the sewage, and I hope to be able to submit them to the committee when dealing with the northern intercepting sewer. The treatment works will probably cost from £25,000 to £30,000, and will, therefore, be of sufficient importance to require reference to the committee. The treatment works will provide for a population of 10,000 people, and the department generally estimates the cost at about £3 per head. We do not like to consider a unit for less than 10,000 people. This sewer is to be 21 inches in diameter throughout its whole length. If the size were increased to 24 inches it would add to the cost, and would provide for 6,000,000 gallons in 24 hours, which is more than is necessary. It is better to have the pipe of one diameter throughout. There is nothing to be gained in increasing or reducing the size. Some of the pipes in connexion with this system will be 12 inches, some 9 inches, and some 6 inches in diameter, but they are not referred to as main sewers. Anything less than 21 inches in diameter is reticulation. The cement used in the main sewer came from New South Wales, and is equal to the best obtainable. It is better than most of the imported cement. I have used this cement for twenty years. We have departed from the egg-shaped sewer in this case because in smaller mains the circular shape is better. The fall for which we are providing ensures a good scouring velocity. The sewer will be self-cleansing. When one-tenth full the velocity will be 1.7 feet per second; when one-quarter full it will be 2.6 feet per second; and when three-quarters full 3.7 feet per second. That is as high as we care to go. The manhole covers are not sealed. To reach the sewer at the bottom one has merely to lift the cover and go down the ladder. A few vents will be provided, but not a great number, as we do not expect any trouble in that direction. The frequent breathing holes provided by the manholes prevents an accumulation of gases, and, in addition, the sewage will be fresh, and not likely to cause offensive smells to arise. No injurious or dangerous gases can collect. The department is both ready and anxious to proceed with this work, as the other section is completed, and we do not want to lose the men. We would be glad to get authority to proceed at an early date.

2. *To Senator Reid.*—If the department decided to manufacture the pipes it would not have to pay any royalty to any firm, as there are no patent rights. With our plant we could make pipes 4 inches, 6 inches, 9 inches, and 12 inches in diameter. Up to 12 inches we call it reticulation. After that it is termed a sewer. The real distinction between reticulation and sewers is whether the discharge is computed on a 24-hour or an 8-hour basis. For a short period in the morning the flow in each of the valleys may equal that for the rest of the day, but it would reach the main sewer at different periods. The discharge from one area has time to get away before that from another area has to be dealt with. Reticulation is the branch which is designed for an 8-hour flow, while a sewer is designed for a 24-hour flow. It is not so much the size of the pipe. Take Blandfordia, the pipes there will be 9 inches, with 6-inch branches. That will deal with the whole of the valley to the south-west. Although the pipes themselves will not be very thick, they will be reinforced, and will be considerably strengthened when surrounded by concrete. They will not be subject to any great pressure, as care is taken to put the packing in tightly in order to prevent subsequent movement. We endeavour to imitate nature so far as possible. If care is not taken with the packing the roof can come down on the pipes like a blow, but if it is well packed that cannot occur. Three or four different strata will be met with in the length of the sewer. There will be hard limestone, schist, as well as clay and gravel. We expect to pass through limestone from the lower end for about 1,000 feet, after which we shall probably enter schist, and in the next valley the sewer will probably pass through gavel. There will probably be some more schist in the Rottenbury area, and near the power-house, in the lower level, we shall probably enter gravel again. We expect to find water there, but there is water throughout the whole length. Once the material is replaced we do not anticipate much trouble from the water.

3. *To Mr. Jackson.*—We do not expect to find diorite on the slopes, but there will be hard limestone. Test holes have been sunk, and at trial shaft number 53, hard limestone and much water were encountered. In the second shaft there was schist and much water. In the third we found clay and sand, with very heavy water, and in the fourth trial shaft clay and schist, but less water. On account of the depth at which the sewer will be placed, the average depth being 50 feet below the surface, it is cheaper to bore and tunnel than to have an open cut. Only near the power-house do we expect to be reasonably near the surface. For the remainder of the distance the depth will be about 50 feet.

4. *To Mr. Mathews.*—I am not aware whether this work will be done by day labour or by contract. The usual practice is to invite tenders first. Then if we consider that we can do the work cheaper we advise the Minister accordingly, and we are given the work to do. So far as I am concerned, if a suitable tender can be obtained I shall be glad to have a contractor carry it out, but I do not think that any contractor

can compete with us. In replacing the soil we endeavour to follow nature as closely as possible. The material taken out is replaced and well rammed. We depend more on dry ramming than on the use of water. The work can be done quite well by dry ramming. If proper material is used, and it is well rammed, there is not much danger of its falling in. Flood waters cannot enter the sewers unless through the manholes, and they are finished to a level, which makes the inflow of flood waters improbable. If some flood water should get in it would not hurt very much. It would be no worse than the flooding of the sewers by the departmental gangs, whose work is constantly going on. We take precautions against the inflow of flood waters because of the danger of sand getting in. It is best to keep sand out, as should it set, it may have to be removed by mechanical means.

5. *To Mr. Mackay.*—When I mentioned that local material would be used, I meant Australian material. Australian cement will be used, and, of course, stone and sand are procurable in the locality. In the case of cement, tenders are not called in the various states, because it is known that New South Wales produces the cheapest cement in Australia. The shipping and other charges from any other State would make it impossible for them to compete with New South Wales. The requirements in connexion with the carriage or cement, such as lining the bags with paper, or placing two small bags inside a larger wheat bag, add to the expense of obtaining cement from other states. In the case of the Queensland sewerage system it would be cheaper to import cement from abroad in casks than to obtain it from the other states. Sometimes the paper inside the bags breaks, and the cement has to be sifted from the paper. From the intercepting sewer there would be pipes, probably 9 inches in diameter, up the roadways, with branches of 6 inches, to the various houses. The responsibility of the householder ceases at his street alignment. The department is responsible to that alignment. The fact that the manholes are placed at fairly short intervals makes the danger from an accumulation of gases negligible. Should an objectionable smell be noticed it could easily be remedied by putting a sealed cover on the manhole and running up a vent, say 30 feet high. We find, however, that very few vents are required. There are usually no covers over the manholes, but, notwithstanding that, there are few complaints of offensive smells. Very little additional expense is involved in having a good number of manholes, as they are the shafts which have been sunk in connexion with the laying out of the mains. Were they not used as manholes they would require filling up. It is better to utilize the shafts as means of access to the sewers than to fill them up.

6. *To Mr. Cook.*—Sewerage works throughout Australia cost much the same. The only difference would be in the varying wage rates in the different states. I am assuming, of course, that the nature of the ground is the same in each case. Where there is hard rock or much water the cost is increased. The fact that there is rock does not necessarily make the job the most expensive one. I have known of jobs which have been expensive because of sand, silt or water. Where there is rock there is not so much timbering required. Worse conditions can be met where there is mud, and where compressed air has to be used, than where there is rock. At Brisbane the cost will be more than if the sewers were being laid in hard rock. In Port Melbourne, where similar conditions were encountered, the job was very costly. The cost of the work done to date has been about £11 per lineal foot. On the main intercepting sewer we have driven 5 miles, have lined 4 miles, and we expect to complete the work within three months. On the north side I expect that we shall strike some hard rock. On previous occasions bona fide tenders were obtained from good men. They evidently did not think that tenders were called merely to get an idea of the cost. The cost has increased within the last couple of years, but I think the limit has now been reached. In addition to the increased wages, the reduction in the number of hours for miners from 48 to 36 per week has added to the cost. The only additional cost incurred because of the great depth of the sewer is in connexion with the shafts. A considerable depth is necessary in connexion with the proposed sewer, in order to get the required grade. The purpose underlying the system is that the sewage shall gravitate to the treatment plants, so that, should any troubles, such as strikes, occur, the effects will be felt 5 miles out, and not in the city. If pumping wells were included in the system a strike or a stopping of the engines would cause trouble near the centre of population. We estimate that this work will require nine months to complete. That will be in time to connect with the buildings now being constructed. Although we can deal with a considerable population by means of septic tanks, we are anxious to avoid the cost of them, as they will all have to be discarded later.

7. *To Senator Lynch.*—The diagrams show in one case some timber beneath the pipes. That is for places where there is mud, gravel or wet conditions. The timber is necessary to allow for drainage. The first diagram is of a sewer through solid rock; the second is where middle class material is met; and the third is where it is through wet ground. Once the timber is placed in position the nature of the ground is of little consequence. The timber is selected jarrah, and down in the earth it will last for many years. There is no danger of subsidence. I have been engaged in sewerage work since 1902, in both main sewers and sewerage generally. For some time I was with the Melbourne and Metropolitan Board of Works. This proposal, both as regards the lay-out and the nature of the material to be employed, represents the best practice in sewerage engineering. There is nothing in connexion with the Canberra sewerage to make it particularly difficult. I cannot imagine any difference of opinion among engineers as to the effectiveness of the proposed system. Although some of the manholes will be in the centre of settled areas, I do not anticipate that any trouble will be caused thereby. Should any objection be raised because of the proximity of a manhole to some person's residence, the cover could be sealed and a vent erected. Trouble is likely to arise only in the early stages, when there is not much flow; but in that case the sewer would be flushed more frequently. In front of the present Federal Parliament House the same system is in operation. The installation of sewers at Canberra is probably less costly than the same work would be in Melbourne or Sydney. At Canberra we have a free hand, and have not to be concerned with the effect of our work on adjacent buildings, nor are we affected by the traffic. There is a little difference between the wages paid in Melbourne and in Canberra, but the wages in Sydney and Canberra are much the same. The distance between the manholes is largely determined by the necessity for accessibility and aeration.

8. *To Mr. Mathews.*—The greatest distance between manholes is underneath the peak of the hill, as shown in the diagram. The hill will be used as a reserve, and because of the great depth it was thought that in this case a greater distance between manholes could be allowed. The tunnel may cost a little extra, as a ventilating fan may be found necessary. As a rule we rarely exceed a distance of 450 feet without providing special ventilation. The longest section without a manhole is only 620 feet. The machines will be circular in shape, and will be constructed of concrete. Bricks are too costly.

(Taken at Melbourne.)

TUESDAY, 19TH AUGUST, 1924.

Present:

Senator LYNCH, in the Chair;

Senator Barnes	Mr. Mackay
Senator Reid	Mr. Mathews.
Mr. Jackson	

Alexander McDonald Grant, Master of Civil Engineering, Melbourne University, Senior Engineer of Sewerage Construction, Melbourne and Metropolitan Board of Works, sworn and examined.

9. *To Senator Lynch.*—I have examined the plans for the proposed southern intercepting sewer at Canberra. They are similar to designs prepared for the Melbourne and Metropolitan Board of Works for the sewerage work in Melbourne. The scheme provides for a population of 40,000 people, and the grade, 1 in 550, is quite satisfactory. I have done a considerable amount of designing for the Melbourne and Metropolitan Board of Works, and I am in a position to state, by glancing at plans, if they are likely to meet the needs of a given population. A flatter grade, especially if the sewer were not working at its full capacity, would probably not transport the solids without flushing, but a grade of 1 in 550 is ample to meet all requirements. With the sewer working at one-tenth of its capacity, a velocity of 1.7 feet per second should be sufficient to carry the solids along the sewer pipes. If the sewer were worked at only one-quarter of its capacity, it would probably require flushing at certain intervals in order to increase the velocity of its flow, but when working normally this should not be necessary. Usually at the outset it is advisable to flush a sewer to ensure the steady flow of the solids, but when a sufficient number of house connexions is made, this flushing is not essential. The manholes shown in the plan are the same in design and diameter as those provided for in the Melbourne and Metropolitan Board of Works's scheme. Speaking generally, the plan represents the best practice in sewerage engineering of America, England, and elsewhere. The distances at which the manholes are to be placed are quite right for a 21-in. sewer. With smaller pipes it is advisable to have the manholes closer together. For ventilation purposes our practice is to erect vent stacks wherever they may be deemed necessary, following upon complaints made by the men working underground. We do not necessarily erect vent stacks at the points complained of, but at the highest point in the main nearest the source of the complaint. In this way we ensure more satisfactory ventilation. We are now putting in vents to sewers that have been laid for a great number of years. For sewers of 21-in. diameter and less, a concrete pipe is cheaper and more satisfactory than a cement sewer laid *in situ,* because it is necessary to finish off the inside of the sewer with a smooth surface, and a man could not work inside a 21-in. pipe. We always test cement sewer pipes with a 30-ft. head of water, and in order to guard against any possible damage we surround the pipes with concrete the full length of the sewer. In this way we strengthen both the joints and the pipe itself. We find concrete sewer construction cheaper than brickwork for the smaller diameters, say, up to 24 inches, and we use good bluestone screenings up to ½-in. gauge. Granite, of which I understand there is a plentiful supply at Canberra, will do splendidly, but gravel is not satisfactory, because screenings with serrated edges are essential for good concrete work. For sewers of larger diameters, brickwork is preferable, and possibly cheaper than concrete.

10. *To Mr. Mackay.*—I should say that the manholes will be the same as those constructed for the Melbourne and Metropolitan Board of Works. They will be hermetically sealed. In order to allow the escape of gases, vent stacks will be placed at regular intervals where required. Some of our sewer mains are laid at great depths. Those at Heidelberg, for instance, are 125 feet deep. There is no pressure on the pipes at that depth. We are obliged by the act governing the operations of the board to call for tenders, but in cases where tenders are not satisfactory we carry out the work by day labour. About two years ago I had a £19,000 sewer main extension carried out by day labour, and I found it most satisfactory. I believe in day labour for our class of work. I have not examined the estimates for the proposed work at Canberra, but I understand the price is approximately the same for similar work done by the Melbourne and Metropolitan Board of Works, viz., about £7 per foot. We use Geelong or Lilydale cement for concrete construction. Tenders are invited in the other states, but local contractors have an advantage in that their transport charges are lighter. The best cement, in my opinion, is that supplied by the Commonwealth Cement Company, Sydney. The plan now before the committee is quite satisfactory in every respect.

11. *To Mr. Mathews.*—The "Union Brand" cement supplied by the Commonwealth Company, Sydney, is quite as good as cement imported from England or America. The Hume pipes, built in 6-ft. lengths, are rather cumbersome for handling in the shafts and tunnels. We have advised the Hume Company that we prefer 4-ft. or 3-ft. 6-in. lengths. The Concrete Construction Company, Port Melbourne, makes the pipes 3 feet long, and the Stoneware Company constructs pipes 2 feet in length. We find the 3-ft. lengths very handy. Lengths up to 4 feet would also be satisfactory, but pipes longer than that prove awkward in the handling. I have already explained that it is difficult, in sewers of diameters up to 24 inches, to lay the sewer *in situ,* because it is necessary to plaster the inside face of the pipes. A rough inside face will lead to trouble. It has to be well trowelled, and made quite smooth. For this reason, concrete pipes are to be preferred. They are bedded in cement and mortar, not only at the joints, but also throughout the whole length of the main.

12. *To Senator Reid.*—We do not manufacture our own pipes, but purchase them from outside companies. I am in favour of day labour for sewer construction, because I think the Melbourne and Metropolitan Board of Works gets a better return for its money. Where contract prices exceed our estimate, we do the work by day labour. The main extension carried out by day labour, to which I referred a few minutes ago, was a 24-in. pipe laid for a distance of about 2 miles. We did that work in about nine months, and well within our estimate of cost. Formerly we laid our sewers with branches for air vents at regular intervals; but, with the increase in population and the rapid building of houses, we found that was a waste of money, so now our practice is to break into the sewer, and place a vent wherever it may be necessary, but always at the highest point in a given locality. Originally the sewerage area of Melbourne was within a 10-mile radius, but owing to the rapid increase in population the area has been extended to 13 miles, and as the sewerage farm is not capable of dealing with the whole of the effluent we are introducing newer features. For instance, we now use the Emscher tank system for the Mordialloc section of the reticulation area. I am also recommending the board to put in an activated sludge plant. Considerable attention is being given to this system in England, with the idea of manufacturing a commercial product of manurial value by breaking down and drying the solids, injecting oxygen into the product, and producing nitrates for fertilizing purposes. At present the process is in the experimental stage. The chief difficulty, I understand, is in de-watering the solids.

13. *To Senator Lynch.*—We think it advisable to strengthen the pipe with a coating of cement for its full length instead of only at the joints, because if trouble occurred we should have to open up right from the surface in order to locate a break in the sewer.

14. *To Senator Reid.*—Tests with a steam roller along the line of a sewer have shown that pressure and vibration do not extend below a depth of 5 feet or 6 feet. Therefore, sewer mains laid deeper than 6 feet are not likely to be damaged by subsidence of earth. As a rule, we specify that in streets carrying traffic the sewer shall be laid not less than 10 feet or 12 feet from the surface, but in right-of-ways, with hardly any traffic, we permit a pipe to be laid at 5 feet or 6 feet.

15. *To Mr. Mackay.*—Supervision in all sewer work is most important, because unsatisfactory packing may lead to serious trouble. Where possible, we "slurry" the whole length of a sewer extension with suitable material. Occasionally we have had trouble through ineffective packing of a sewer main. We now exercise special supervision over that work.

The committee adjourned.

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