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REMARKS ON THE SCHEME PROPOSED FOR THE SEWERAGE AND DRAINAGE OF THE WESTERN SUBURBS.

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PROFESSOR HUXLEY in his address to the Society of Arts, October 25, 1881, stated :—" Disagreeable and imperfect as the old cesspool system was, it was attended with very little danger as compared with that which waits upon the modern water-sewage system, if this system is imperfect. If it is perfect, then it is very perfect; and, in fact, it is the only possible system in great cities in the present day. It has, however, this terrible peculiarity—that if it is imperfect, it becomes the most admirable machinery for distributing the death and disease which may be found in one locality as widely as possible into others, and into the very houses of the people. That I believe to be as absolutely true a statement as any to be found in the records of science of the present day, and therefore it becomes a question, how are we to see that this water-sewage apparatus is what I may call reasonably perfect?"

Professor Huxley's statement is clear, true, and forcible, and having in view the immense importance of the interests at stake, and the expenditure involved it is most desirable that the scheme proposed for the sewerage of the Western Suburbs of Sydney should be examined to ascertain whether it be reasonably perfect, and whether the first principles which should govern the construction of a sanitary system of sewerage have been duly regarded.

The leading features of the proposal may be briefly summarized under five heads : (a) The adoption of the water carriage system of sewerage; (b) The adaptation of the scheme to the requirements of the estimated future population; (c) The provision for the

admission of rain water to the sewers; (d) The disposal of the sewage and combined sewage and rainwater by filtration and irrigation; (e) The transmission of the sewage from the elevated portions by gravitation and from the low-lying parts by pumping.

It is not proposed to discuss the wisdom of adopting the water carriage system, as this system properly applied is, beyond doubt, the one most capable of remedying the unsanitary condition of the area over which it is intended to operate. It will, however, be very necessary to carefully consider the manner in which it is proposed to apply this system.

The members present must all be more or less familiar with the area embraced in the scheme, it will therefore be unnecessary to give a detailed description of its natural features. It should, however, be particularly noticed that parts of two distinct watersheds comprise the whole area, one lying to the north and the other to the south of a dividing ridge which extends in an easterly and westerly direction. The Southern, drains towards Cook's River, on the south, which is the general direction of the inclination of the proposed sewers; the Northern, drains towards the tidal waters of the Parramatta River to the north, and the slope is, therefore, contrary to the general fall of the sewers, which rise into this watershed through tunnels under the dividing ridge. The whole drainage area is divided into three systems, corresponding with three main outlets provided; the first, or Northern system, will discharge into the main Bondi sewer; the second, or Southern system, will discharge into the existing main Botany sewer; the third, or Western system, will discharge on to the sewage farm at Botany Bay through a trunk sewer, the construction of which is provided for in the design.

The report shows very clearly that the population of the western suburbs is increasing rapidly, and that the suburbs adjoining the city are the most densely populated, the population decreasing in density towards the west; the range being from 36 persons per acre at Newtown to 4.79 at Burwood. The estimated future population is 45 per acre at Newtown, diminishing to 30 per acre at Burwood and Strathfield. It will thus be seen that the

population on the eastern portion of the area is approaching the estimated maximum, whilst towards the western extremity the present population is barely one-sixth of the estimated future population. The report estimates that a period of 18 to 20 years will elapse before the maximum population is reached. The sewers are designed to remove a volume of sewage corresponding to a consumption of water by the prospective population of 72 gallons per head, one half to be removed in six hours, combined with a volume of rainwater produced by a rainfall at the rate of two inches per day on an area of 100 superficial feet per head of the prospective population on the northern area, and 200 superficial feet per head of the future population on the southern and western areas. The above mentioned combined quantities of sewage and rainfall, it is estimated, will be removed when the sewers are flowing about three-quarters full. The report says at page 13:—"The areas and gradients, together with steps at the intersections, are so regulated as to insure self-cleansing, and to carry off effectively the maximum quantity of sewage and rainfall." The velocities of flow under such circumstances are given in the report, and for the principal sewers are as follows:—

Northern System—Main Sewer 5ft. x 4ft. reduced to 4ft. 2in. x 2ft. 6in. Inclinations 1 in 1509 increasing to 1 in 800. "The levels of the sewers have been so regulated and adjusted at each branch that an uniform flow line will be secured, and the velocity, which, at the estimated maximum flow in the 5ft. by 4ft. sewer is calculated at 165 feet per minute will gradually decrease to 141 feet per minute in the 4ft. 2in. x 2ft. 6in. sewer."

Southern System—30in. circular sewer, inclination, 1 in 1,000, velocity for maximum depth of flow 154 feet per minute.

Western System—Main out-fall consisting of three circular sewers, each 6 feet in diameter; inclination 1 in 1,700, velocity for maximum flow, 189 feet per minute.

Eastern Branch—6ft. 6in. x 5ft. 6in. reduced to 4ft. 0in. x 2ft. 8in., inclinations 1 in 1,509, 1 in 1,000, and 1 in 700; maximum velocities vary from 193 to 135 feet per minute.

Northern Branch—5ft. 6in. x 4ft. 6in. reduced to 4ft. 0in. x 2ft. 8in., inclinations, 1 in 1,509, 1 in 1,200, 1 in 800, and 1 in 600; maximum velocities vary from 175 to 140 feet per minute.

Western Branch—6ft. 10in. x 5ft. 10in. reduced to 3ft. 9in. x 2ft. 6in., inclinations, 1 in 1,509, and 1 in 1,200; maximum velocities vary from 198 feet to 146 feet per minute.

It must be borne in mind that the velocities just mentioned are those which may be expected when the sewers are acting under abnormal conditions, that is to say when rain falls during the period of maximum sewage flow.

The velocity of flow in the sewers will diminish as the volume flowing becomes less. Many of the velocities given are below the standard of 180 feet per minute, are undesirably slow, and will be a source of trouble; any reduction of these velocities will render the whole system, which is already far from being perfect, very imperfect, and therefore unsanitary.

Reduction in the maximum velocity of flow will take place to a serious extent due to a reduction in the volume flowing, and will be brought about in this manner:—(a) Long intervals of dry weather when no rain water will enter the sewers; (b) Difference between the population actually contributing sewage and the prospective population; (c) Difference between the actual consumption of water, and the estimated future consumption at the higher rate of 72 gallons per head per day. The first cause will always prevail to a greater or less extent. The second and third may in time gradually disappear, but in the meantime will produce serious consequences. These causes will operate most severely in impairing, if not altogether destroying for a time the sanitary efficiency of the Western system.

The Western system is quite independent of the other two. The triplicate 6 feet circular sewers forming the outfall will extend from the sewage farm at Botany Bay to the Warren Estate. It is proposed to construct two of the sewers at first, the third when needed. At the termination of the outfall at the Warren Estate three main sewers will branch off, named respectively the Eastern, the Northern, and the Western, having drainage areas, taken in the

same order of 2,657, 2,005, and 4,100 acres. The area drained by the Eastern branch lies nearest to the city, and has, therefore, the densest population of the three; the drainage area of the Northern branch lying next has a much less dense population. The present mean population per acre on these areas is for the Eastern 10, Northern 8, and Western 4.63; the prospective maximum population is, on the Eastern 40 per acre, on the Northern 33, and on the Western 30 per acre. The time estimated for the present population to increase to the prospective maximum is 18 to 20 years. The amount of sewage which will be conveyed by each of these three sewers, if constructed within the next few years, will bear about the same proportion to the maximum amount of sewage they are designed to convey that the present population bears to the prospective population, provided the consumption of water from the mains be 72 gallons from the commencement. If a less amount per head be used a corresponding reduction in the volume of the sewage will follow.

It has already been stated that the amount of rain water to be admitted into the sewers of the Western system is estimated on the basis of a rainfall at the rate of 2in. per day upon 200 superficial feet per head of the population. The volume of rainfall entering the sewers will, therefore, vary according to the population. The above area of 200 superficial feet per head is made up of two parts, one part being taken as roof area, and the other part as yard area; each area will be found to be comparatively impervious, and will shed the rain water rapidly into the sewers.

The amount of sewage to be conveyed compared with the amount of rain water when both are at their maximum is considerably less, being in the proportion of 1 of sewage to 1.39 of rainfall; if the sewage flow be compared with the volume of the combined flow, the proportion will be 1 of sewage to 2.39 of sewage and rainfall.

It has been previously shown that the intention of the design is to produce a self-cleansing flow when the sewers are conveying the prospective maximum volume of sewage and rainfall; it is, therefore, manifest that the sewage alone from the population during the early days of the sewers will have a very sluggish movement.

In England it has been found that a velocity of flow of 150 feet per minute at the least, is necessary to maintain the sewers in a sanitary condition, and, considering the warmer temperature which here prevails, a velocity of 180 feet per minute is required to ensure a speedy removal of the sewage before decomposition sets in.

The following calculations have been made for the purpose of estimating the volume and velocity of flow of sewage when the sewers have been completed, say three or four years hence :—The western branch of the Western system will be examined, as this drains the largest area of the three. This area will not wholly drain by gravitation ; 1,100 acres out of the total of 4,100 acres lie too low, and the sewage therefrom will have to be elevated by pumps. However, as it borders the harbour in a comparatively narrow strip, and the population being very scattered, it will doubtless be very many years before it contributes sewage to the western branch. The length of sewer to be particularly examined is that portion chiefly in tunnel extending from the head of Long Cove Creek, Petersham, to Iron Cove Creek, Ashfield, at a distance of about 8,600 feet. Through this portion nearly the whole of the drainage from the Western area of the Western system will eventually pass. The sewer is to be 6 feet 6 inches high by 5 feet 6 inches wide. A portion of the drainage area lying between the head of Long Cove Creek and the end of the branch at Marrickville, the drainage from which will not enter the tunnel, must be excluded from the calculation. This area amounts to about 40 acres. The area, therefore, which will contribute sewage and rain-water to that section of the Western branch under examination is 2,960 acres. An increase to the present population of 50 per cent. is a fair allowance to make for purpose of ascertaining the probable amount of sewage which will be passed into the sewer within a reasonable time from the completion of the drainage works. Using the data adopted in the report for the purpose of ascertaining the daily maximum volume of sewage—viz., a water supply of 72 gallons per head per day, one-half flowing off in six hours—the flow of sewage from the 2,960 acres is found to be 2,072 gallons per minute, the inclination of

the 6 feet 6 inches by 5 feet 6 inches sewer is one in 1,509. This volume of sewage will be 13½ inches deep, and have a velocity of 132 feet per minute. Seventy-two gallons per head, however, will not be used at so early a period; 36 gallons, or one-half, is a fair estimate. The sewage discharge will therefore be reduced to 1,036 gallons per minute. For an inclination of 1 in 1,509 this volume will have a velocity of flow of 1·82 feet per second, or 109·2 feet per minute, and a depth of flow of about 10 inches.

Now, as a velocity of 180 feet per minute has been shown to be necessary, it is quite evident that the sanitary condition of the sewer will be very defective until such times as the population shall have increased to that extent necessary to produce a volume of sewage sufficient to secure the desired velocity. This volume would be 6,907 gallons per minute, and would require a total population of 69,075 persons, using 72 gallons per head per day, to produce it, or 99,468 persons using 50 gallons per head. The present average consumption of water does not exceed one-half the prospective amount, or 36 gallons per head. It is necessary to investigate the efficiency of sewers in this manner, because the health of the present and rising generation should have equal consideration with the health of those who will live 15 or 20 years hence. The report provides 42 flushing stations, not confined to the western area, but distributed over the three systems. This is an indication that difficulties have been anticipated, and flushing is to be adopted to surmount them. The evils, however, will not be removed by flushing; they may be somewhat mitigated. The volume of sewage in the Western system will be so small, compared with the capacity of the sewers, that the sewers will become huge gasholders. Efficient ventilation (the sewers being in tunnel) will only be obtained at a considerable expenditure, and if periodical flushes are sent down the sewers in a volume sufficiently great to be effective, the ventilation arrangements may be upset. The report gives very little information about these flushing stations, and the amount of water it will be necessary to provide for flushing purposes. It will hardly be a sanitary procedure to store the sewage itself for flushing—such a course would probably

increase the danger. If water be used direct from the mains, how will the quantity required to flush the sewers effect the general supply? The rainfall cannot be depended upon to flush the sewers —it comes at such uncertain intervals. The experience of the past eight months of drought should teach the lesson most effectually not to construct sewers depending on the rainfall to keep them clean. During rainless months and droughts, which unfortunately are of too frequent recurrence, such sewers would become very foul and unhealthy, and it may be truly anticipated that during these dry periods, water from the mains will be reluctantly given, if at all, for flushing purposes. It is contrary to the teachings of sanitary science to make the efficiency of a system of sewers dependent on so uncertain an element as the local rainfall. It has been the practice in past years to admit storm or rain water to the sewers for two purposes—firstly to get rid of it from the surface, where it is apt to prove inconvenient, and secondly to scour the drains out. The amount of rain proposed to be admitted is so small compared with that which may be expected, as to render the construction of ample storm-water channels in no way less necessary. In fact the report recommends this course. It must, therefore, be to effect the second purpose that rain water is proposed to be admitted, and there are good grounds for believing that the grades of the sewers have been made so undesirably slight, under the belief that the rain water will counteract any tendency towards unsanitary consequences. Rain water should be rigidly excluded from the sewers. Rain water from the roof areas will be clean, and there can be no possible objection to its discharge into the surface channels, as at present. Rain water falling on yards will no doubt be polluted, but not more so than the water from street surfaces, which, according to the report, is to be excluded from the sewers, and rightly so; and the yard water should be treated in a similar manner.

It is difficult to see how the admission of rain water to the sewers will be restricted to the quantities provided for in the design. A rule may easily be laid down, but it is questionable to what extent it will be observed in practice. If rain water be