

- (a) Efficiency with regard to bacterial removal; (b) Utilization of the manurial properties of the sewage on land; (c) Cost of treatment.

There is no doubt but that suitable land is much more efficient as a means of removing bacteria from sewage than the usual methods of sewage biological filtration. With land the particles of filtering material are necessarily much finer and therefore more efficient as a strainer, a very much greater area of filtering area is consequently required per given volume of sewage. The sewage has not only to encounter the perpendicular height of percolation but has also to pass through the lateral extent of area before it reaches the main effluent discharge. The question of bacteria removal, however, is not so much one of comparative degree, so much as whether land treatment is capable of removal to the extent of rendering a water practically more infectious. The percentage removal of bacteria may in the case of both land intermittent and artificial biological filtration be as high as can be produced by even slow sand filtration for drinking waters. The bacteria remaining in the effluents, however, may be far and away above the standard count allowed for drinking water. Referring again to the Lawrence Filter No. 1 where a bacterial efficiency removal of 97.3 per cent. was obtained, we find that the number of bacteria was reduced from about  $1\frac{1}{2}$  millions to 40,000 per c.c. The percentage removal is higher than that required in the case of mechanical filter plants by the United

The previous table gives the average figures for the bacteriological analysis of the final effluents from eight land intermittent plants in Great Britain.

A glance at the above biological analysis will convince anyone that in no case can the effluents be termed fit for drinking purposes. The chief advantage of land treatment as compared with other processes is often ascribed to the fact that land is more capable of removing pathogenic germs. This advantage, however, loses a great deal of its importance when we find that the effluents are so far removed from drinking water standards. In Europe the conclusions arrived at are similar to those of the Royal Commission. Schottelius, in connection with the Freiburg sewage and land treatment reduced the number of bacteria in the sewage from 790,600 to 6,700 per c.c. or a reduction of 99.2 per cent. Beckurts and Blaseirs at Brunswick were successful in ob-

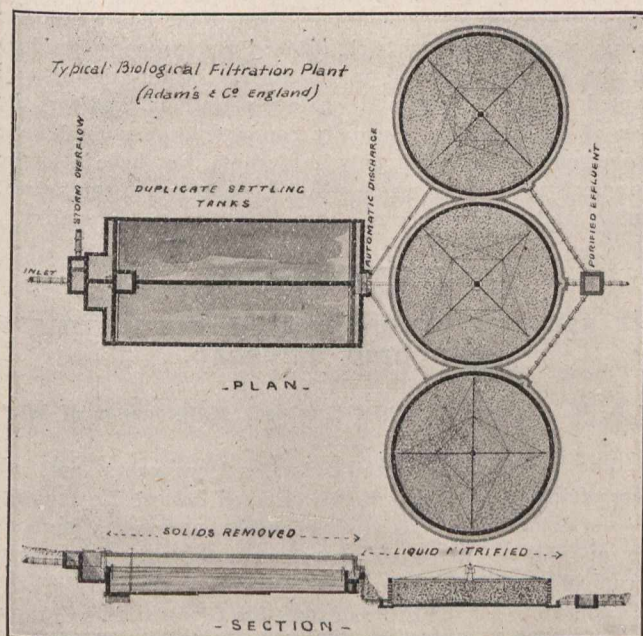
(Continued on page 248.)

### SOME FEATURES OF PAVING MATERIALS.

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In the consideration of the laying of a good roadway there are primarily the adaptability of the material, also its durability, and cost of execution and maintenance. Where the traffic of vehicles may be conducted with facility, and the surface material offers the least resistance, while there is no protuberance formed or hollow made by the heavy weight of passing wagons, then such a roadway may be considered as well adapted for the purpose intended. The cost of the material and the labor entailed in laying, and the necessary grade in the construction of the roadway, enter largely into the calculations. The engineer's ingenuity is also brought into requisition in the consideration of the subsoil upon which the roadway is to be constructed, as much depends upon its character for the material and manner of manipulation to be adopted. To a community that has to be taxed for the construction, maintenance and repairs of a public roadway, the cost is a very important question. Yet, the kind and quality of the material, as well as the method of construction, should have the greatest consideration, as it is upon this basis that a proper estimate can be obtained which will be productive of the best results. Of course, much will depend also upon the locality where the roadway is to be constructed and the general traffic which it is likely to receive. There are several classes of roadways, viz., those in streets of cities and towns, suburban villages, private drives or country roads. For the paving of streets in cities or towns frequently vitrified brick, sheet asphalt, creosoted wood blocks, stone blocks, or asphalt blocks are adopted. Again, for suburban roadways sometimes macadam, tar macadam, vitrified brick or petrolithic may be utilized, while for ordinary country roads gravel or earth may be adopted.

In the formation and construction of streets in cities and towns, where considerable heavy traffic may be required, or where sewerage or drainage operations are to be taken into account, the kind of material that shall meet these requirements at the least possible cost and give the greatest satisfaction, is the one which shall meet with approval and be adopted. In the forming of public streets, smoothness of vehicular traffic, the minimizing of noise, the facility with which it may be swept and kept clean in a thorough, sanitary condition, and the means of access to sewerage or drainage operations without affecting the materials, and having them replaced satisfactorily in position—these are elements that are worthy of the greatest consideration. Of course, smoothness is a very important factor, but frequently the horses are apt to slip while running at too great a speed, but this may be obviated by reducing the pace and having the horses properly shod. There are some streets in cities where heavy-loaded wagons are prohibited from travelling, and which are strictly reserved for carriage or light vehicular traffic. In such cases materials may be adopted for the highest class of construction that shall have the



States State Board of Health. The bacteria remaining to the number of 40,000 would require a further percentage removal of 99.6 per cent. to bring the bacterial count within the German standard for drinking waters by not more than 100 bacterial per c.c.

The fifth Report of the Royal Commission on Sewage Disposal states, par 194, page 142: "Our investigations have not shown that there is any essential bacteriological distinction between effluents from land and effluents from artificial filters, though effluents from land usually contain fewer micro-organisms than effluents from the artificial filters which are at present in use. The bacteria in the filter effluents can, however, be largely reduced, if this is necessary, by some additional process, such as sand filtration or sterilization, but for the reasons which are given under the section of this Report dealing with standards, we do not consider that the further process would usually be required."

From the above statement it will be noted that the Commissioners do not consider that there is any essential difference as far as bacterial removal is concerned between land and artificial biological filtration. The term essential must be taken as applying to drinking water standards.