

owing to the stream being confined to a narrow channel through the reclamation. The fate of the Tank Stream has been the fate of other neighbouring and much larger streams. Although these streams have become almost obliterated as natural features, they make their presence known in a very inconvenient manner. The large closed channels which have been constructed to replace the original open watercourses prove in every instance too limited in capacity for the immense amount of water which rushes down from the adjacent slopes during heavy rainstorms, and in dry weather they become huge gas holders charged with the gas disengaged from the streams of decomposing sewage which meanders through the accumulation of silt on the floor. Outside the city boundary there are many other streams upon which population is converging; these seem destined to share a similar fate. Concurrent with the spread of population over the whole district comprised in the basins of Cook's and Parramatta Rivers and their tributaries, streets are being formed, water channels cut, and kerbing and guttering laid; these works, together with the hardening of the surface of the ground by traffic, cause the rapid concentration of the water resulting from rainstorms, which is then quickly precipitated into the main watercourses and channels. This concentration and rapid flow gives to the water erosive power, hence large quantities of silt, together with mud from streets and house refuse, are carried down and deposited around about the mouth of the stream, upon the flats, or spread over the flow of the harbour. Large accumulations of silt are thus being formed, a considerable proportion of which consists of putrescible organic matter. The decay of this matter, when exposed on the mud flats at low tide, is a growing nuisance, increasing with the increase of population. On some portions of the populated area, and, notably that within the city boundaries, the water carriage system for the disposal of foecal matter and house slops has been adopted. At present the sewers discharge into the harbour waters, causing their pollution to an almost unbearable extent. A system of intercepting sewers, now in course of construction by the Government, will divert the bulk of the sewage, and cause its discharge into the ocean waters. Whilst the lighter

and most offensive matters will thus be removed, no appreciable diminution in the amount of heavy silt now discharged into the harbour will be effected. The solid and semi-solid refuse from dwelling houses and factories—that heterogeneous mixture known as rubbish—is got rid of in a variety of ways. When collected by the organised staffs of the city and suburban municipalities it is used for filling in excavations and natural depressions, for reclamations, and the formation of park lands, or it is deposited at recognized “tips.” In the outlying thinly populated districts the householder throws his rubbish where most convenient. In this manner large accumulations of rubbish, containing a high percentage of putrescible organic matter, are gradually being made upon areas over which population is rapidly spreading, and even at this date many rubbish tips have become sites for dwelling houses. In and around the metropolis the original topographical features have been greatly changed by the grading of streets, preparation of building sites, formation of railway embankments, and reclamations. Little thought appears to have been given to the effect which such changes may have upon the surface and subsoil drainage. Original water-courses and depressions have thus been in many instances entirely obliterated, and subterranean basins formed by the embankments made across the natural lines of drainage. Whatever water percolates through the surface finds, in many cases, a permanent lodgment beneath. It is well known that this subsoil water, after acting as a leeching agent of a stratum, consisting largely of organic refuse, is scarcely less foul than sewage itself. Above these subterranean accumulations of foul water the ground air brings to the surface those poisonous emanations which are invariably the result of the putrid decomposition of animal matter. Of all the dangers to health which may surround human habitations there is none which more insidiously undermines health than a saturated surface or subsoil. Any level undrained surface is unhealthy, but the concentration of unsanitary influences arising from want of drainage is apt to be found where the surface or subsoil receives the fermentable refuse of a crowded population.

The previous remarks upon the natural condition of the whole area, and the unhealthy results arising from the settlement of population thereon, lead now to the considerations of what should be done to improve its present sanitary condition, and provide beforehand for future requirements.

Mr. W. Clark, in his report to the Government on the drainage of the city of Sydney and its suburbs, has indicated the steps which should be taken in regard to low-lying areas bordering the harbour. Referring to the low land at Double Bay, Rushcutter's Bay, and Lacrozia Valley, he says: "In all these places, where the land is but a few feet above sea level, and too low to afford healthy sites for houses without pumping the drainage and subsoil water, I would recommend that the further erection of buildings should cease, that the land be resumed by the Government, and laid out for public use as places of recreation; moreover, that in each of these cases an open channel be formed through them for carrying off the surface waters of the district, which has here its natural outlet." Mr. Clark's recommendation should be carried out in its entirety, and ample scope will be found for its application to those extensive low-lying areas at the outlet of Cook's River and those marshy unhealthy areas so frequently met with bordering the harbour, particularly westward of the city.

It has been the practice hitherto, when making reclamations, not to continue the filling in landwards beyond the high water mark, which frequently is the boundary of private property. This practice must not continue; the level of the surface of the reclamation should be continued inland, with a gentle rise until it meets the natural surface, otherwise great evils will arise, an unfortunate example of which is exhibited by the Blackwattle Swamp reclamation. The open channel should be so capacious that the level of the flood-waters will not be unduly raised in their natural inland channels, and so cause damage to private property. In some instances canals may easily be constructed, which will afford ample escape for storm-water, as well as giving facilities for trade. At Iron Cove Creek, Long Cove Creek, and Hen and Chicken Bay canals could easily be cut as far as the main western road. These

canals would not be expensive to make, and would be a considerable step towards the reclamation of the large tracts of swampy land which exist there. No matter what improvements may be effected a large amount of silt will be carried down by storm-waters. If the reclamations around the outlets of the main drainage channels are improperly made the silt will be driven further out into the harbour and spread over the bottom. If steps be taken to encourage the deposit to accumulate in one place its removal by means of dredges will be facilitated.

A radical change is necessary in the method of treating the main lines of natural drainage along the bottoms of the valleys. Instead of allowing population to hem the creeks and watercourses in, and confine them within the narrowest possible bounds, which is now the practice, a reserve should be made not less than two chains in width all along the bottom of the valley, so as to include the watercourses within its limits. The irregularities of the channel would have to be corrected by straightening the course and carrying it along the centre of the reservation. The whole of the bottom of the channel and the sides for a portion of their height would have to be concreted or bricked. A roadway aside of the channel would be required for effecting the removal of silt and rubbish. Plantations of trees at a sufficient distance from the channel to prevent drainage from the roots could be made and outside the plantations streets for ordinary traffic. Under no circumstances, whatever, should the channel be covered over, but it should be left to the full influence of the purifying action of the air and sunlight. A channel so constructed would be essentially a storm water channel. For the conveyance of sewage, small sewers would have to be constructed one on each side.

The channel would afford a convenient outlet for subsoil drains, which are absolutely necessary for rendering healthy extensive, flat, low-lying areas chiefly in the western suburbs.

Subsoil drainage does not appear to have received much attention yet, and there are many areas which would be all the better for the institution of this highly desirable sanitary measure. The writer has been observing the effect of the recent prevalence

of wet weather upon the clayey soils of the western suburbs, a good opportunity being afforded by the numerous trenches opened in connection with the laying of water pipes, and there is but one conclusion to be arrived at, which is, that a sewerage scheme for those districts unaccompanied with systematic subsoil drainage, and the prohibition of residence on low-lying areas will not secure those results which it is expected to accomplish. Sub-drainage should be provided in all cases where the construction of road or railway embankments may tend to cause the accumulation of subsoil water on the uphill side. The great weight of the superincumbent bank of earth compresses the underlying soil, and thus obstructs the passage of the water. The mass of earth in the embankment being loose acts as a sponge rapidly absorbing the rain which falls upon it, and gradually discharging it at the base. The ground on the lower side of the embankment will thus be kept damp and unhealthy, as well as the upper side. The extensive filling in at the site of the Railway Workshops at Eveleigh, may be expected to cause an unhealthy dampness in the ground on the downhill side. This area being flat, clay ground always was damp and unhealthy, its condition must now be worse. Unfortunately it is being rapidly covered with dwelling houses. There are numerous other instances of a similar character and the evils now arising from them could have been largely, if not wholly, prevented by a proper system of subsoil drainage. No doubt, in the near future many railways will be constructed in the Metropolitan district, and precautions against retarding the subsoil drainage should be taken. All filled in areas should be drained. Drainage will not correct all the evils which result from the use of house and street rubbish for filling in and levelling up purposes. The application of town rubbish to such purposes should be absolutely prohibited. Healthy sites for dwelling houses can never be formed with such materials, even if a layer of so called sound rubbish is spread above it. An evolution of poisonous gas will be coincident with every fall of the barometer. A proportion of this gas will rise under the floors of houses built over the area and find its way into the rooms above. In the summer time sudden

changes in the barometric pressure of the air are frequent, and are of common occurrence after sunset. The warmth of the season accelerates the decomposition of the organic matters in the mass of filling causing the disengagement of large quantities of gas which, if the change in the air pressure takes place during sleeping hours, must lower the vitality of those subjected to its influence. The impervious covering formed by the concrete foundations of wood paved streets will compel the ground air to seek outlets at the sides in dangerous proximity to cellars and basements. It is not clear how this evil may be avoided. All house and street refuse should be destroyed by fire. In growing communities rubbish tips cannot be kept out of the way of advancing population. The thorough and systematic cleansing of the surface of the populated areas is necessary to reduce the pollution of the harbour and rivers. The conveyance of liquid refuse from dwellings all over the Metropolitan area will no doubt be eventually effected by sewers which will receive the faecal refuse as well. The disposal of the sewage is a problem, the solution of which will present many difficulties. A scheme for the interception of the sewage, which at present flows into the harbour from the city of Sydney and several adjoining suburbs, and its conveyance underground to the ocean, is nearly completed. The districts remote from the coast line are debarred from using a similar method. Two other courses are, however, available. The sewage from each separate valley may at its outfall into the harbour be filtered. Where the discharge would be effected into the salt water the refined degree of purification necessary in those instances where the discharge takes place into fresh water streams would not be required. At the bottom of all the valleys reclamations are necessary and these reclamations if made would form convenient sites for filter beds. Under such a scheme each valley should be made a district, the residents of which should be held responsible for the proper disposal of all their solid and liquid refuse—they should have the use of reclaimed areas for recreation purposes. The cost of the necessary works and their maintenance would be defrayed by a rate levied within the district.

The other course open is to collect the sewage at the various outfalls and pump it to such an elevation as may be necessary, to enable it to descend by gravitation to the coast, or on to an area of ground inland prepared for use as a sewage farm. In deciding upon the adoption of sewage schemes for the inland districts it will be necessary to provide for a very large population. Sewage schemes when carried out afford such a convenient means for disposing of much unpleasant matter, that it is possible to crowd a greater number of houses upon a given area than would otherwise have been possible. Dr. G. V. Poore refers to this in a lecture delivered by him recently in London. He said: "A complete system of water-carried sewage encourages overcrowding, because a sewer does away with the necessity of any curtilage to a house. The density of population in some parts of London steadily increases. What once were gardens or back yards are now dwelling houses. Houses steadily increase in height, and, there being no need of any arrangement for filth disposal, except by a sewer, the houses are built in serried ranks, and often back to back. We make no serious efforts to control building schemes, but when with the lapse of time, the dwellings of the rich become the dwellings of the poor, we simply wonder what is to be done, and make no effort to prevent what we are almost powerless to remedy. From a sanitary point of view overcrowding is most undesirable. It breeds squalor, discontent, and disease."

Dr. Poore's remarks are essentially true, and show the necessity of legislative action being taken to limit the number of houses which shall be allowed on a given area of land. Such action would be a most desirable adjunct to Mr. Reid's Widths of Streets and Lanes Act. It should also take cognisance of those areas which are, by reason of their low elevation, utterly unfit for habitation.

The density of population on any area has a direct influence upon the rapidity with which rainwater, falling on the uplands, will be precipitated on to the lower levels. The volume of water which flows off an unbuilt-on area during a heavy rainstorm is no indication of the amount which will flow off during a similar rainstorm when the area has been extensively built over. The tendency is

always to diminish the time required, on account of the facilities afforded by paved channels and drains for the rapid down flow of the water. Amply capacious storm-water outlets should, therefore, be provided for all districts which in the near future will be thickly populated. These storm-water outlets should be quite distinct from the sewers, for they serve a different purpose.

In concluding these remarks the writer desires to draw attention to the necessity that exists for legislative action and the passing of laws for the promotion, as well as the enforcement, of sanitary measures, without which many existing evils cannot be successfully combatted, nor can measures providing for future requirements be undertaken. And another important consideration presents itself — it is this: The people generally require educating on sanitary matters, and their knowledge of the laws which govern health increased. With this education of the masses attained, proper sanitary enactments will achieve the best results.