

XX.—*On Drainage and Sewerage, &c., of Towns, with special relation to the late Epidemics in Hobart Town and Launceston.* By SIR W. T. DENISON, F.R.S., &c.  
[Read 9th November, 1853.]

THE prevalence during the last three or four months of a fever, whose type was, I believe, assimilated most closely to that which characterizes scarlet fever, has induced me to bring under the notice of the Royal Society, in the first place, the nature of some of those influences which may have aggravated, if not caused, the disease; and in the second, an outline of the precautions which ought to be taken to secure to the inhabitants of Hobart Town a continuance of the advantages which its position entitles them to claim,—situated as it is on the banks of a noble river, with an atmosphere pure and healthy, if not affected by influences arising from within the city itself.

It would be altogether out of place were I to enter into a medical disquisition on the cause of fevers, and the effect produced by them on the human frame, but I may be allowed to submit a brief abstract of some of the facts established by the “Health of Towns’ Commissioners” in 1844; at which period a close and searching investigation was made into the state of many towns in England, the results of which, with some modification from causes peculiar to each locality, are of universal application.

The evidence taken before the commissioners, or collected by them, goes to show that neglect in cleansing and draining the dwellings of the poor, and the absence of proper ventilation, is productive of the worst effects.

That fever is constantly present in one form or another where the people live in dirt and filth.

That fever breaks out first and becomes more prevalent and fatal in the neighbourhood of uncovered sewers, stagnant ditches and ponds, gutters full of putrifying matter, nightmen's yards, &c. That the effect of want of cleanliness and bad drainage, where their action is not sufficient to produce actual fever, is shown in the disease of the digestive organs, and predisposes the human frame to receive some of the most common and fatal maladies to which it is subject.

That persons who reside in habitations badly drained and subject to the influence of malaria, even if free from attacks of actual disease, are undergoing a process of deterioration; their constitutions are injured, mothers are unable to attend to their children—these latter have bad health, and the mortality among them is great.

That the ability of the labouring classes to maintain themselves is very much diminished by disease and weakness, engendered by the causes above alluded to.

I need only notice briefly the moral effects produced by such a state of things; they are, however, just as injurious to the character of the man who is subjected to them, as to his physical well-being. The lowering effect produced upon the frame by malaria is such as *drives* a man, if I may use the term, to the use of different kinds of stimulants; and if his home cannot be made comfortable, he is almost compelled to resort to the public-house.

The result of discomfort and incipient disease is often seen in confirmed habits of drunkenness and dissipation, which operate equally to the detriment of the physical and moral character.

This is a brief summary of some of the effects due to the various causes which want of cleanliness brings into action. I use the term want of cleanliness advisedly, not limiting it to the absence of habits of personal cleanliness, but apply-

ing it generally, to include all those cases, whatever may be the cause, where a disregard to all ideas of comfort as dependent upon order and method, or, to use a more expressive term, on *tidiness*, is exhibited.

The subject is deserving of special consideration at present, as from the circumstances in which the colony is now placed, there is a natural tendency towards a state of things analogous to that which prevailed in many of the towns of England, from which the evidence, bearing upon the facts stated above, was drawn.

House rent is high ;—there is therefore every disposition among the labouring classes to crowd as many as possible into one room.

Fuel and water are dear ;—proper attention will not therefore be paid to ventilation or cleanliness.

Labour is very much in demand ;—less than usual therefore will be expended in keeping the houses and adjoining yards clean,—in removing soil, rubbish, &c.

It is by no means improbable that the epidemic which has prevailed, and which indeed does still prevail in Hobart Town and elsewhere, has been rendered more fatal than it otherwise would have been by the causes alluded to above ; for the evidence given to the commissioners tended to prove that the poisonous condition of the atmosphere which they inhale predisposes children to acute fevers, accompanied with a rash upon the skin ; such as scarlet fever, measles, small-pox, and renders such diseases fearfully mortal.

The evils arising from the state of things above described are patent enough ; but how can they be met ? How can a remedy be applied, simple in its operation, and at the same time effective enough to neutralize, if not all, at all events the most pressing, of the influences which affect so injuriously the health and morals of a town population ? In reply to

this I would observe, that the evidence given to the Health of Towns' Commissioners was sufficient to prove that in the towns of England the application of a proper system of cleansing and draining reduced the mortality in those districts in which fever constantly prevailed to an extent of one-third, or even, in some instances, of one-half; and although such a system would not remove the evils arising from overcrowding the habitations of the poor, or from the faulty construction of the buildings in which they reside, yet, by creating a better atmosphere around them, many of the most active causes of disease would be neutralized.

I will proceed, therefore, to enquire into the principles by which a proper system of drainage should be regulated, and then discuss the best mode of applying these principles to the drainage of Hobart Town and Launceston; and I will lay before the Society such information as to the construction of sewers, their size, form, and the materials of which they may be composed, as may afford useful hints to those upon whom has devolved by law the charge of superintending the drainage and cleansing of these towns, besides enabling them to form an approximate estimate of the cost of such an undertaking.

We are met at the outset of an enquiry of this kind, by the fact that the character of the drainage must be to a great extent dependent upon the nature of the supply of water furnished to the inhabitants; and upon consideration this will appear perfectly clear. With a large supply of water, much must pass through the sewers; and again, these will be more easily cleansed and kept in order where the rush of water down them is frequent and large.

As a preliminary, therefore, to any enquiry into the drainage of towns, it is necessary to say a few words as to the supply of water, which is not only essential to good drainage.

but operates beneficially upon the habits of the people, by encouraging and facilitating cleanliness.

In both Hobart Town and Launceston this supply is deficient. In Hobart Town, the source, though it may be said to be perennial, is trifling in amount; while in Launceston, proper means have not yet been adopted for turning to account the ample streams discharged by the South Esk, a large portion of which river might be directed through the town if necessary.

In Hobart Town, the supply for many years, indeed until recourse is had to the water of the Derwent, will always be rather scanty; but by constructing reservoirs in the valleys above the town, a great body of water might be retained at an elevation sufficient to carry it through all the streets.

To return to the consideration of drainage: the elements of which a general system is composed are;—

1st. Main sewers, by which the accumulated drainage of the town is carried to its outlet, wherever that may be.

2nd. Branch sewers, by which the drainage of a certain amount of the area of the town is carried into the main sewer.

3rd. House-drains, or small channels by which the drainage of isolated buildings are discharged into the branch sewers.

With regard to the main sewer or sewers, it is evident that the dimensions of these must be sufficient to carry off not merely the drainage of the buildings composing the town, but also that of the whole area which discharges itself into the same channels.

In point of fact, the main sewer of a town often occupies the place of an old watercourse, which formed the outlet of the drainage of a large district, comprising not only the

area of the town, but also that of its suburbs ; and the size of this sewer is very often dependent more upon the necessity of a rapid discharge of the water poured into it during heavy rains, than upon the actual drainage from the town.

In any calculations, therefore, which are made for determining the size of these main sewers, attention must be paid to the area of the district for which it is the outlet ; to the maximum quantity of rain known to fall within a given period ; to the usual discharge from the town. And it must also be remembered, that the effect of a perfect system of drainage is to carry off the water which falls on the surface much more rapidly than would happen were it allowed, as is now the case, to find its way gradually to the outlet or main sewer by such imperfect channels as it can make for itself ; and, therefore, that the more perfect the system of drainage, the larger must be the main outlet.

The branch sewers, which convey the drainage of different portions of the town to the main sewer, must be constructed with reference to the maximum amount of water which will pass through them in the heaviest rains.

It would be false economy to make the sewers too small to convey the maximum charge, and equally so to make them larger than necessary. The size will be determined by a joint consideration of the quantity of water to be passed through them in a given time, and the velocity of discharge, which depends upon the fall or the slope which can be given to the bottom.

It is desirable to maintain, as far as possible, an uniform fall in the sewers, for if the upper portion be steep and the lower portion more nearly horizontal, the water flowing less rapidly through this latter would not be carried off as fast as it would be brought down from above, and there would

be a risk of the crown of the sewer being forced up, unless the dimensions were increased in the inverse proportion to the velocity of the water through it.

This is a matter to which attention should be paid, for it frequently occurs that the valley through which the main sewer runs has steep sides, and is then level, or nearly so, for some distance from the edge of the watercourse. In such cases it is necessary to increase the dimensions of the branch sewer on the level parts, in order to prevent the risk of damage which would be certain to happen should this portion be choked or gorged with water.

As to the actual construction of these sewers, this must depend of course very much upon the materials of which they are made. In some places, stone will be cheaper than brick; in others, it might be possible to use cylindrical pipes of different diameters, made of strong earthenware.

The engineer must of course be guided in the employment of any or all of these by the peculiar circumstances of the case. A preference of one over another should result only from a close examination of the advantages and disadvantages attendant upon each,—among which of course their relative economy is one of the most important considerations.

It is most desirable that no leakage should take place through the bottom or sides of the branch sewer, which should, therefore, always be carefully bedded in cement.

Where the sewers are built of brick, and the amount of water-way required is more than an 18-inch barrel drain would supply, the oval or egg form is that which combines most advantages. The effect of the scour of a small quantity of water is far greater in a sewer of this shape than in one with a flat floor. The quantity of material required in

the construction of a given length is much less, and the strength to resist the tendency of the earth to press in the sides of the sewer is far greater, than in one with upright sides.

It is most desirable that the entrance into these branch sewers from the street, as gully-holes, &c., should be carefully trapped, so as not to allow the stench from the refuse contained in them to make its way into the streets or into the houses.

It is not necessary that I should enter more at length into details, my object being to lay before the Society the general principles which should guide those who are called upon either to submit or discuss plans for a comprehensive scheme of drainage for towns, together with such general observations upon form and materials as may be useful as hints.

In applying these observations to the towns of this colony, but more especially to Hobart Town, I would observe with reference to the directions of the main sewers, that the lines in which these will run are plainly determined by the outline of the land upon which the town is built. The Hobart Town Rivulet is the great outlet, not only for the town itself, but also for the side of Mount Wellington and the various gullies which are formed in the flanks of the mountain.

In heavy rains, the rush of water from the hills is so great as to fill the present watercourse nearly to the brim at the lower part, near the outfall into the river. It would not, therefore, be practicable to diminish the section of the channel here, though at points higher up the stream, where the fall is greater, a reduction might of course be effected.

At Launceston, the shape of the ground would also seem



to point out the direction of the main sewer, which in one case would follow the bottom of the valley in which the town is built; while the North Esk River would form the main outlet for a large portion of the town,—the branch sewers being carried at once into the channel of the river.

In many parts of Hobart Town the fall to the rivulet, or main outlet, is so rapid and short, as to render it probable that branch sewers of small dimensions would be amply sufficient to carry off, not merely the drainage from the houses, but also all the surface drainage of the streets; care being taken to provide against the risk of these small drains being choked by the accumulation of rubbish and mud from the streets.

With regard to drains from the houses to the branch sewers, it is difficult to lay down any precise rules for the guidance of the engineer or builder. These drains are a matter for the consideration of the owner of the property; and although law will step in to prevent any injury or nuisance which may be occasioned by the neglect or indifference of a proprietor, either to a neighbour or to the public, yet he must be allowed a great latitude as to the means which he may choose to employ to prevent such injury or nuisance.

The same considerations which regulate the size of the branch sewers, namely, those which relate to the quantity of matter discharged through them, and the slope or fall, apply with equal cogency to house drains.

It must be remembered that the smaller these drains are the more effective will be the scour of the water which is passed through them, and an earthenware pipe of moderate dimensions will in general be quite adequate to carry off every thing, unless where the length of the drain is great and the fall but trifling.

Though the mode in which the proprietor of land and houses may choose to drain them is, in justice and reason, left to himself, yet the community is too deeply interested in the question to allow of such an exercise of individual privilege as might lead a man to refuse to drain altogether ; for by so doing he is practically injuring others, and the Legislature may justly interfere, and say that the rights of individuals must succumb when they interfere with the public good.

Legislative action will then be required to compel individuals to carry off, through the sewers, the refuse which, if left to accumulate and decay on their properties, might prove not only a nuisance, but a serious evil ; and the same enactment would prescribe certain limits both to the rights of individuals to resist, and the rights of the corporate body to enforce, certain specific modes of action.

A more difficult question, however, is, that of the mode of providing the funds which would be required to carry out a comprehensive system of drainage ; and with a few words upon this subject, I shall conclude a paper which I feel at once to be too long and too short,—too long as a mere sketch or outline, but far too brief if considered as an Essay on Drainage.

There are three parties interested in the subject of the drainage of large towns :—

- 1st. The individual owners of property in the town.
- 2nd. The whole body of inhabitants resident in the town.
- 3rd. The community generally.

Among these three parties must be distributed in certain proportions the cost of carrying out the whole of the works which will be required for an effective system of drainage.

But it would be obviously unjust to charge upon the present generation the whole cost of an undertaking of such

magnitude, the benefit from which will be felt for centuries. The money required should therefore be raised by way of loan, the interest of which, together with a sinking fund, by which the whole debt would be paid off in, say fifty years, would be charged upon the three parties before alluded to.

When, however, we come to consider the share of the burthen which each party is to bear, we find that the owner of property, though called upon in the first instance to execute the work of draining his estate, manages very soon to relieve himself of any pressure on that account by charging it upon the occupier in the shape of rent. And thus, in practice, the cost of that portion of the work which is more particularly public will have to be defrayed by the inhabitants of the town, represented by the Corporation, and the general community, represented by the Legislative Council.

The share of the expense which will fall on the inhabitants will take the shape of a rate levied by the Corporation, while the general revenue will be charged with a certain annual payment representing the interest of the colony at large in the undertaking.

When it is considered that the inhabitants of the town contribute to the general revenue in full proportion to their numbers, perhaps the whole cost of a general system of drainage might be divided into two equal portions, one of which should be paid out of local funds, the other out of the general revenue.

This, however, would be one of the matters which must come before the Legislature whenever the details of an enactment for providing for the systematic drainage of either Hobart Town or Launceston are under consideration; and it is to be hoped that the importance of the subject to the physical and moral well-being of the community will, ere long ensure the introduction of a measure conferring upon

the municipalities of these towns such power as may be necessary to enable them to carry out effectively one of the principal objects for which such bodies are organized.

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XXI.—*Observations on the Census of the United States, taken 1st June, 1850. From the Official Report of the Superintendent of Census. By JAMES BARNARD, Esq. [Read 13th October, 1852.]*

THIS, the seventh, enumeration of the inhabitants of the United States exhibits results which every citizen of that country must contemplate with gratification and pride. Since the census of 1840 there have been added to the territory of the Republic, by annexation, conquest, and purchase, 824,969 square miles; and its title to a region covering 341,463 square miles, (previously claimed and partially occupied by England), has been established by negotiation, and brought within its acknowledged boundaries. By such means the area of the United States has been extended, during the past ten years, from 2,055,163 to 3,221,595 square miles, exclusive of the great lakes which lie upon its northern border, and the bays which indent its shores on the Atlantic and Pacific.\*

\* The Australasiatic group of British Colonies contains, together, almost a similar area; viz.—

The Continent of New Holland or Australia, comprising its principal division of New South Wales, South Australia, Western Australia, and North Australia, is 2400 miles from east to west, and 2000 miles the greatest breadth from north to south, having a superficies of about 3,000,000 square miles, reaching very nearly to the same area as the United States.

Tasmania, about 200 miles south of New Holland, contains 24,000 square miles.

New Zealand, 1000 miles to the east of New Holland, has an area of 100,000 square miles.