SEWAGE DISPOSAL IN CITIES.

INTO every city there must be constantly brought water, food, fuel, and other matters sufficient in quantity for the needs of the people and animals in it. In the use of these things, not a grain of the matter of which they are composed is destroyed, but much of it undergoes a great change in form and in properties. The warning cry of a common game among children that "what goes up must come down" may be changed in such case to "what goes in must come out." A large part of the used material is disposed of by the atmosphere, into which it passes in the form of gases of various kinds, the products of combustion, respiration, fermentation, etc., there is still left a very large amount of liquid and solid refuse which is not only useless within the city, and in the way, but is, or is liable to become, offensive and dangerous.

The question as to the best means of disposing of this refuse matter, including ashes, garbage, street sweepings, excreta, and water befouled by domestic or factory uses, is one of the most important problems with which a municipality has to deal.

The ancient, uncivilized way of answering the question is to leave it to each individual householder to get rid of his waste products as best he can.

In the cities of mediaeval times these were usually deposited in the streets, the excreta being collected during the day in jars which were emptied at night.

The nuisances and pestilences which resulted from this method of sewage disposal gradually led to the adoption of other methods giving less offense to the senses, and chief among these was the formation of pits or special receptacles in the ground for the storage of filth, or what is known as the privy or cess-pool system.

The term cess- or cess-pool, known also as "soe," or "sus-pool," signifies literally a "soak-pool," and this is a good characterization of the majority of them. For a time this method gets rid of visible nuisances, and seems to produce good results, but sooner or later it gives rise to the gravest danger to health, and to serious loss to the city which persists in it. In order to understand how and why it does this we must know something of the composition of that form of refuse known as sewage.

Sewage, in the sense in which the word is used in this paper, includes not only excreta, but all water rendered impure by domestic use or by waste products. It consists therefore of water holding in suspension and in solution very diverse substances, but its most important peculiarities depend upon the fact that it contains a large amount of organic matter, part of which is alive in the form of myriads of extremely minute organisms, and a part of which is dead and in process of decomposition into simpler combinations of the carbon, nitrogen, oxygen, hydrogen, sulphur, and phosphorus of which its molecules have been built up.

This decomposition is for the most part effected by micro-organisms, and if these are killed, as may be done by heat or by certain chemicals, decomposition ceases.

Each tiny microbe consumes in its growth and multiplication a minute portion of dead matter, and excretes as products certain substances which, while injurious or poisonous to itself, may be the food necessary for another species.

The changes thus produced are known as fermentation, nitrification, putrefaction, etc., the latter term being applied when offensive gases are produced. The chief function of dead organic matter is as a store of force in the shape of food for living beings, of which, until quite recently, little has been known, and the importance of which in the economy of nature we are only just beginning to discover.

Life in this world, as it were, a balancing or seesaw between different organisms, in which each helps the rest—a cycle of actions which are to a certain extent dependent on each other.

The molecules of the grain of wheat in part help to construct the muscle cells in a man's arm, and in part furnish fuel or motive power to these cells, while the excreted products of these cells in the form of carbonic acid, urea, etc., and finally the products of the decomposition of these cells, may go to construct a new grain of wheat.

But to enable the vegetable to make use of the animal cell as food, the latter must be split up into simpler combinations, and this is effected by micro-organisms of various kinds. The great majority of these minute beings are harmless to man so long as they are confined to his skin and alimentary canal; in fact, every one carries millions of them on and within himself,
and it is doubtful whether he could properly digest his food without their help. There are, however, some forms of these little granules and rods, or micrococci and bacteria, which are not so innocent and harmless, but which, on the contrary, produce disease and death in many of those to whose systems they gain admittance.

Some of these disease germs multiply only within the bodies of living animals, as, for instance, those which give rise to small-pox and scarlet fever; they retain their vitality for a time when thrown off in excretions; but they do not increase in number until they gain access to living tissues, and hence the diseases which they cause are propagated by contagion only. Other disease germs multiply, so far as we know, almost exclusively outside the living body, and produce their effects on man not by growing within him, but by poisoning him with their products, as common yeast may be said to be the cause of delirium tremens through the agency of the alcohol which it produces. Malaria is a type of this class.

A third kind multiply both within and without the living body, and some of these appear to especially multiply and flourish in human excreta. As yet we know very little of the life history of these disease germs, or as to how they produce their effects; we are not even certain as to whether they are distinct separate species or whether they may not be some of the common micro-organisms which by over-feeding or otherwise have become abnormal, microscopic monsters as it were, producing evil instead of good.

What we do know is that a very minute quantity of excreta from a case of cholera or of typhoid fever may, when introduced into the alimentary canal of a healthy person, produce in that person a disease similar to the one from which the germ originally came; and we also have good reason to believe that if a few such germs fall into a mass of excreta, as in a cesspool, they may under certain conditions multiply very rapidly and render the whole mass of filth infectious, so that any portion of it will be capable of conveying the disease.

Their action is closely analogous to that of yeast, and the diseases which are supposed to be due to such action are known as the symptomatic or ferment diseases.

Hence comes one great danger of retaining or storing in the vicinity of human habitations quantities of organic matter suitable for the nourishment of such organisms, for the channels through which such collections may become dangerously inoculated are so numerous and, in the present state of our knowledge, so impossibly to guard against, that casks of powder or cases of dynamite would be really safer neighbors.

Sewage is not only a source of danger in this way, but also through the products of its decomposition. The most important of these in connection are the gases and effluvia evolved in putrefaction, such as hydrogen sulphide, ammonium sulphide, carbon dioxide, and certain organic vapors of very complex constitution, chiefly characterized by unpleasant odors.

When concentrated, as in old cess-pools or vaults, these may produce suffocation and almost immediate death, or great prostration, violent vomiting and purging, convulsions, and death in from one to two days.

The circumstances are rare which produce such effects as these; usually the gases are greatly diluted before being breathed, and the effects are less marked.

Constant exposure to such air impairs health gradually, but distinctly, especially in infants and children, the symptoms produced being loss of appetite, languor, slight headache, etc.

It may be said that the gases from decomposing sewage can not be very injurious or their effects would be observed among scavengers, workers in sewers, and plumbers, all of whom are specially exposed to these exhalations.

The fact is that a certain number of those employed in these occupations become sick soon after they engage in them, a few are forced to take to some other trade, a few die, and the survivors of this process of natural selection are those best able to resist the deleterious influences to which they are subjected, their power of resistance to which is strengthened by habit. Such men can breathe without apparent ill effect the air from a foul choked sewer, a few whiffs of which will sicken the unaccustomed by-standers, when the drain is opened.

Unpleasant sights and smells are not necessarily injurious to health, although they may turn the scale in the case of a feeble invalid just hesitating between life and death, but they are to be avoided and avorted as far as possible for the sake of
public comfort. One may become so accustomed to them as hardly to perceive their presence, but that is no reason why those not so wonted should be compelled to suffer from them.

The gaseous and other products of decomposition of sewage vary greatly according to the amount of free oxygen present, for upon this depends largely the character of the micro-organisms which are at work. Some of these can only exist in the presence of free oxygen, others only in its absence, and thus two very different kinds may be at work in the same cess-pool, the oxygen lovers at the top and the oxygen haters in the depths.

What may be termed the normal and beneficent processes of decomposition go on most rapidly and efficiently where there is a free and constant supply of oxygen, and methods of sewage disposal which provide for this supply are, other things being equal, the best. It is for this reason that a porous soil, alternately moistened with sewage and then dried, so that each particle of the soil becomes covered with a thin layer of organic matter, thus exposing an enormous area to the air when this again finds its way into the interstices of the soil, and so giving the aerobic organisms the most favorable conditions for their development, produces such excellent results; and in like manner the agitation of sewage with large quantities of water, or the forcing of air through it, so as to allow access of the dissolved oxygen to every particle, results in rapid decomposition and the ultimate purification of the mass, while at the same time the products are compounds of nitrogen which are very valuable in many ways.

On the other hand, a soil constantly saturated with sewage, as in the vicinity of a leaky cess-pool, can not thus purify itself, and the decomposition which goes on under such circumstances gives rise to products which are specially offensive and dangerous, contaminating the ground water, and through this the wells and springs in the vicinity, and contaminating also the ground air, which in cold weather is drawn into all houses which have not air-tight cellar floors and walls.

But, it may be asked, if the dangers and discomforts which arise from the storage of filth in or near human habitations are so great, why is it that in so many cities the people appear to prefer to make use of cess-pools even after sewers have been constructed, that wells containing polluted water continue in use, and that proposals to do away with these evils meet with stubborn opposition, and sometimes give rise to bitter hostility against the proposers of such improvements? The answer to this is that the danger is in most cases not apparent to the great majority of people, and that sights and odors which to those unaccustomed to them are extremely offensive may be unnoticed or tolerated with complacency by those who are constantly in their presence.

Cleanliness is a relative term; the ideas of a Polish Jew of the lower classes, of a New England housewife, and of a chemist are very different with regard to this subject, and a glass which all these considered clean would be at once rejected as impure by the experimenter who wishes to know whether the fluid which he places in it is free from living germs.

Moreover, cleanliness is not to be secured without some cost and labor, and sanitary improvements almost always involve some immediate inconveniences which to the ignorant majority seem of much more importance than the possible future benefits to be derived from them.

In attempting to teach the people that it is true economy to furnish this cost and labor we must recognize the fact that in many cases privy vaults and cess-pools cause no immediate and self-evident injury to the health of those living in the midst of, or over, them; that water contaminated with the products of decomposing sewage is drunk with apparent impunity by many persons; and that prior to the outbreak of an epidemic it is often difficult, if not impossible, to prove that the sickness and death rate of a community are increased by the presence of filth, especially if this filth is not apparent on the surface of the streets and yards, but is concealed in the soil beneath.

No one whose attention has not been specially directed to the subject, and who has had no practical experience in sanitary investigations, has any adequate idea of the many ways in which air, water, and food are rendered impure and unfit for use by sewage and its products.

The soil of one of the largest cities in this country is honeycombed by over 70,000 vaults and cess-pools, and the general saturation of the soil with filth is such that no wells in the place are fit for use.

Other large cities have sewers badly
planned and worse constructed, leaky, clogged, so nearly level in some places as to be little more than long cess-pools, with outlets so placed as to silt up docks and befoul the sides of piers and shipping, or so that at times their contents mingle with the water supply—buried monuments of the ignorance of the men who planned them, of the rascalities of those who constructed them, and of the blind folly of those who are responsible for their continuance. Yet those who urge improvement in these things are met by the objection that the death rate is only two or three per thousand in excess of what it ought to be, and that it is unwise to create alarm, because it will injure the commerce of the place.

Physicians and sanitarians have concluded that stored filth, and air or water contaminated by sewage or its products, are dangerous, from observations of the course of certain epidemic diseases, and from comparisons of the death rates of different localities, or of the same locality at different times, where different methods of sewage disposal and water supply have been made use of. The teachings of epidemic cholera and typhoid are sometimes terribly plain, so plain that the wayfaring man, though a fool, need not err therein, but, unfortunately, they are soon forgotten.

The memory of the Plymouth outbreak is still fresh in the minds of the newspaper-reading public, but how many now remember the lessons of the North Boston, the Guildford, the Over Darwen, or the Caterham outbreaks, all of which were due to the same cause?

In like manner the literature of cholera contains abundant evidence as to the influence of polluted soil and water on the spread of this disease, but the details of this evidence are almost totally unknown to the public.

Great as is the influence of sewage pollution in the presence of the specific germs of cholera or typhoid, the sum of the injury to health and loss of life produced by noteworthy epidemics of these diseases is really insignificant as compared with the results of continued slow poisoning produced upon communities by the organisms and products of filth.

To fully appreciate the loss of health and wealth which occurs in this way we must study the vital statistics of different localities for long periods, and we shall then find that in all towns in which a proper system of sewerage has been intro-

duced the death rate has been reduced, and especially that typhoid fever has been greatly diminished.

For example, in Munich, from 1854 to 1859, when leaky cess-pools were in use, the mortality from fever was 24.2; from 1869 to 1865, when the cess-pools were cemented and made water-tight, it was 16.8; from 1866 to 1873, when there was partial sewerage, it was 13.3, and from 1876 to 1883, when sewerage was complete, it was 8.7.

In Hamburg, from 1836 to 1844, when there was no sewerage, 46.5 out of every 1000 deaths were due to typhoid; from 1871 to 1880, after the sewerage was completed, the proportion of deaths from typhoid fell to 13.3.

It must be borne in mind that the improvement to health from a system of sewerage does not follow immediately; it requires a year or two for the filth-sodden soil to be relieved of its burden by nature's little scavengers, but the result is none the less certain.

The ideal system of disposal of the sewage of a city is one which removes it promptly and completely beyond the city limits, which makes full use of its fertilizing powers, which neither causes danger to health nor gives offense to the senses of sight or smell either within or without the city, which is to the least possible extent dependent upon the care and skill of the ordinary municipal laborer, and which does not involve too great cost either in its construction or its management.

This ideal is by no means an impossible one, but it is so for many cities. The majority must make the best compromise they can, and must do this while hampered with unfavorable conditions of soil, of badly planned and constructed works, and of debt, the heritage from ignorant, careless, or corrupt governing bodies.

No two cities present the same conditions. Each requires special study and treatment.

The first question to be decided in each case is, What shall be the ultimate disposal of the sewage? As stated above, it is desirable, if possible, to make use of its fertilizing powers.

Among the most important sources of stored force in the world which are available for the use of man are the compounds of nitrogen. They are essential to the growth and development of animals and plants, are limited in quantity,
and at present it is uncertain whether there are any processes in either the organic or the inorganic world by which, when wholly decomposed, they are renewed to any material extent, by which the free gaseous nitrogen of the atmosphere enters into such combinations as are necessary for the higher forms of life. Yet we are constantly wasting and throwing away these compounds, burning them in explosives, sending them to the rivers and the sea in the form of sewage, or allowing them to decompose in such a way as to derive no benefit from the force thus produced.

We borrow and do not repay; our soil grows poorer, and the demand for fertilizers increases; from large areas of this country the most valuable constituents of the land have been, and are still being, extracted and sent to Europe to be ultimately run into the sea through the sewers of her great cities.

It is true that what is lost in this way to one locality is in many cases gained by another; the sewage which goes into the rivers and the sea contributes directly or indirectly to the support of life of fish, etc., which are of use to man; but the loss to a given state is none the less grievous, and none the less to be avoided, if possible, because a distant land at some future time may derive some benefit from it.

The advocates of the various storage systems of disposal of excreta, including the dry-earth system, the Chinese and Pale systems, and the privy odorless excavating system, urge this as an argument against the system of water carriage, saying that we should not send to distant islands for fertilizers and at the same time waste the same materials at home. The reply to this is that the conversion of sewage into a fertilizer is not profitable in this country at the present time, and it involves more or less of the evils of storage.

The comment of the Sanitary Engineer upon the statement that Boston has just paid four or five million dollars for a tube through which to throw eight hundred thousand dollars’ worth of fertilizing matters into the sea yearly is as follows: "Admitting the supposed value of the sewage—in the same sense that the value of some mines is estimated, viz., by multiplying the cubic contents of a vein so many feet thick by the value of one cubic foot obtained by an assay yielding so many ounces of gold to the ton—admitting that the $800,000 may all be there, the practical question before the Bostonians is, What will it cost to get that value out of the sewage? We believe that it would cost from one and a half to two million dollars annually in interest and current expenditure to accomplish this result."

At present it is cheaper and easier to go West and get a new farm than it is to restore an exhausted one, and fertilizers can be made from other materials much cheaper than from sewage. This state of things will not continue indefinitely, and sewage will become more valuable; but until the time comes when it pays to collect it, it will be disposed of in the easiest and cheapest way which will prevent nuisance and danger to health.

Where land suitable for sewage farming is available, it should be used for the purpose, if it does not materially increase the cost; and even if it does increase the cost, if the alternative is the discharge of the sewage into fresh-water, unless the stream is very large.

This system of sewage irrigation has now been fairly tested at a number of places, and where the circumstances are favorable it gives very satisfactory results.

The less dilute the sewage, and the less its dilution varies, the greater its value, and hence those systems of sewerage which separate the sewage from the rainfall and soil water will hereafter have the advantage, and hence, other things being equal, it is desirable that the system of sewers of a city should be such that in the future the sewage can be utilized.

For sewage farming, properly so called, a large amount of land is necessary, for if the fertilizing material be supplied in excess of the needs of the growing crops, this excess is not stored up so as to increase the richness of the soil, but is dissolved out and passes off with the effluent water. It is most profitable when applied to green crops, and it is probable that the method of what is called ensilage, or storage of green crops so as to allow only a limited and special form of fermentation to occur in the mass, will be specially important in this connection. To dispose of the sewage of a city by water carriage, a general and sufficient supply of water is necessary, and conversely, when a town has obtained a general system of water supply a system of sewers should be provided for the removal of the water after it has been made
foul by use. In the Liernur system the least possible quantity of water is admitted to the pipes designed to convey excreta, and a general water supply is not necessary; but this point is of no practical importance to us, since all our cities have such a water supply.

In a city which has a general water supply, but no sewers, the greater part of the water fouled by household use, or by waste products from manufactories, is allowed to run off over the surface in gutters until it reaches a natural water-course. No more water is allowed to pass into the cess-pools than is necessary to work the water-closets, in order to diminish the frequency with which the pits must be emptied, and for the same reason those forms of closets are preferred which use the least water, which forms are, as a rule, the least desirable. The results are very unsatisfactory, and especially so in the lower portions of the town, and it may be laid down as a rule that, in a city which has a general water supply, a system of sewers should be provided for the removal of the fouled water whether the excreta be removed in this way or not.

But the addition of the excreta, with a sufficient amount of water to insure its carriage, does not require any material increase in the capacity or cost of the sewers, nor does it materially add to the offensiveness of their contents, and hence, both for economical and for sanitary reasons, it is now generally admitted that all fouled water shall be removed by the sewers.

In the preparation of plans for a system of sewerage for a city the following points must be considered, viz., the ultimate disposition of the sewage, position of the outlet, area to be sewered, proportion of rainfall to be admitted to the sewers, nature and amount of water supply, population to be provided for, topography of the place, drainage, whether there is a necessity for pumping-works, means of flushing and cleansing the sewers, and provisions for their ventilation.

The methods of disposal to be considered may be: first, the discharge of the sewage directly into a stream, lake, harbor, or sea; second, to treat the sewage by some process designed to remove the greater part of the organic matter, allowing only a comparatively pure effluent to pass into the stream; third, to compel the sewage to flow over or through land prepared for the purpose, and thus to purify it.

The first system is the one usually adopted for the sake of cheapness, but the results are often very unsatisfactory.

If the sewage be discharged into a running stream, there is the risk of pollution of the water supply of the city itself, or of that of its neighbors lower down the stream, and of injury to the fish.

It might be thought that at least the point from which the water supply of the city is taken would be located far up the stream from the point or points at which sewage is discharged that there would be no risk of the contamination of the former by the latter, but this is not always the case, and engineers know that, owing to the extension of a city above the point of in-take of its water supply, or to reflux currents at certain times, due to tides, or winds, or high water, there are several cities in this country which occasionally supply their inhabitants with water contaminated with their own sewage, while those whose water supply is more or less polluted by the sewage of other localities are so numerous as to form the rule rather than the exception.

As regards the destruction of fish by sewage, this is mainly due to chemical wastes rather than to excreta. Fresh excreta, not in a state of putrefaction, may be discharged into a stream in comparatively large quantity without injury to its inhabitants; on the contrary, such excreta furnish food to myriads of organisms which in their turn become food for fish.

Putrefying sewage is injurious to fish, as it is to all the higher forms of animal life.

The effect of the discharge of sewage into water which is turbid from minute particles of clay is to form a precipitate with these particles, and thus to clarify the water.

Sooner or later many of our cities will be compelled by their neighbors to provide means of purification of their sewage before allowing it to flow into streams. Such purification is best effected by applying the sewage to land either by ordinary irrigation or by intermittent downward filtration. Where land is not available for this purpose, purification may be effected by chemicals of various kinds, among the most important of which are lime, alumina, iron, etc. All of these processes involve the production of large amounts of precipitated matter or sludge, which must be dried and disposed of; and all of
them which are really efficacious in giving an effluent which may be discharged into a stream without danger are expensive.

One of the most important questions to be settled in connection with sewerage plans for a given locality is the method of disposal of storm water and of ground water which is to be adopted.

One of the first urgent needs as a city grows is for channels to convey away the rain-fall in order to prevent the flooding of streets, cellars, etc. The open ditches or small natural water-courses at first used for this purpose are in the way of traffic, and are liable to become offensive, and the next step is to construct under-ground channels for the removal of the surface water and of soil drainage.

These are not intended to convey sewage, and in most cities, until within the last forty years, it was forbidden by law to discharge sewage into them.

In St. Louis it was not permissible to drain a privy into a sewer prior to 1842; in London not until 1844, in Baltimore and in the greater part of Paris it is forbidden to this day.

The prohibition was a wise one, for the older drain sewers are as a rule entirely unfit for conveying the waste of houses fitted up with the modern conveniences, and it is to attempts to use such channels for this purpose that many of the complaints made against sewers are due.

In the older, closely built, and almost completely paved portions of a city, unless an unusually perfect system of street cleaning is carried out, the first washings of a street by a storm, after a dry season, or after the melting of the layers of snow and filth which accumulate in the winter, are practically sewage, and will pollute a water-course or harbor quite as effectually as the discharge from a sewer, but for a very short time only.

The improvement in health which the construction of sewers has been found to produce in cities has been in many cases, no doubt, due quite as much to the drainage and removal of ground water thus produced as to the removal of filth, but it is in most cases not desirable to use sewers as drains, though all sewers, however impervious, produce some effect in this way, and would do so were they solid instead of hollow, since the ground water will find an easier route along their external surface than through the undisturbed and solid earth. The objection to the use of sewers as subsoil drains is that if water can pass from without inward through their joints, sewage may in a dry season pass out and pollute the soil, leaving solid matter stranded within to obstruct the pipe. This objection may be to a certain extent, and under some circumstances entirely, overcome by making the invert or lower part of the sewer water-tight, and leaving the upper part, or arch, pervious, so as to drain the surrounding soil, but this should only be done if the sewage is to be neither utilized nor pumped, since under either of these conditions it should be diluted as little as possible. As a rule it is better to keep the drainage channels entirely separate from those intended for conveying sewage, although they should often follow the same lines, and even, for the sake of economy, be laid in the same trenches.

The importance, from a sanitary point of view, of thorough and deep drainage in cities is by no means sufficiently appreciated. In speaking of the ultimate disposal of sewage, attention has been called to the fact that a porous soil, by virtue of the oxygen which it contains, and the microorganisms which develop in its interstices, has great power to decompose organic matter, and to starve out disease germs; and this power is as important for the soil beneath a city as it is for that of a sewage farm.

It is not within the scope of this article to consider the relative merits of this or that particular system of sewerage, or to discuss details of construction. It is easy to see that what may be desirable in old and closely built streets, with high buildings lining either side, and subject to heavy traffic, may be neither desirable nor possible, on account of expense, in a town where the houses are scattered, having large yards, and where the traffic on the streets is light.

In the first case it may be the truest economy to construct a subway sufficiently capacious to contain not only the channels for sewage and for street wash, but all the water, gas, and steam pipes which form such a labyrinth in such localities, in order to prevent the expense and delay which excavation in such a street for extension or repairs always causes; while, in the second case, a comparatively simple and cheap system of earthen pipes for the conveyance of sewage only, combined with another still cheaper system for subsoil
drainage, may be the only thing which the value of the adjacent property will justify. No one system is best for all places.

Although sewers are intended to carry foul water, they can, and should, be so constructed and connected as not to be offensive, and a very important means of securing this is to have the house drainage so arranged that all foul water shall be at once delivered to the sewer. Fresh sewage is not specially offensive or dangerous, but it is not possible to keep any system of sewers free from bad odors if putrefying sewage is turned into them.

The worst of all arrangements is that by which cess-pools are preserved and the overflow allowed to drain into the sewers; and where this is done the sewers will always be offensive.

Sewers cost money, but there is no better investment for property owners. The cost of a system of sewers for a city varies from five to fifteen dollars per head of population, and the increase in value in real estate which they serve varies from ten to twenty-five per cent.

It seems to be a common idea that any one who can run levels and plot contour lines can plan a system of sewerage, that the average contractor can be trusted to carry out the plans properly, and that when the work is completed anybody is fit to take care of it. All this is a great mistake. Properly constructed sewers are among the most permanent works of the engineer; they should last for hundreds of years, and be planned for the future as well as the present, and the employment of the best experts obtainable, both for the preparation of the plans and the careful superintendence of the construction, is the only true economy.

The supervision of the sewers after they are constructed should be also given to a skilled engineer, and it should include all house connections. In a system of sewers thus planned, constructed, and managed there will be no collection of dangerous and offensive gases, and no risk of the causation and spread of disease through their agency. The greatest difficulty in the way of obtaining such a system in most of our large cities is the fact that they already have a number of underground channels, forming a dilapidated patchwork, which they are pleased to call a system of sewers, and which they are unwilling to abandon.

The wisest course in such a case is often to begin entirely anew and carry out a proper plan. As such a plan is for the benefit of future generations, no less, and even more, than for the present one, it is eminently proper that a large part of the burden of the cost of its construction should be borne by the future population, and there are no objects of municipal expenditure for which it is more proper to defray the cost by borrowing money than for a pure water supply and for sewerage.

As regards water supply this is now generally admitted; but the public does not yet understand that sewers are equally important, that, in fact, the one necessitates the other; and the sooner this lesson is learned and acted upon, the better it will be for all concerned, but especially for four classes, viz., owners of city real estate, merchants, the industrious poor, and young children.