On sewage and sewage rivers / by Robert Angus Smith.

Contributors

Smith, Robert Angus, 1817-1884.
Simon, Sir John, 1816-1904
Royal College of Surgeons of England

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BY ROBERT ANGUS SMITH, Ph.D., F.C.S.

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VIII.—*On Sewage and Sewage Rivers.*

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[*Read January 23rd*, 1855.]

The removal of refuse from a town gains importance as the town increases, rising at last to be a matter of the greatest moment and surrounded with the greatest difficulties. At the same time, if we take only theoretical grounds, we may say that the removal of refuse must become easier as a town increases, because there is an increased combination of individuals to share the trouble and the expense. This method of viewing the matter I believe to be the true one, whatever practice may say as to the difficulties. The modes of removing refuse are many, but they may very readily be reduced to two; 1st, The removal from the place of original location by carts or any other means of overland carriage; 2nd, The removal in tubes or pipes with an abundance of water. The first method is the most general, it is the original method; it may be said to be the universal method, the exceptions to it are so few. This universality does not occur from any superiority which it possesses, but from its simplicity, although I probably use that word in a wrong sense; I ought rather to say, from the fact that it arises naturally when the least amount of thought is directed to the subject. The refuse is deposited in the nearest convenient place, and it is removed when it becomes intolerable. This plan has been adopted in all ages and countries with more or less care. From the filthy

savage up to the refined inhabitant of Paris, all classes of people have made use of it. Simple as it is to begin with, the structure of cities no sooner becomes complex than this system becomes complex too. Space becomes of great value, and the places for deposit in towns cannot be spared. Time becomes of great value, and workmen to remove the refuse are expensive; distance from the fields increases, and the difficulties as well as the nuisance of the removal increase with it.

The simplicity of the plan then ceases. Either a large space must be occupied with the refuse in the town, as with us; or a small space frequently emptied, as at Paris. In the first case, we have a city with a row of ashpits and receptacles of soil equal in length with the rows of our houses, covering a large per centage of the ground of our towns, and accumulating enormous amounts of impure matter. In the second, we have a house subject to unwholesome inconveniences, far exceeding, certainly, all that we suffer here, the want of space confining it to the house, and the removals being uncomfortably frequent. The simplicity is lost from another cause also, the labour has become one which requires great skill to prevent discomfort and disease, whilst the whole plan itself, if we judge from results in Paris, is obliged to give way at last and seek the assistance of the second method alluded to—the use of conveyance in tubes by means of water.

Under the most refined management of this system in Paris the refuse is conveyed into dry closets, as they may be called, having no water to wash down the soil, which is conveyed either into a moveable cylinder of zinc or into a cesspool in the cellar. If a moveable cylinder is used, it is at once conveyed away by carts, the more liquid part flowing away by an overflow pipe, the solid remaining. If the cesspool is used, it is emptied once or twice a year by means of a pump. The deposit, which is of the thickness of very wet mud, is

pumped into airtight barrels, the pump-tube being made to dip down to the bottom of the cesspool so as to bring up the solid and leave the liquid. Some disinfecting liquid, chloride of zinc, is put into the barrel so as to prevent any nuisance in the streets. When this deposit has been pumped up into the barrels, it is carted off to La Villette or taken to the canal boats and conveyed by them. Here the barrels are emptied and the contents conveyed by pipes to Bondy. There the matter is allowed to deposit in a large reservoir, or filthy lake, from that it flows to another, where more is deposited, and so on to a fourth, where the deposit is small. The liquid is then used for the manufacture of ammonia and its salts.

The establishment at La Villette consists chiefly of a great underground tank completely arched over, and above this a building consisting mainly of a series of archways, into which the carts may enter to deposit the contents of the barrels into the holes in the floor. The contents flow, as before stated, to Bondy, sent by a forcing pump. Bondy is seven feet higher in level. The pipe is one foot in diameter, made of tinned iron, covered with asphalt. The number of barrels emptied here daily is from 1,200 to 1,500.

This is the manner in which the heavier soil is treated when it is taken from the cesspool. The liquid matter is then disinfected with chloride of zinc, and pumped out into the streets, from which it runs into the sewers. Four men are appointed to do this, three and a foreman. They are provided with test paper, in order to see when the sulphuretted hydrogen is removed. But the smell is beyond their management apparently, as the operation fills the cellars with the most violent stench, and the street has the same unpleasant odour to a great distance. Certainly we may be too particular in such things. A French writer, to whom this subject is dear, considers that the *pruderie* of the English in such matters prevents them from enjoying the great blessings of the Paris method, adding that the dislike of these substances

spoken of is so great in the aristocratic quarters of London that it is not probable that any alteration will be made on the system for a long time.

The other method of having closed receptacles for the soil in the house or even out of the house is also in use, but in practice both the methods have an uncomfortable and dangerous result from the want of water and the impossibility of obtaining any cleanliness without it. As far as the principle is concerned, the continental method, in all its modifications, is merely the ordinary outdoor convenience, so common with us, conveyed into the interior of the house; a place where idleness alone could place it, unless it were connected with abundant means of purification.

The other modification of what may be called the overland means of conveyance is that adopted in this city and neighbourhood, where the material lies open in countless, or I should rather say in 60,000 places, diffusing itself over the whole town, and evaporating as rapidly as the various states of weather allow it, uncurbed in its movements, except by a wall at the side, which is quite unable to confine this result of decay. In one respect we have the advantage that this matter is not inside the house, that the system of building gives room enough behind every house for a yard, and we are not crowded one over the other, or unwholesomely confined on narrow shelves. At the same time we have this disadvantage, that the rivers are not kept pure as at Paris and elsewhere, whilst the land also is rendered impure, and the constant cleanings infest the air. Having a mixture of all systems we have the advantages of none and some of the evils of all.

The advantages of the overland system include the sale of the material, which in Paris is something of consequence, when stated in a certain form; the poudrette which is manufactured is sold at about twenty shillings a ton, but it is not bought eagerly, and in fact is not of very great value. The amount

sold is of course enough to pay abundantly those engaged in the manufacture; but they have made such terms with the municipality as to ensure them a profitable business. It appears, on inquiry, that neither does our primitive method or no-method pay, nor the refined method of Paris. The expense there of cleaning a cesspool is seven francs, and it must be emptied as soon as filled. The expense of cleaning Manchester is about £8,000 a year for the 250,000 inhabitants, making for each about 7d. a year. In Edinburgh the value of the ground, manured by a very careless method of using some of the refuse, has been raised from a trifle to £150,000, which is to be taken as the value of that portion of the manure which is there used, being equal to £7,500 a year. This is the sum which the property would fetch in the market, and the sum the proprietors would be entitled to if the sewage were taken from them, according to certain legal opinions. The proprietors have also had sufficient power in the city councils to prevent any success in depriving them of their privileges.

We may conclude from the practice of these three cities, Paris, Manchester, and Edinburgh, that there is in existence no complete plan for the treatment of the refuse of a town, although the plan in Edinburgh shows that such a system is not only possible, but in the highest degree successful, and only wanting in profit to Edinburgh, because that town has not seen its value in time but has left its riches to those who were more diligent. The experiment is, however, a great one; the subject is one which must now take a most prominent place in our home affairs for many years to come, until it shall be decided that it is as unwise to destroy the property of the country by losing the refuse, as it is to allow goods to be burnt in warehouses and in shipping, as is our custom, without taking the means of precaution which are placed in our reach.

I thought these remarks necessary before bringing the sub-

ject of this paper before you, in order that I might draw the conclusion that, in the two methods mentioned of leading away the refuse in barrels and manufacturing it into poudrette, and of leading it away in carts and selling it without manufacture, no profit is to be expected, but the town or the country must pay a constant price for cleaning; whereas, by leading the refuse away by means of water, a price is obtained more than sufficient to clean the town. Water seems, then, the only successful conveyancer, according to practice, unless, of course, the new Manchester experiment of conveying it by railway should turn out valuable, although by no means likely to do so to any very great extent. Even if it were to turn out profitable, it would still be objectionable from the fact that the town is by its means not preserved in a sufficient state of purity as before mentioned. If, however, the water-closet system be used, the town is not only kept clean but the conveyance is made in the manner that has hitherto turned out most profitable, as at Edinburgh, and which has been found needful, so as to make the other or overland system complete as at Paris; whilst the disgusting manufacture carried on at that place, and occupying so much land, is dispensed with, and the still more disgusting system of clearing adopted here is also done away with, a plan by no means producing such bad results as on the continent, not from any merits of its own, but because there is here scope for extension, and our houses are not confined to the limits of city walls. As the irrigation method at Edinburgh has at present the most decided success, or in other words the conveyance by water been found cheapest even when partially tried, it seems only natural to conclude that the conveyance should be by water the whole way, as would be the case if the English water-closet system were carried out to its full extent. The chief evil connected with that system is the hitherto great loss of the products; and the chief difficulty with regard to irrigation is the obtaining suitable ground in the neighbourhood. The

large supplies of water now coming into our towns has given us a capacity for extending the water-closet into every house, and I believe that it is the true one, in spite of the obstacles placed in its way in our own town. It has fortunately taken hold of England in a manner such as to prevent all power of receding. Removal by water seems to have begun in every large town, ancient and modern, but never at any time brought to perfection, because peace and prosperity and a knowledge of the arts have so seldom endured long in any one place. The tendency of improvement has always manifested itself in the direction of removal by water and by underground sewers. The usual way has been to remove the opening of the sewer to the lower part of the town, but in course of time this portion of the neighbourhood becomes surrounded with inhabitants, and great inconveniences arise; it is then drained into a river or brook, if there be one, and again that becomes a closely inhabited district, whilst the nuisance of the drainage is sufficient from a large town to render impure the largest rivers. This state of affairs is generally of very gradual rise from the beginning; no one can be blamed, no one could have foreseen the evil; as to the end no one need claim much credit for seeing that something must be done; the evil rises up in a hideous form before us all; our capital city appears to be built on a cesspool, instead of a magnificent river, and Manchester becomes a proverb, by giving its rivers and canals such blackness as not only to render them disagreeable, but to cast a shade of gloom on all who come into the town.

Various Methods of Treatment.

The methods of treating the fluid matter of the sewers are few. The practice of allowing it to go into the river has long been objected to. The method of applying it to land, and so taking hold of it before entering the river, although long in gradually increasing practice, was first

brought into comparison with other methods in modern times in England by Mr. Smith, of Deanston, and Mr. Chadwick. Mr. Chadwick's account of it in the general report of the sanitary condition of the labouring classes, gave it, perhaps, the first prominent place among systems, and he has always supported it in the publications of the Board of Health. Smith, of Deanston, published an account of his method in the first report of the Health of Towns Commission. Mr. Cubitt was desirous of having it brought into practice, but could see no plan by which it could be made economical for London. Those who have tried sewage manure are chiefly private persons. It has been found to render land so productive that it yields actually from 70 to 80 bushels of wheat per acre, and has sometimes increased the pasture tenfold. This remarkable result is enough, of course, to justify any probable amount of expenditure. Mr. Wilkins, (in the journal of the Society of Arts,) thinks it would be advisable to use it even if £100 were spent upon an acre, his peculiar method being an expensive one, considering that £10 an acre has been considered a large sum for the improvement of land, only justified by the success attending recent discoveries in draining and manuring. That success must be enormous which ventures to breathe £100 per acre. Such fertility of soil would certainly allow us to build upon farms works of such a kind that health and appearance might also be consulted as well as profit.

Smith's proposal was to irrigate meadows with the sewer water, by overflowing them in the method long in use with ordinary water; Mr. Chadwick recommended the use of the jet and the hose to sprinkle the water over the land, and to save the use of pipes and drains.

Mr. Corbett proposed the use of pipes for the irrigation near Manchester, and recommended a lifting pump at Ordsall or Trafford Moss. Mr. P. H. Holland began the system adopted by Mr. Chadwick and himself, of watering with the

hose; but being compelled to carry the refuse in boats he was obliged to desist. At the same time it became clear that a very short time of such a top dressing as he used was not enough to produce the remarkable results detailed at Edinburgh. Although very strong manure is not needed, very dilute is of little advantage, requiring too much labour and too much water. Mr. Holland added manure to the water which he used, as he could not get it direct from any strong sewer. The sewer water of towns so well supplied with water as Manchester and London cannot be of such value as to allow expensive carriage; whereas there are times of great rains when it is only to a slight degree rendered impure.

Let us suppose that all the water flowing down a Manchester sewer were to be put upon the ground. Let us say there are twenty million gallons from the waterworks, add to this occasionally the rainfall from drainage, over, let us suppose, twenty miles of surface. The land here has quite enough to do with its own rainfall, not knowing how to pass it with sufficient rapidity through the ground, but how are we to convey to it the rainfall of other twenty miles. Let us suppose we have twenty square miles to let it fall upon, there is double the rainfall for it, how damp must that land then be in a county already too damp. But even twenty miles is an enormous extent to cover and not easily obtained, or if obtained not easily managed. If, however, it will be too much to put double the rainfall on, then more than twenty miles must be used, rendering the work still greater and more difficult and expensive.

But this is the mere rainfall during floods filling the sewers too full. What, then, is to become of the twenty million gallons every day of the year besides? To put them upon any land would be, of course, to injure the climate of the district to a great extent, unless the breadth of land were enormous; and to put this water on as irrigation for meadows involves a difficulty inherent in the formation of the land

around us, perhaps, however, a difficulty that is not insuperable, although the climate must always be considered. To put on this water with the hose, is certainly out of the question. It is in fact to form a new waterworks of a reversed kind, and to give out all the water of the present waterworks and more, not by the standing pipes in the streets and houses, such as at present deliver it, but by the hose or flexible pipes held in men's hands continually until all is run out.

If the use of sewage manure were to be generally adopted, the sewers must be carried out of the town; they would then not run into the river, but probably along the river. It would be impossible to remove the water from them as rapidly and as regularly as it flows, so that it would be needful to have a large tank or reservoir. This reservoir would receive all the water which now is supplied by the waterworks; and, in fact, would be a second waterworks on a scale greater than the one at Woodhead. The advocates for sewerage manure say that it may be put on in all weathers; but we cannot suppose that this will occur, neither can we possibly imagine any probable circumstances which would induce the men of Lancashire to stand with hose in hand until that enormous amount of water were put upon the land. It must be done by the irrigation system, or the method must be resorted to of having separate drainage for water closets; by whom it was originally proposed I do not know, but which I have advocated in a short paper on Sanitary economy in some of your hands. My own belief is, that this would be an excellent system; the best hitherto proposed, both as to convenience and to profit. It is unnecessary, however, to dwell long on it. I conceive that if it were adopted, the sewers would produce a manure so strong that it might readily be mixed with the refuse water from the factories, and still be valuable. I do not, however, think that it is essential to use it all liquid. In the above state it might be used liquid near the towns. And here we come to another dif-

ficulty attending all the liquid manure plans, it is that of getting suitable land and sufficiently extensive near towns. I confess I am unable to argue this well, but I am inclined to think that the manure is so abundant that it will readily supply persons to a great distance. If the water closet sewers are kept distinct, it is probable that precipitation and preparation would be essential, as the manure would not be in a fit state to put on land without loss and nuisance; but if the sewer water remain as it is, the distance of carriage and the amount to be put on land seem to be great difficulties, quite insuperable in the way of applying all the refuse matter of a large city. If, again, all of it is not applied, there is no advantage in having any portion applied, as far as the purity of the stream is concerned; at least it is not for us to waste our time thinking on merely a small diminution of the evil.

It has been proposed, also, to take the sewage into a reservoir, and allow it to precipitate. This is the method adopted with the contents of cesspools at Paris, but there the matter is undiluted, and even of that the densest portion only is taken, leaving the liquid to be run off into the sewers. The poudrette formed is not of great value, and sells for much less than our artificial manures, about a pound a ton. The deposit in sewer water ponds was found, in an instance mentioned by Smith of Deanston, to be worth very little. It was sold for one shilling a ton, but the analysis and especially the amount of phosphates is wanting to determine its real worth.

Leaving that aside, the matter valuable for manure is not in suspension merely, and cannot therefore be obtained by subsidence only. For these reasons it has been proposed to filter the sewage water, and this method certainly produces very fair water in appearance, and leaves a great amount of valuable manure in the filter. But the oxidizing power of the soil and of porous bodies is the cause of much waste of

material of pure organic origin, and the ammonia is converted into nitric acid, forming very soluble salts, easily washed away. There is also in no artificial filter, a ready power by which the phosphates can be eliminated.

The mode of using liquid manure only, is in reality the filtration by the use of a natural filter, the ground; and in a case like this, the success is complete. The ground has the power of absorbing a certain amount of salts, especially if united with organic matter, such as the phosphates often are, and the surface to which the liquid manure is applied is so great, that there is no danger whatever of losing much of its value. Filtration on any practicable artificial scale will not produce this result, but will allow much valuable matter to be lost.

The subsidence method and the artificial filtration are both liable to another great objection, that the ammoniacal salts are not taken from solution in the slightest degree. On the Paris plan, the liquid from their highly concentrated manures is used in the manufacture of ammonia and its salts, as it is strong enough to allow of the expense of heating and distilling from retorts into acids which retain it. The slowness of the process of ordinary subsidence is also an objection.

There was proposed, it seems difficult to know by whom at first, a plan for precipitating with lime. There was a commission appointed by Parliament to inquire into it. The preliminary inquiry was held before Sir Henry de la Beche, F. L. Wollaston, Richard Phillips, Esq., and Dr. Lyon Playfair. In 1845, Mr. Wicksted proposed lime for precipitating sewage; and Mr. Higgs, in April, 1846, took a patent for lime. There is a dispute as to who was first in proposing this, but I see that in 1846 also Dr. Stenhouse proposed a plan for precipitating with lime; so that, apparently, the well known clearing property of lime has given rise to the idea in many minds of using it for sewage, and these were published at the time when the subject was very much occupying public

attention. Mr. Calvert has proposed it also for the Medlock, as I am told, with the addition of some original, and I do not doubt valuable, plans for collecting the precipitate without interrupting the flow of the stream.

The inquiry into the plan proposed by Mr. Higgs, to have a reservoir at Bermondsey, in which he would precipitate the sewage by lime, gave rise to some points for consideration, which may be mentioned.

It was stated that the phosphates would precipitate, and that this would take place in about six hours.

It was also said that the sulphuretted hydrogen would be thrown down by lime.

The ammonia would be lost entirely, except such as might be formed from the solid organic matter containing nitrogen, and found in the precipitate; of course, all that came from urine, which gives the greatest portion, was lost.

There was another objection, as this precipitate was to be dried, and in that case the lime would prevent the preservation of the portion of the ammonia left in the solid, at least to a great extent, entirely removing the other portion.

The sulphuretted hydrogen was not quite removed, as was admitted, but it was proposed to be burnt by passing it through the fire. The same thing was to be done with the remaining organic substance which caused the residual smell after the lime had done its utmost towards deodorizing. This plan of burning gases, by passing them over fire or through hot chimnies, is by no means an efficient one, unless the gases be small in quantity and the fire long. I have seen it more than once quite fail. The escaping ammonia was to be retained by means of muriatic acid, which would unite with it meeting in the flue. This is a plan attended with difficulties, unless the flue has very little draught in it. On the whole, then, lime does not seem desirable, because it does not quite destroy the sulphurretted hydrogen, and does not retain the ammonia; otherwise I must allow that it is really a beau-

tiful precipitant, and the water, when drawn from it, appears perfectly pure.

Mr. Higgs did not propose to deal with all the sewage water of London, but only the portion about breakfast time. The amount was too large to manage. That certainly will be a difficulty with London, with Manchester the difficulty is much less, and a trifle, supposing the water closet drainage to be separately treated. He proposed, also, to have rails over the reservoir, so that persons might walk over it, throw down the lime from waggons and stir it about. This makes the matter still more difficult and expensive. Six tons of matter were to be dried daily.

The plan is well worth considering, and the lime is by no means to be at once condemned, when used with proper precautions, although one chemist, Paulet, calls it a vicious method which loses the ammonia and the salts of potash and soda. The precipitate in the case he refers to consisted of

Chalk	44.96
Magnesia	1.32
Phosphoric acid	40.18
Organic matter	13.54
Or loss by fire	100.

This I call rather a brilliant result; we are not given to understand how much ammonia was in this organic matter, but even were there none the amount of phosphoric acid is worth preserving. The French practice so much boasted of actually even now throws away the ammonia and alkaline salts in the liquid which runs into the sewers, retaining only that portion which drains from the dense mass which is transported to Bondy. The use of charcoal as a filter for sewage water is not to be recommended, as little of value is removed. The use of ordinary soil and clay as a precipitant would be better, as they remove a great amount of valuable matter, but this I think scarcely sufficient, although in some circustances

not to be put aside. As a scientific inquiry the researches of Professor Way, on the absorption of salts by soil, are of much interest and value, explaining the use of soil and its action in nature. He himself does not, however, recommend it as an economical method of collecting the matter of sewage manure.

I am told that Mr. Dyer had a plan of keeping the rivers pure, but I have not heard a full explanation of it. He says that those who dirty the water should clean it; and this, in reference to manufactures, is a point worth your consideration. Those who take into their works pure water might take the trouble of filtering it before they allowed it to go back. Instead of that, there has been an irregularity in the whole management of these affairs, from the tops of the hills of Lancashire down to the very town halls, and, I am sorry to say, a selfishness, in seeking or taking water, which has completely defeated the objects of all. It happens, now, that in one of the wettest climates of England there is a want of water for manufactures, although there is no need for even a small portion of what falls, and one man, by using a few gallons, and sending them back dirty, pollutes a whole stream. There has been an extravagance and waste, in this respect, which has put many to great trouble and expense, and caused an extensive series of water-works, extending over the whole county, and made by private individuals, for the use of their own works. This plan, of allowing no one to send in the impure water from his works, would not, however, be a sufficient cure for the evil we are speaking of. The amount of towns, villages, and isolated houses in this district, is so great, that they alone are sufficient to pollute the streams to a great extent, leaving out the largest town, Manchester. We have, then, to deal with an evil which extends itself along the banks of our streams, from this place to their very source, and in every portion, I might almost say, of both banks. It has been mentioned to me by Mr. M'Dougall, that, to keep the

Irwell pure, every impure stream should be retained and purified before it is allowed to enter the main stream. But this is a plan which will not suit all circumstances, as the river is made impure by drainage direct in many places. Sometimes it is a small sewer, which will not bear separate purification; sometimes it is the trickling out of impurities from the soil—the drainage of dirty streets or land.

Plan for Manchester and South Lancashire.

The plan which I propose has already been published in a skeleton form, but I will endeavour to explain it more fully. I do not pretend to say that the plan is original,—it is made up of the things that I have seen and heard, as most other persons make their plans; but the result, at least, has novelty, and of course, in my opinion, is the best hitherto devised. As a whole, it was new to me.

And first, I begin with the maxim similar to one I have mentioned—that no dirty water should be allowed to go into the river. If this is managed, the river will be clean.

To effect this, every town would carry its drainage to a point out of the town. The sewer water to be then treated by precipitants, and allowed to pass off clean. When there is not a town to be dealt with, but a district, then a certain portion of the houses and works on the river bank will be united into a drainage district, and this sewer water will run into a drain or drains parallel to the river, until there is a sufficient amount collected for precipitation. There will be then a constant succession of tanks, equal to the density of the population. There will also be a continual line of sewage drains as far as the population extends; or, in other words, a dirty river running parallel with the clean one: just as we have, in the town, a set of sewer drains running parallel with our pure hill water. The sewers of all houses must be sent into this drain, and it will be a great advantage to all persons having isolated

houses on the rivers, and to all villages, hamlets, and towns of every kind. I think the time is certainly come when we may adopt common counsel in Lancashire, and act as an united body instead of acting as a number of isolated individuals. The sewer or drain along the river will be also a reservoir of manure, that is, the sewage water may be taken out of the sewer, and put upon the land all along the river, so that it will be a mode of conveying manure in a state ready for use to a very large portion of the country, especially in the case of winding rivers, such as we have in the land lying above us. The water used for manure will then filter through the ground, and naturally will take the course of drainage water, which I propose shall, in all cases, go directly into the river, and so keep constantly adding to the amount of pure water in the river.

These drains, I think, should be very simple,—much simpler than those used for pure water, and merely brick semicircles, according as may be decided on. They might be covered with a simple covering of flat stone, unless it happens that a district is too large, and that a very large drain is needful. In any case, when these drains become full, they pass into a reservoir, and the sewage is precipitated. They then pass out pure into the river. So much confidence may be had in the liquid manure, that I believe people will be anxious to avoid the loss of any of this substance passing by them. The right to use this manure would be sold, of course, and, if obtained in this easy manner, without expense of carriage, as we may say, it will, no doubt, be most gladly used.

At any rate, I wish to explain that this provides for the manuring and draining of the land, and cleansing of the river by one and the same plan. This plan makes use of all the alkalies, ammonia, potash and soda; so that nothing put on the land is lost, and a pure water is returned to the river. I believe the banks of the rivers might, in this way, be made rich gardens. But it is certain that all the sewer water could

not be used, and it is also clear that it would not be so rich as that of Edinburgh, so that equal results could scarcely be expected. The amount not used in this manner would flow down the sewer, and would be led into the first tank or reservoir, there to be precipitated. There the solid matter would be kept, and the fluid, when clear, would proceed. There is then a constant succession of sewers for the water that has not been used on the way. Below every town and district giving off much impure water, such a depositing reservoir would be placed. Every person might then receive from the river, water for manufacturing purposes, and the making of private reservoirs, now so numerous, might be almost entirely saved. There are a few cases where fine colours are wanted, where this water might not be so well fitted as fresh water from drainage land, but these cases would be few. This would be a great saving both of land and labour, as well as water, to the country.

But not to expand too much upon it, it is then to be asked how is the precipitation to be effected.

I have mentioned that the precipitation will take place in the reservoirs, but if they are to be disinfected, so can the sewers be disinfected; it is not needful then that the precipitant be added in the reservoirs. Besides there is a difficulty in mixing the water of a reservoir, which Mr. Wrigg proposed to get over by having rails across it, allowing men to go to any part. This would, however, by no means get over the difficulty, as a man could only mix well that part which was within reach of his arm, and if the whole surface of the reservoir were covered with little whirlpools, mixing themselves in every spot, the whole mass would not thereby be mixed. I consider, therefore, that it would be of great advantage to mix in the sewer themselves; by this means the sewers would be disinfected, that great evil would be removed which we have endeavoured vainly to shut in by means of traps; some outlet, however, it will decidedly make for itself, whilst being shut

in it renders the sewers still more dangerous to clean. By disinfecting the sewers the decomposition is put a stop to during their whole course, the mixture also is being made during the flow of the water, and by the time it comes to the reservoir it will be ready to precipitate.

It has been said that this liquid will flow along the river in the manner that was proposed for removing the sewage from London, some years ago, by the painter Martin. I increase the plan simply by a succession of these. Now this liquid in its flow will form a constant supply of liquid manure, it will therefore answer the purpose of the elaborate set of tubes made by some parties for irrigation, and it may be pumped out on the surrounding ground and spread by a jet or by irrigation. It may even be drained off to a lower level, where it is convenient, and where the fall of the river is great, so as to irrigate by gravitation. This liquid being disinfected, may without fear be put upon the land without scattering around it a noisome odour. The system includes all the best portions of the other systems, in my opinion, whilst it adds new features not to be found in any hitherto devised system.

If the water were to be used by jet only, then there would be a great excess at certain portions of the year, and as it could not be properly disposed of, it must be allowed to go again into the river. This argument is, I think, almost conclusive against the mere use of the liquid manure plan; it neither uses its material, nor leaves time for consideration to the farmer, every day is bringing down its stated quantity, if it be on Christmas or Midsummer, and for good or evil this must be disposed of. If we use large precipitating tanks, we get rid of that difficulty; the matter stands until it is wanted.

But again, if we reject the liquid manure system we reject a method which has already been shewn to be of the very highest value, and more than that, we lead the liquid manure

over a great tract of country without making use of it when there, making some miles of piping in all probability without using the water except at the extremity; whereas, that long line of sewerage is itself a large and constant, as well as convenient reservoir. The same cannot be said to an equal extent of the pipes. Moreover, by disinfecting the sewer itself, we give time for the odour to be removed, taking away all fear whatever from the otherwise to be dreaded reservoir of impure water.

If this method were adopted, it is easily seen that the Irwell, the Medlock, the Irk, and the canals would at once be clean, the filthy water would not be seen, but mere condensing water would of course go back to the river. The expense of constructing a culvert, such as would convey the impure water down the river, could not be great. I am not an engineer, and cannot calculate it; but I believe, nevertheless, that it may be done cheaply and at a price which would justify its immediate commencement. The estimates for such things are generally very high, because people begin with such extravagant ideas. We see that there are many miles of sewage in this town, how many hundred I do not know, but this would be the addition of six or ten only for the immediate neighbourhood; and to begin with the Medlock, not much more than two or three. There is no need of buying land, there is land enough unbought, and the price of covering over the Medlock with such powerful arches as they are now putting upon it, would be immeasurably greater than this far more useful sewer. I would put the sewer at the side of the river, the bed is often not quite covered at one side; if sunk a little it would lie steadily, and do its work without giving any one less room or causing any one to complain.

Although this plan would act even if confined to the town, or even if confined to the Medlock, I prefer proposing it for the whole district, because there, I think, its advantages will be chiefly felt; at the same time, it is a scheme which may

be tried in pieces, so as to allow the most cautious beginning, although the first beginnings cannot well be supposed to be highly profitable. As to the mode of disinfection,† it is an independent part of the subject, and although I have got much to say on that point, I am debarred by the rules of the society from bringing it forward in this place; and as I believe I have used all the time allowed by the society for reading a paper, I trust that I have given to the members a little additional material for forming a correct judgment on this great subject.

† This refers to a method of disinfection and of disinfecting sewers I patented lately myself and the Mc Dougall-The powder is now sold as Mc Dougalls disinfecting powder.