But, failing this, they direct me, on their behalf, to suggest to the sanitary authorities of other protected towns in this neighbourhood that an arrangement should be previously adopted by which, to some extent, the object alluded to may be attained. I shall, therefore, be happy to forward you, at the termination of each successive week, a list of the cases of infectious disease reported to me under the Notification Act, and shall be obliged if you will kindly favour me with similar weekly information respecting your own district. I have the pleasure of forwarding you herewith my return for last week, and beg to remain, my dear Sir, yours very faithfully,

JOHN TATHAM.

To this appeal I received favourable replies from thirty-two health officers; and, thus powerfully supported, I set to work forthwith. With a view of rendering the circulation of local returns as little irksome as possible to my fellow contributors, I at once made arrangements for the tabulation in my own office of the weekly returns from the several towns, and the construction of a table which, by the aid of a copying-press, I was able to circulate early in each week to my several colleagues.

The object which I had in view in undertaking the collection and circulation of returns, as here described, was that of testing the practicability of establishing a register of infectious disease. This practicability having been established, I at once took steps to introduce the matter to the notice of the Local Government Board, with the suggestion that they, as the central authority, should take the matter in hand as a "going concern," and relieve me of a duty which appeared to belong more fitly to a State department.

In order to enlist the support of my colleagues in this appeal to headquarters, I addressed a communication to each of my colleagues, asking their co-operation, as follows:

"Urban Sanitary Authority,

"Town Hall, Salford, March 19th, 1888.

"MY DEAR SIR,—The project of collecting and circulating returns of infectious sickness, which, with the co-operation of my colleagues of the Public Health Service, I have been privileged to carry out since the beginning of the year, has been very successful; and I hear from many correspondents that the timely information—especially as to small-pox incidence—which I have been the humble means of distributing, has proved of great assistance to the authorities concerned.

"The returns from the several towns have been regularly sent in, and I have been able to present a copy to each of my contributors on the Thursday in each week.

"Situated, however, as I am—with a small and an over-worked clerical staff—you will easily understand that I should like to be relieved of my self-imposed duty, if only I could secure that it would be faithfully discharged by others. Whilst, therefore, I have no immediate intention of discontinuing the circulation of these returns, I think you will agree with me that the proper authority to publish them is the Local Government Board; and the object of the present letter is to ask you to help me to induce that Board to take upon themselves this important function.

"If, therefore, you would obtain from your Health Committee an expression of opinion (in the form of a resolution to be forwarded to the President) affirming the desirability of the weekly publication by the Local Government Board of sickness returns for the several notification towns, I think that the object would eventually be attained. I have myself obtained the concurrence of my own Health Committee in this view, and I have little doubt that if the Local Government Board found that a similar desire obtained amongst a considerable number of the notification authorities, the Board would accede to the request.

"Kindly send me a reply, saying whether or not you will help me in this way; and, in the event of your consenting to do so, be good enough to obtain the resolution and have it forwarded to the Board on the earliest practical occasion.—I remain, my dear Sir, yours very faithfully and obliged,

JOHN TATHAM.

I also obtained from the Salford Health Committee the following resolution, which was duly forwarded to the President of the Local Government Board:

"The Health Committee of this borough having had under their consideration the representations of their medical officer of health on the subject of disease registration, are of opinion that a system of central registration of infectious disease is desirable (similar to that of the Registrar General in respect of deaths), whereby sanitary authorities of one 'notification town' may be warned in time of the approach of any infectious disease from other towns

of the country. And this Committee therefore respectfully urges the Local Government Board to undertake the collection and publication of weekly returns of infectious sickness for all the towns which are provided with legal powers for the compulsory notification of infectious disease."

On the receipt of this resolution, together with a large number of similar communications from other notification towns, the Local Government Board addressed a circular of inquiry, not to the medical officers of health, but to the sanitary authorities themselves, of all the towns possessing notification powers, asking whether, in the event of the Board's undertaking the publication of weekly returns of sickness, the authorities individually would agree to furnish the Board with the requisite local returns. I do not know the exact number of favourable replies which the Board received to their circular, but I have received information from my colleagues that the Board's proposal has met with general approval.

Why the Board should still hesitate to perform what would appear to outsiders a peculiarly appropriate function, it is a little difficult to understand. The suggestion, however, has been offered to the Board as a practical one, and I hope shortly to see it carried into effect.

THE SEWAGE QUESTION IN GLASGOW.

Read in the Section of Public Medicine at the Annual Meeting of the British Medical Association, held in Glasgow, August, 1888.

By J. B. RUSSELL, M.D.,

Medical Officer of Health, Glasgow.

THE disposal of sewage is a subject which has a very present interest to the community of Glasgow; and I am sure no part of the proceedings of the British Medical Association will attract more public attention or raise greater hopes of local advantage than the discussion now to be begun. In this view I think the most useful contribution I can make to the proceedings is to give a very condensed statement of the history and present position of the question of sewage disposal as it affects Glasgow. The Association could not do a greater service to the community which is now honoured with its entertainment than by giving the discussion special reference to the difficulties of their sewage question. The practical utility of the advice of experts depends upon the extent to which their individual theories are adapted to the circumstances of the case upon which they are consulted. Within the drainage area of the Clyde there are "large towns," "small towns," and "country districts" presenting such variety of circumstances, that nothing which can be said on sewage disposal can be entirely destitute of application to some item in the vast problem of its purification. The question which most interests the great community of which Glasgow is the centre is what method is on the whole best suited to their circumstances.

The history of the Glasgow "sewage question" is the same as of every other sewage question which exercises, or has exercised, the minds of the inhabitants of cities. The successive steps are sewers, water-supply, water-closets, polluted tributaries, then pollution of the main stream. The first common sewers were formed in 1790. The first common water-supply was taken from the Clyde above the town in 1806, and supplemented from the same source in 1808. In 1831, we are told that "Till the formation of the Glasgow Water Works in 1806, there were very few water-closets in the city, but they are now to be found, not only in the first, but in the second and third rate houses." At this date there were five miles of sewers laid down in forty-five streets. They had been extended to forty-one miles by 1848, and to sixty miles in 1860. Just as sewers extended, complaints of the foulness of the numerous local tributaries of the Clyde arose; beginning with the Molendinar, on whose banks the city was first planted. The visitations of cholera in 1832, 1848, and 1853, increasingly virulent within the area of the river water-supply, showed that even two miles and a half above Glasgow Bridge the Clyde had, from pollution of its upper reaches, ceased to be fit for dietic use.

The Gorbals gravitation water, introduced to the south side of the river in 1846, shielded that portion of the city from the cholera in 1853; and Loch Katrine water, introduced in 1859, com-

pleted our safeguard, so that we have had no epidemic of cholera since. By 1849 the pollution of the Clyde had thoroughly attracted public attention. It is remarkable that the references to its condition in the *Glasgow Herald* of that date were couched in language quite as emphatic and strong as any ever applied to the Clyde at the present time. Take the following, for example, in October, 1849: "The effect of some thousands of water-closets pouring their contents into the Clyde cannot but be odious in the extreme, and everyone may have felt that in summer days, after a long drought, the river from this cause literally sweats abomination, and we have more than once seen people sickened from it on board the steamers." If this was the state of things nearly forty years ago, what ought it to be now? The population in and about Glasgow has doubled. A water-supply for all purposes averaging 40,000,000 gallons, or equal to four-fifths of the volume of the Clyde in time of drought, is distributed and flows polluted to the river. Whereas in 1864 there were only 28,000 water-closets within the area of the water-supply, there are now 118,000. The tributaries which distressed our forefathers have gradually been dealt with, either by running culverts down their beds and making them sewers, or by intercepting the city portion of the sewage and conveying it direct to the Clyde. Public urinals abound. Water is applied freely with the hose in our back courts and closes, flushing their surface filth to the drains. In short, there are few cities in which more has been done to remove filth from the environment of the dwelling; but, excepting the diminishing proportion systematically removed by privy-pail and ash-cart, it has all been transferred to the river. Nothing in the sanitary operations of late years has ultimately advantaged the river except the improvement of our streets. Since the abolition of Road Trusts and the development of the tramway system, macadamised roads have been almost entirely displaced by granite run in with bitumen. The system of scavenging has also been greatly improved, so that the rain-washings must be much less foul.

The interesting question remains, how is it that the offensiveness of the Clyde has not proportionately increased? The probable answer is that the operations of the Clyde Trust have tended to dilute the sewage with a steadily increasing amount of impounded tidal water, and have also facilitated its removal seawards. Since 1849 the extent of quayage and the water area of the harbour have been tripled; the former, at this date, extends to over six miles, the latter to 154 acres. The channel below the harbour has been straightened and deepened. The result is that the spring tidal range has been increased from 2 feet 5 inches in 1755 to 11 feet 2 inches in 1888, of which 2 feet 8 inches has been gained since 1853. There is actually 14 inches more range between high and low water in the harbour than at Port Glasgow. In 1800 the time of high water was three hours behind Port Glasgow, now it is only one hour. The effect of those changes in expediting the removal of sewage down the river has been shown by careful experiments with floats. In 1858 a float took 43½ tides, or 537 hours, to reach Port Glasgow, a distance of about 19½ miles. In 1879 it took only 10 tides, or 120 hours 40 minutes, to reach Gourock, a distance of fully 24 miles. Roughly speaking, the sewage was removed seawards at more than five times the speed, or in less than a fifth of the time. In 1879 there was a weir above Albert Bridge, which was removed, and after its removal in 1881 these float experiments were repeated. It was found that the rate of movement was somewhat less. I shall not trouble you with the precise figures, but this statement will seem more important to Glasgow citizens than to strangers, as the removal of the weir was expected to put still further off the evil day of the sewage question. Another fact which helps to explain why the public expression of Glasgow opinion has not exceeded in recent years the intensity to which it had attained in 1849 is that by the extension of railway communications on both banks of the river down to points in the open firth passenger traffic has been almost wholly withdrawn from the upper Clyde. Greenock was connected by rail with Glasgow in 1841, and all the other exits by rail to the coast have been provided since 1849. The odours of the Clyde below the harbour are therefore less familiar to Glasgow people than they were forty years ago. But the sewage question is not to be solved in this way. In fact you will recognise the natural sequence of events, when I state that it has been transferred as a burning question to the lower reaches of the river. As we have seen, it began in the Molendinar. It was pushed into the Clyde, and now it has been partially removed to the Tail of the Bank and Loch Long. The 154 acres over which Glasgow harbour and docks extend form a huge settling pond,

from which last year 610,000 cubic yards of more or less foul deposit was dredged and transferred to Loch Long at a cost to the Clyde Trustees of about 6d. per cubic yard, exclusive of interest on plant, which Mr. Deas informs me may amount to 3d. additional.

No prophet is required to tell us that in the circumstances described our sewage question will not keep much longer. It is not surprising, in view of public opinion in 1849, that it was found necessary to consult Mr. Bateman in 1853. In conjunction with the late Professor Anderson he made a provisional report in July, 1858, in which, as the result of local experiments, precipitation was condemned because, though effectual in deodorizing, the precipitate could not be sold at a price which would cover the cost. Reference was made to the 1858 float observations as proof that the sewage must be conveyed "to a very great distance." This was an introduction to a positive opinion a few months later in favour of engineering works similar to those then projected for London. The Town Council, with Scotch caution, resolved to wait until London had shown the way. Meanwhile they were beset with all sorts of schemes, and, in 1867, remitted them all to Messrs. Bateman and Bazalgette in a minute, which gives vivid expression to the bewilderment caused by a multitude of counsellors. They reported, in 1868, in favour of a scheme by which the whole sewage would be conveyed to the Ayrshire coast, one-fifth by gravitation alone and the remainder after an average lift of 32 feet. The area dealt with was Glasgow and suburbs, estimated at a population of 500,000, and providing for an increase in twenty years to 750,000. The actual sewage was 35,000,000 gallons per day, independent of rainfall, or 70 gallons per head, of which 54 was water-supply. The works were calculated to take a maximum flow of 110,000,000. The cost was estimated to be upwards of £1,250,000, entailing an annual charge of £55,000, which was equal to a rate of 5½d. per pound on the assessable rental of the area included. At an additional cost, not estimated, for pumping works, land, etc., a system of irrigation was suggested. As to available land they made the important statement, subsequently confirmed by Sir John Hawkshaw, that "the total area of land within the valley of the Clyde, under a contour of 50 feet above ordnance datum, suitable for the reception of the sewage, is about 9,500 acres, of which 1,500 acres are upon the north and the remainder upon the south bank of the river below the city." They point out that the land on the north side lay close to residences and in the way of the westward growth of the city; while in view of the claims of neighbouring towns, only 7,000 acres could safely be taken on the south side. They therefore advised recourse to the sandy land on the Ayrshire coast.

The next step was the Royal Commission to Sir John Hawkshaw, who reported in 1876 on the entire drainage area of the Clyde. The scheme applicable to Glasgow and suburbs included also Coatbridge, Airdrie, and the towns along the course of the outfall sewer, which discharged at Fairland Head, opposite the Little Cumbrae Island. The population thus served was estimated at 800,000. The actual sewage, including rainfall, was 120,000,000 gallons per day, and the maximum flow, to receive which the sewers were constructed, was 50 per cent. more. The estimated cost was £2,500,000. The annual charge for pumping, maintenance, and interest was £108,000, which meant a rate of 6½d. per pound on the assessable rental of the area dealt with. It is important to note that Glasgow and suburbs alone, Sir John Hawkshaw calculated, produced 48,000,000 gallons per day, without rainfall, the proportion per head being 70 gallons, of which 53 was water-supply.

Preliminary to the adoption of this scheme, Sir John recommended the appointment of a Board of Sanitary Commissioners of the Clyde. An endeavour to carry out this suggestion by private Bill was unsuccessful, and Government has hitherto failed to implement a promise of general legislation for this purpose.

In 1877, the Town Council, by a deputation of their number, applied their own minds to the question, and came to the conclusion that the sewage of Glasgow might, "after being rendered clear by precipitation and filtration, be passed into the Clyde." Mr. Bateman was asked to supply an engineering scheme for this purpose and suggested three, all of which ended in bringing the sewage to one or more points on the river above Dumbarton. A sentence thrown in at the end of his report raised doubts as to whether the clarified effluent would, after reaching the river, in the circumstances of tidal retardation previously described, be dispersed before again becoming offensive. This was a revival of

the float experiment of 1838, but, as already stated, their repetition now showed that the circumstances were entirely altered. Besides, numerous laboratory experiments were immediately instituted by Dr. Wallace, at the request of the Council, with this result—"that Glasgow sewage, properly defecated and introduced into the Clyde at a point below the city, will not, under any circumstances, give rise to a nuisance." The deputation in 1880 again made a tour of the various towns in England where sewage processes were in operation, and also investigated the Lierned system in Amsterdam. In the light of all the information thus obtained, they reaffirmed the conclusion arrived at three years previously. In 1881, the Sewage Committee adopted Bateman's scheme No. 3, by which the sewage of the north side was to be treated at Dalmuir, and of the south at a point in the parish of Govan. The area dealt with extended to 14,900 acres, with an existing population of 710,000 persons, yielding $36\frac{1}{2}$ million gallons of sewage per day, exclusive of rainfall. This is 51 gallons per head, of which $45\frac{1}{2}$ is water-supply. The works provided for 1,350,000 persons, yielding 62,500,000 gallons. Exclusive of cost of land and interference with property, this scheme was, according to a revised estimate, to involve an expenditure of £800,000 on works alone. The annual charge for pumping was £3,400. The cost of treatment and disposing of the sludge was roughly estimated at £40,000 to £45,000 a year. An idea was somehow suggested that the removal of the weir would for a time make the sewage question less urgent. Partly under the influence of that idea, and partly from the existence of so many administrative authorities among the sewage-producing communities, this scheme was not further considered. I have already pointed out that the removal of the weir has certainly had no such effect, though other circumstances have gradually tended in some degree to mitigate the nuisance at our own doors. There is now some prospect of the extension of the municipality, so as to include the whole populous area; and I have no doubt that, as the Lord Provost stated last night, one of the first questions which will engage the consolidated Council will be the purification of the Clyde.

ON SEWAGE DISPOSAL FOR WATER-CLOSET TOWNS.

Read in the Section of Public Medicine at the Annual Meeting of the British Medical Association in Glasgow, August, 1888.

By ALFRED CARPENTER, M.D.

It having been determined that "The Disposal of Sewage" be one of the subjects for consideration at this meeting, I think it right not to allow the most correct way of dealing with sewage to be put out of sight, because of its simplicity. It is twenty-two years since I introduced a method of treating town sewage to the notice of an assembly of men of science, specially called to consider the subject of town drainage. That was at the congress assembled at Leamington in 1865. I have repeatedly followed up the same subject at various meetings of scientific, medical, and sanitary bodies, always dwelling upon the points connected with the utilisation of sewage on land by so-called "broad irrigation." At the International Congress assembled in London in 1881, I submitted in general terms a series of propositions for the consideration of the congress, and I now venture to re-state them for the consideration of this meeting in terms more explicit and detailed.

1. That the application of the sewage of a water-closet town to land in close proximity to dwelling-houses is not injurious to the health of the inhabitants of those houses, provided the sewage be fresh; that it be applied in an intermittent manner, and the effluent be capable of rapid removal from the irrigated fields.

2. The judicious application of sewage to soil of almost any kind, if it be mainly inorganic, will satisfactorily cleanse the effluent water, and fit it for discharge into any ordinary stream, provided the area treated is not less than an acre for each 250 persons.

3. That vegetable products grown upon fields irrigated by sewage are satisfactory and safe as articles of food, for both animals and man.

4. That sewage farms if properly managed do not set up either parasitic or epidemic disease among those working on the farm or among the cattle fed upon its produce.

5. That this immunity exists because the conditions necessary for the propagation and continuance of those disease germs which affect man and animals are absent, the microbic life on sewage farms being antagonistic to the life of disease germs, the latter, therefore, soon cease as such to exist.

6. That sewage farms may be carried on in perfect safety close to populations. It is not, however, argued that the effluent water is safe to use for dietetic purposes.

7. That there is an aspect in sewage farming which shows that it is a wise policy for the nation to encourage that form of utilisation from a political economy point of view.

8. That to be financially successful such farms require that the rainfall be separated from the sewage; the area large enough for alternate cropping, and the capital employed sufficient to insure a continuous and rapid consumption of the crops produced.

9. That if practicable sewage utilisation by surface irrigation should be, for financial reasons, within the area of its own watershed, and close to the populations producing the sewage, but it is not a necessity that it should be so, provided it be applied to the land within a few hours, not more than twelve, of its discharge, and that there is no arrest of movement for more than very short periods before it is so utilised.

Several years have passed away since the matter contained in those propositions were put forth to the medical profession. I now intend to carry on the evidence as to their soundness by reference to the experience which has been gained in various parts of the kingdom, since the last report to a medical body, namely, 1881, but more especially by the results which have followed its continued application to the same land in my own neighbourhood since that time.

There are two facts which no amount of argument derived from the use of chemicals, or the bungling of local authority officials can controvert or deprive of their significance:—

1. The utilisation of sewage has been carried out on the same land consecutively for thirty years, frequently in a bungling manner, the area, however, being increased as the increase of population required it. Commencing with thirty-six acres only in 1851, it was all but abandoned as an incorrect proceeding, because the quantity of sewage applied was in excess of the power of the soil to deal with it. Three hundred acres were then obtained about the time that I first became connected with the farm. These have been increased by new purchases as the quantity of sewage to be applied from increasing population rendered it absolutely necessary to enlarge the area of application, but the land irrigated for the first time thirty years ago still continues in use, and effects its object as perfectly as on the first application. The subsoil of the farm two feet below the surface shows very little alteration, and three feet below is not in any way contaminated by the continued application of sewage. The various crops grown upon the land take out the manurial properties of the sewage, and allow the soil to continue its purifying power even better than at first. To effect this, however, it is necessary that the cropping be incessant and that the land have occasional rest for a year from sewage application. The tendency of the repeated application of sewage to land is to silt up the lower portion of the subsoil and prevent it acting as a filter below the plough level, except for a short time. It follows, therefore, that the sewage must pass over the land rather than through it, and although intermittent downwards filtration may purify the water, it will be temporary only, unless the soil is turned over frequently, so as to allow of its aëration. A sewage farm will bear deep ploughing better than other land, and grow larger crops in consequence.

2. The second great fact is that notwithstanding the very large price paid for the land at Beddington and Norwood, namely, sometimes as much as £300 an acre, or more for some of it, and a total cost of nearly £250,000, it has seldom been necessary to make more than a 2d. rate upon the parish to meet all the charges required to be met. The capital raised is now being paid off, but not lost, and in forty years from the last loan, the whole farm will be the freehold of the borough, without any liability at all upon it, paying a fair sum towards the reduction of the rates, and retaining a large open space with abundance of vegetation, in the midst of a large population, and providing a considerable amount of out-of-door work. The capital raised is an investment for the future, and not a scattering of immense sums of money in works which may become useless, like to those now being carried out by the Metropolitan Board of Works at the Thames outfall, by Crossness and Barking.