

Report of the Highway and Sewerage Committee of the Local Board of Health.

Contributors

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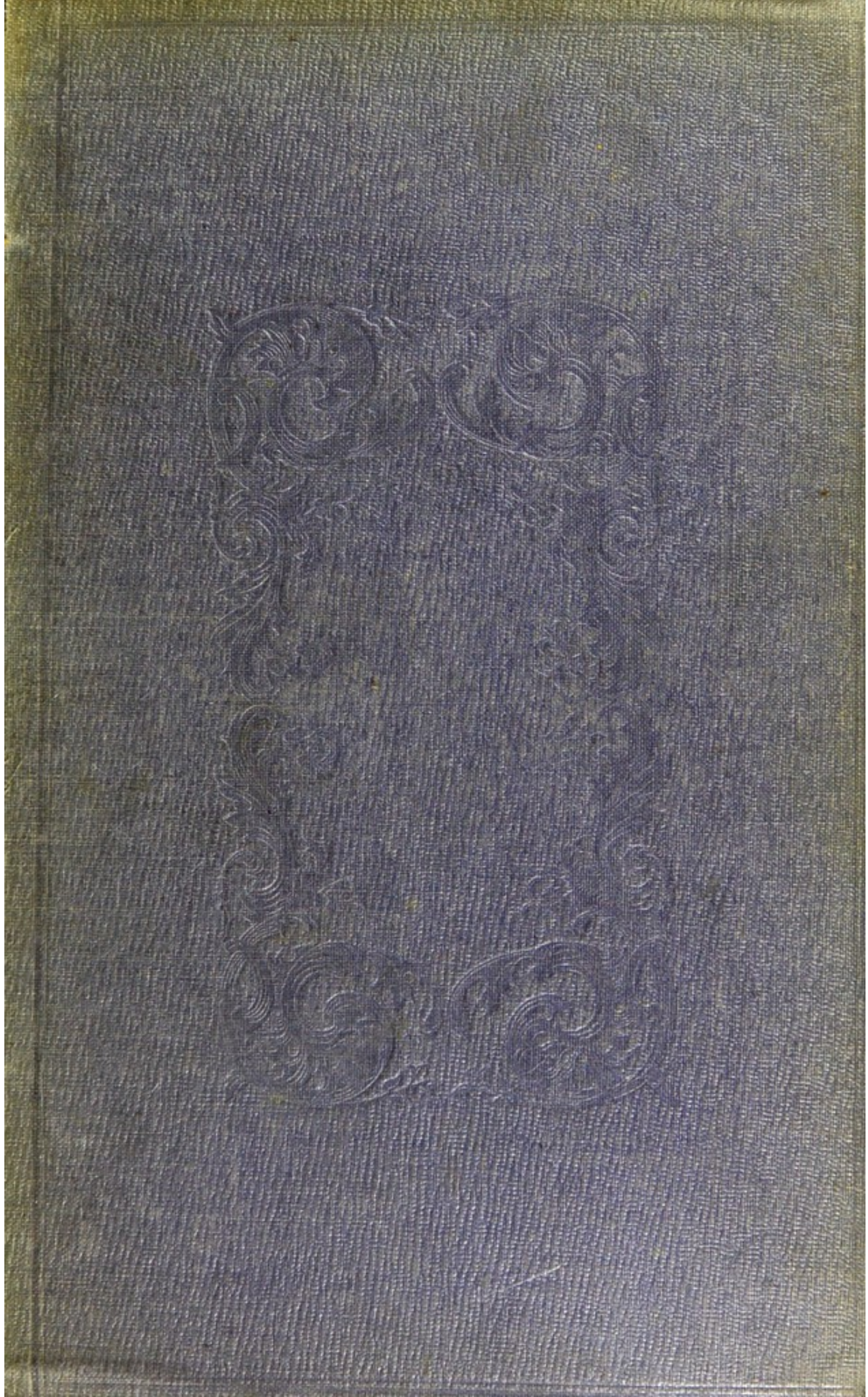
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Tell on the Serpentine
Ranger's Report on Supply
Scientist

Clay on the Supply of Med. Leg. Tr.
Ground of Health Report

Homersham on Meteorology

Hassall's Microscope

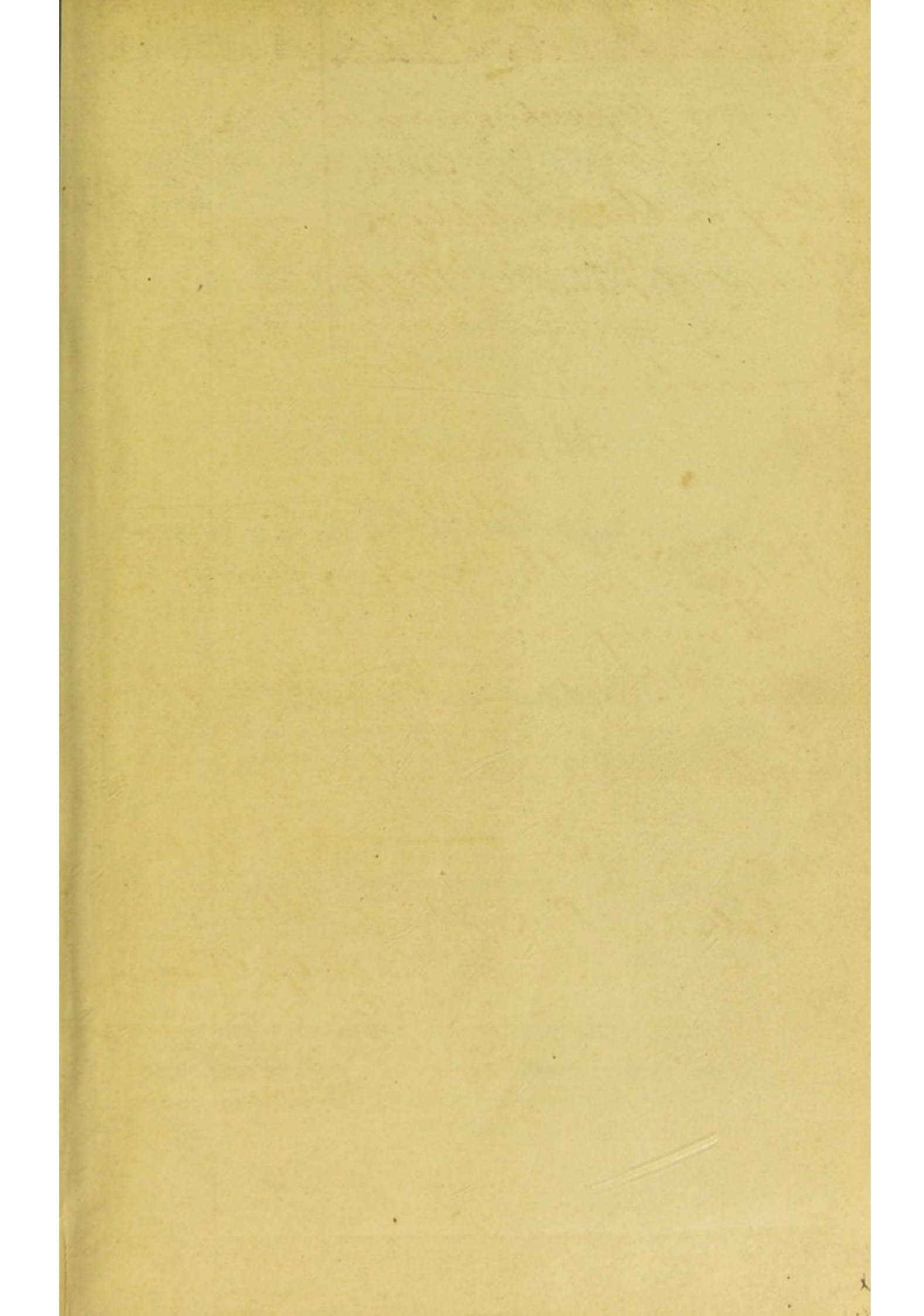
Robertson on the ^{of Water of course} ~~Winton Water~~
Napier on the Soft Springs of
the Surrey sands

W. H. Taylor West Medley Report

Rowlandson on Napier's Scheme

Ranger on Southampton Water Supply

Wickstead Reports on the
Inventor Supply New



consumes, by the application of his mode of testing, as much soap as if the *whole* were hard water, and he vouches for the fact. Hence it follows, that his own mode of applying the soap test is liable to a great fallacy, because it cannot enable him to distinguish between the quantity of saline matter contained in two waters, one of which holds only *half as much* as the other. A chemical analysis would of course immediately show the difference. Dr. Clark refers this result to some peculiarity in the Leicester waters. We are inclined to regard it as one of those necessary fallacies which must arise where we endeavour to obtain numerical results by processes which are incapable of affording them. We do not know any stronger condemnation of this mode of testing waters, than this statement of results in the letter published in the Leicester Report.

You will now be able to appreciate our reasons for not applying Dr Clark's mode of testing to the Leicester waters. We have applied the old soap test, as it has been long known to chemists to determine the relative hardness of three waters, which it was desirable to compare; but we have not marked this hardness in degrees, for the simple reason that it cannot be done with any practical utility. The only standard with which the hardness of water can be fairly compared as unity is *Distilled water*; but, except for particular purposes, it is not required to take this unity for comparison.

AR. AIKIN, F.G.S., F.L.S., V.P. London Chem. Soc., &c., &c.

ALFRED SWAINE TAYLOR, M.D., F.R.S. &c., &c.

Professors of Chemistry in Guy's Hospital.

GUY'S HOSPITAL,

March 6, 1850.

LEICESTER, Local Board of Health

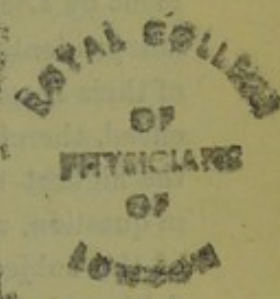
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REPORT

OF THE HIGHWAY AND SEWERAGE COMMITTEE

OF THE

LOCAL BOARD OF HEALTH.



IN presenting to the Local Board a letter from the General Board of Health, on the subject of the proposed scheme of sewerage for this borough, together with the Report of Mr. Lee, one of their Superintending Inspectors, on which such letter is founded, and the observations of Mr. Wicksteed in reply, the Highway and Sewerage Committee feel it to be their duty to address to the Local Board a few preliminary remarks.

The Act of Parliament constituting the Town Council the Local Board of Health, received the royal assent and came into operation on the 1st August, 1849, and one of the first questions which occupied the attention of the Board, was the appointment of a competent Engineer, to devise an efficient system of sewerage; it being well-known from the low level of several densely-populated districts in this town, that the accomplishment of this important object would require more than ordinary skill and consideration.

At a Meeting of the Board, held on the 5th September, 1849, it was moved by Mr. Whetstone, seconded by Mr. Thos. Macaulay, and carried unanimously, in pursuance of a unanimous recommendation from this Committee, moved by Dr. Shaw, and seconded by Mr. Moore,—“That Thomas Wicksteed, Esq., of London, should be appointed Engineer, for the purpose of reporting as to the best mode of draining and sewerage the borough, and of presenting a plan with an estimate of the expense.” Mr. Wicksteed was personally unknown to every member of the Board, and he was selected solely on account of his high

professional reputation, and the admirable evidence given by him as published in the first Report of the Commissioners for enquiring into the Sanitary State of Large Towns and Populous Districts.

At the time of his appointment, it was not known, or even suspected, that any personal feeling of hostility existed towards him on the part of any influential member of the General Board, or that the Superintending Inspectors of the General Board would have been permitted to act as principal Engineers for any Local Board; as, *a priori*, such employment by Local Boards would have appeared to be inconsistent with the independent position of the General Board and the perfect impartiality of their Inspectors in reporting on the plans of other Engineers. Influenced, therefore, solely by a desire to procure the best plan by securing the highest engineering talent, the Local Board made the appointment in question, and Mr. Wicksteed at once entered upon the consideration of the subject and the examination of the district. The result of his deliberation was embodied in a Report presented to the Board, and an Act of Parliament was applied for in the Session of 1851, to enable the Local Board to purchase the land, and form the main sewers and outfall recommended by Mr. Wicksteed.

When the notices for this Bill were given and the Parliamentary plans prepared, copies of the Bill, &c., and plans were sent to the General Board, but no communication was received from them until the day appointed for the Bill going before the Committee of the House of Commons, when the Chairman, Mr. Bernal, stated that he had just received a long letter from the General Board on the subject of the Bill, which would render it necessary for the promoters to communicate with the General Board before it could be further proceeded with. He, therefore, very politely adjourned the Committee to the following day, and wrote a letter with which the Borough Members, Mr. Whetstone, and the Town Clerk proceeded at once to the General Board.

Their names were sent up, but Mr. Ellis alone was admitted to an interview, the Board having in the first instance stated that they could not see any of the deputation.

The result of the interview of Mr. Ellis with Mr. Chadwick was that the Bill was altered in one of the clauses, so as to prevent the Local Board borrowing money without the previous consent of the General Board.

No intimation was given that the scheme itself contained such defects in principle or detail, or was so radically objectionable, as to render it probable that such consent would be withheld.

The Bill, thus altered, proceeded and received the royal assent. It may, however, be observed, that independently of the power to carry out a particular plan of sewerage, the Act contains many other provisions which have been since found most valuable and beneficial in their operation, and have relieved the Committee from many difficulties which arose from the imperfections of the Public Health Act.

The Act having been obtained, and the Local Board having received from Mr Wicksteed a more detailed report as to the mode in which the scheme should be carried out, with particulars of the proper dimensions of the sewers and culverts in different parts of the borough, with certain general estimates of expense,—application was made to the General Board for permission to borrow the sum of £35,000, to enable the Local Board to undertake the works. This application was made on the 20th of August, and was accompanied by a copy of Mr. Wicksteed's report. Further plans were asked for, and sent in September; and the General Board were at the same time informed that Mr. Wicksteed, who resides in London, would be ready to attend them at any time to afford any further particulars or information if any were required; and, in addition to this intimation, Mr. Wicksteed sent his chief assistant to the office on the 3rd of October last, with two plans and an estimate, for the express purpose of inquiring whether the General Board desired any further information or wished him (Mr. Wicksteed) to attend the Board personally.

His assistant (Mr. Ralphs) was informed that the Board believed they had then all that would be necessary.

Several weeks having passed and nothing having been heard, the Town Clerk was directed by the Committee to write to the General Board, urging the importance of an early decision and representing the serious inconvenience resulting from delay. After waiting till November a Report was received from the General Board, stating that the delay had arisen from the imperfect information afforded, and that Mr. Lee, one of their Superintending Inspectors, would visit Leicester to examine the district, and report to the General Board his opinion on the scheme.

Without, therefore, any previous application having been made to Mr. Wicksteed for information or elucidation of his Report, Mr. Lee came to Leicester on the 26th of November, and he was then informed that it was, in the opinion of the Local Board, very extraordinary that the General Board had not, either from a feeling of courtesy to Mr. Wicksteed, or from a sense of justice to the town, communicated with their Engineer, and received from him any information they required,

together with an explanation of any point which appeared open to objection, and which the Engineer was evidently the proper party to afford. Mr. Lee apparently acquiesced in the opinion that some want of consideration had been shown in this respect, and distinctly stated that on his return to town, and before making any Report, he should, in fairness to Mr. Wicksteed, request a personal interview with him, and hear his explanation of the plan proposed. Mr. Lee also attended one of the meetings of your Committee, and promised to make his Report within about ten days; and, although he intimated his opinion that the scheme was capable of improvement in certain minor particulars, in which this Committee expressed their willingness to meet his views, he gave them no reason to expect that his Report would condemn it as fundamentally vicious and incapable of amendment.

The Committee again waited until the 5th of February, when thinking that the time had arrived for again urging the subject on the attention of the Board, they requested the borough members personally to see the General Board, and represent the disappointment occasioned by this unlooked-for delay. Mr. Chadwick stated that Mr. Lee's Report had been received that morning only, and that the decision of the General Board would be come to in a few days. Their letter containing this decision was received on the 14th February, but not being accompanied by a copy of Mr. Lee's Report, the same was applied for, and was received on the 22nd February.

Immediately on receipt of this report, in which the proposed scheme is condemned *in toto* and in the most unqualified terms, and which moreover, *was made by Mr. Lee without any communication whatever with Mr. Wicksteed, your engineer*, a copy was sent to Mr. Wicksteed, in order that he might have an opportunity of explaining and defending his scheme, and answering the objections of Mr. Lee; so that both might simultaneously be presented to the Local Board. His observations in vindication of his plans are appended to this Report.

The Committee think it right to observe, that the General Board appear to be of opinion that no scheme can be laid down for the proper and effectual sewerage of the borough, until a plan, prepared on the principle recommended by the General Board, and shewing all the houses intended to be drained, and all the existing sewers, culverts, drains, cellars, and privies, shall have been made.

It is almost unnecessary to say, that the preparation of such a plan would entail very serious expense, and much loss of time—and, considering the fact that the Board are now in possession of a very accu-

rate plan made by Mr. Flint, showing the levels of every street, and various other particulars, the Committee are of opinion that this requirement is unreasonable, and that Mr. Flint's plan, with the additional plans prepared by Mr. Wicksteed, are amply sufficient to enable the Board to determine as to the proper direction of the main lines of sewerage; particularly as they have informed Mr. Lee of their readiness to supply other details upon the plan from time to time, as the drainage of the different streets shall be determined upon by the Board.

The objections to the proposed scheme on the part of the General Board are various. One of their principal objections appears, however, to be that a considerable part of the town might be drained by gravitation, whereas by the proposed plan the whole of the sewage is conducted to an artificial outlet, and then raised by engine power. The question depends on the relative cost and practicability of the two modes; but, it may be observed, that the plan of the General Board would involve two independent systems of sewers, and two outfalls—one for the higher parts, and another for the lower parts of the town,—and it is presumed, from the general views expressed by the Board, a third system of sewers for carrying off the surface drainage.

Whether the observations of Mr. Wicksteed in his Preliminary Report, and the further explanation of this part of his scheme contained in his reply to the strictures of Mr. Lee, are not satisfactory and conclusive, will be for the Local Board to determine.

Another objection is, that the sewers and outfall recommended by Mr. Wicksteed are so constructed as to be incapable of properly carrying off the rain water, and that some danger is to be apprehended on that account, from the gorging of the sewers and the emission of pestilential gases (to use the words of Mr. Lee) even in ordinary rains.

On this most important point Mr. Wicksteed speaks with great confidence, and enters into the consideration of the question with much particularity; and, as one of the most experienced Water Engineers of the day, his opinion deserves to be treated with attention and respect.

The General Board further state, that some of the principal sewers are not shewn on the parliamentary plan; although indicated on that presented to the General Board.

The reason of this is obvious, and would be at once apparent to any one conversant with parliamentary practice. It is this—that in a parliamentary plan so much only of a scheme is shown as the promoters apply to parliament for powers to carry out. The Local Board

possessing under the Public Health Act the requisite authorities for constructing sewers and culverts in the streets of the borough, no new powers were, therefore, asked or required. All that the parliamentary plan shows is, consequently, those sewers and works only which interfere with certain private rights, or require the purchase of certain private lands or interests. Another objection is, that the exposure of a large quantity of sewage in the proposed reservoirs would be prejudicial to the health of the inhabitants—that the reservoirs are unnecessarily large and expensive—and that the manufacture of solid manure from the sewage would be a profitless and hazardous undertaking. With respect to the size of the reservoirs, the Committee informed Mr. Lee that they were desirous of making the reservoirs in the first instance as small as practicable, taking only the precaution of purchasing sufficient land to enable them to enlarge them at a future time if found necessary; and that they were also willing to meet the views of the General Board by constructing the works of the reservoirs in such manner as to allow of the distribution of the liquid manure over any lands in the neighbourhood of the reservoirs, conveniently situate for its reception. As regards the expense of the reservoirs and the deodorizing of the sewage, the Committee have reason to believe that a beneficial arrangement might have been made with a private company in London, which would have relieved the borough from a considerable portion of the cost of the works connected with the reservoirs, the Committee never having contemplated the manufacture of manure on their own account. That the exposure of this sewage on the proposed site would be prejudicial to the health of the inhabitants, is an assertion which is not supported by the opinion of your Officer of Health.

There was considerable difficulty in providing a proper site for the outfall, and the Committee feel satisfied that none could have been selected more free from objection than the one recommended.

Whether the distribution of liquid sewage over all the lands adjacent to the Town of Leicester, according to the favourite theory of the General Board, would contribute more to the comfort of the inhabitants, and the salubrity of the atmosphere—or whether any mode can be pointed out for discharging the sewage into the canal, which will not be objected to by the inhabitants of Belgrave, and other places on the line of the Canal without first partially deodorizing the same—or whether the produce of grass-land would, by the full application of the fertilizing powers of liquified manure, be four, or five-fold above the ordinary

amount of production in the Country, and enhance the value of land from £4, or £5, to £15, or £20 an acre, as maintained by some of the promoters of the liquid manure theory—are points on which very considerable difference of opinion is known to exist among those who are well qualified to form a judgment.

The practical question for the consideration of the Local Board, under existing circumstances, is, what course it is expedient to adopt.

The Committee deeply regret the obstruction which has thus unexpectedly arisen to the immediate progress of sanitary improvement, as they are fully satisfied that there is a great amount of preventible disease in the borough, which would be remedied to an appreciable extent by an improved system of sewerage; and that the mortality, which, in some of the undrained parts, is no less than 5 per cent per annum, might have been very materially reduced.

Four courses appear to be open to the Local Board,—

1st.—To seek an interview with the General Board for the purpose of ascertaining whether their objections can be wholly or partially removed, or any alteration made in the proposed scheme consistently with the preservation of its essential features.

2nd.—To petition parliament, representing the circumstances of the case, and to request the members for the borough to found a motion thereon for Returns of the proceedings of the General Board in Leicester and other towns, with the names of the Engineers whose plans have been sanctioned, and whether they are persons in the employ of the General Board as Superintending Inspectors, or otherwise.

3rd.—To submit the scheme, with the objections of the General Board, to the consideration of some other Engineer, to be agreed upon by the Local and the General Board, for his deliberate and impartial judgment; or,

4th.—To suspend all further proceedings for the present, under the not very improbable supposition, that among other changes, some modification may take place in the constitution of the General Board, or in the principles on which their sanction to sewerage schemes is given or withheld.

Each of these courses has been advocated by different individuals.

The Committee, are, however, so deeply impressed with the paramount importance of an improved system of sewerage in order to lessen the high rate of mortality which now exists in some parts of the Borough, that they cannot advise the Local Board to relinquish the duty which they have undertaken, either in disappointment or despair,

without, in the first instance, seeking for a personal interview with the General Board.

Should that interview lead to no practical results, you will, at all events, have the satisfaction of having done your duty to the town, and the responsibility attaching to the unnecessary continuance of an excessive rate of mortality in this Borough will no longer rest with the Local Board.

By order of the Highway and Sewerage Committee,

SAMUEL STONE,

CLERK OF THE BOARD.

REPORT

OF THE GENERAL BOARD OF HEALTH,

ON A SCHEME FOR THE DRAINAGE OF LEICESTER AND THE CONVERSION OF THE SEWERAGE WATER THEREOF INTO MANURE, BY WILLIAM LEE, ESQ., SUPERINTENDING INSPECTOR.

9, *Duke-street, Westminster*, 26th January, 1852.

MY LORDS AND GENTLEMEN,

THE Town Council of Leicester, as the Local Board of Health for that borough, having, under the powers of "The Leicester Sewerage Act, 1851," and "The Public Health Act, 1848," prepared a scheme for the main sewers and outfall of the sewerage of the said borough, and other works; and having memorialized your honourable board to sanction the borrowing on mortgage of the public rates of the said borough, the sum of thirty-five thousand pounds for the execution of such works, and for improving existing, or constructing other sewers, you were pleased to direct that I should visit the said borough, and examine the plans and documents forwarded with such memorial, and then report to you in writing.

On receipt of such instructions, I visited Leicester on the 26th day of November last, and have to regret, that two months should have elapsed before the presentation of my report. Your honourable board know that other unexpected and urgent duties have caused this delay on my part to be unavoidable.

I append hereto the memorial and correspondence connected therewith; also, a printed Report on the Sewerage, Drainage, and Supply of Water for the Borough of Leicester, by Thomas Wicksteed, Esq., furnished to me by the Sewerage and Highway Committee of the Borough; a further report, in writing, by the same gentleman, forwarded with the memorial; a more specific estimate of the cost of the proposed works, also by Mr. Wicksteed; and a copy of the "Leicester Sewerage Act, 1851."

I also append a set of tracings on cloth, from a block or skeleton survey of the town, made a few years since, but not showing the houses or buildings in the town, scale, in an inch; also, a small scale skeleton plan on tracing paper, showing the directions of the proposed main sewers, with the drainage area of each; and a series of lines indicating contours at four feet distances; also, a printed plan of the town, on a scale of seven chains in an inch, published in 1844, and now coloured to show the direction of the main sewers and the drainage areas; also, another copy of the same, coloured, to show the direction in which the streets fall, the valleys, and the ridges; also, the sections and skeleton plan of the main sewers, prepared in compliance with the standing orders of Parliament for "The Leicester Sewerage Act, 1851."

I was attended during my inspection of the site of the proposed works by Joseph Whetstone, Esq., of the Highway and Sewerage Committee, Samuel Stone, Esq., Town Clerk, John Buck, Esq., Officer of

Health, and Samuel S. Harris, Esq., Local Surveyor. I feel it my duty to say, that I received from these gentlemen all the assistance and information in their power; and that both they and the committee are deeply sensible of the importance of speedy measures for the sanitary improvement of the borough.

NO SURVEY SHOWING BUILDINGS OF THE TOWN.

Knowing the importance of a proper survey, showing all the houses, courts, privies, &c., and their levels, as set forth in specimen plans and minutes on surveys (prepared by your honourable board, and issued for the assistance of the Local Boards throughout the country), my first inquiry was as to the existence of any such survey and plans of Leicester. I was informed by the Town Clerk that no such plan had been prepared, but that the block survey had been submitted to you, and a communication received from your secretary, which was of a satisfactory nature.

A meeting of the Highway and Sewerage Committee was held the same evening, at which I attended, by invitation, when the letter from Mr. Austin was referred to, and found to be in accordance with your "Minutes on Surveys."

I explained to the Committee the absolute necessity of such a detail survey being completed, previously to the designing of any efficient and economical drainage works; and the following day was favoured by the Town Clerk with a resolution, of which the following is a copy:—

"At a meeting of the Highway and Sewerage Committee of the Local Board of Health for the Borough of Leicester, held at the Town Hall, on the 26th day of November, 1851,

"It was resolved unanimously,

"That having heard the suggestions of Mr. Lee, with respect to the importance of the General Plan of the Town, exhibiting the number of houses, and the drainage of each street, this Committee is fully prepared to undertake that the details shall be supplied from time to time, as the sewerage or drainage of the different streets shall be determined upon."

I have already stated my conviction of the anxious desire of the Committee to remedy, without delay, the evils existing in the town; and this resolution, unanimously passed, proves their sincerity. The works, however, for the construction of which you are asked to sanction the mortgage of £30,000, have been all designed in the absence of any such survey or plan. There are no proper data upon which to adjust and decide the specific sizes, depths, and inclinations of the proposed sewers. The fitness of each for the work to be done can only, therefore, at the best, be matter of probable conjecture, instead of being the result of exact calculation.

Mr. Wicksteed's estimates furnished for the main sewerage amount to £30,000, but the Memorial of the Local Board states—

"That in addition to the said estimated sum, the said Local Board propose to expend the further sum of five thousand pounds in improving existing, or constructing new sewers, culverts, and drains, within the said borough."

With respect to this additional amount of £5,000, there is no plan or document to show where, or in what manner, the money is proposed to be expended.

This scheme of sewers is confined to one main sewer for the eastern side of the town; another for the western side of the town; a main, called the suburb sewer; a small sewer from Frog-island; and the sewers beyond the houses, to convey the sewage thus collected to the engine well and the outfall. The total length of these sewers is about five miles, but only about three miles are within the town. The length of streets and public places due to the population, and remaining to be otherwise provided with sewers, is nearly forty miles. A foot note, at page 10 of Mr. Wicksteed's printed report, states that the branch and small lines will cost £25,000, but none of this is included in the £30,000 named in the memorial. No plan or section is given of any such works, except that a red line is laid on the coloured tracing, and one of the small printed plans, showing the direction of what is called the "Central Branch Sewer," and the area to be drained by it, is stated. I find, also, a statement in the printed report, that the diameter is to be twenty-seven inches. Your honourable board will be surprised to find, that while the sewer, 350 yards in length, from a small district of eighteen acres, called Frog-island, only partly built upon, is included among the "main sewers" of the scheme before you, the "Central Branch Sewer," as it is called, is entirely omitted; and yet it will be 1,460 yards in length, through a line of principal streets, and is intended to receive all the sewers from a complete drainage area of 229 acres of land; nearly all of which is built up, containing at least one-fourth of the population of Leicester, including the markets and all the centre of the town.

I shall have to allude to this sewer again hereinafter, but must state now, that when you are called upon to exercise the great responsibility imposed upon your honourable board by the legislature, this most important sewer should not have been omitted from a scheme intended for the main sewers of the town.

I must notice as objections to the proposed sewers:—

1st. The constructive defects.

2nd. Sanitary objections.

3rd. The excessive cost.

These several general heads include specific considerations, such as the direction, depth, size, and materials of the proposed sewers, and their suitableness for the public service.

Many of these circumstances are so connected together as scarcely to admit of separate discussion, and I therefore propose to treat of each sewer distinctly; then of their combinations, as the streams become united, until the whole scheme is thus brought under review. The engines, reservoirs, and proposed desiccation, or precipitation, will be considered after the main sewers themselves have been dealt with.

PRELIMINARY OBSERVATIONS.

It is right to say that Leicester is a difficult town to drain, so far as concerns the main sewerage; but when the general plan of outfall and principal sewers shall have been settled and adopted, the secondary or branch sewers will be exceedingly simple. I think I have met with no town in which the details, including the house drainage, admit of more economical and efficient arrangements on the principal of back drainage.

MR. WICKSTEED'S DESCRIPTION OF HIS SCHEME.

For the chief points in connection with this scheme, I must refer your honourable board to the printed and written reports by Mr. Wicksteed, appended hereto. It will be seen that he contemplates no other main sewers than these for the removal of rain water falling on the drainage areas of the several sewers, and says:—

("CAPACITY OF SEWERS.")

Page 8, *Written Report.*

"It is calculated that the ordinary amount of sewage, at the end of thirty years, will be equal to five millions of gallons per diem; but the main sewers are calculated to deliver twenty eight millions of gallons, per twenty-four hours, which, taking the drainage area at 1,212 acres, and assuming that two-thirds of the rain-fall flow off the ground into the sewers, would be sufficient for $1\frac{1}{4}$ inches fall in twenty-four hours."

Page 16, *Printed Report.*

"The quantity of water now passing through the sewers under ordinary circumstances may be taken as equal to one million of gallons per diem, and I calculate that when the proposed sewers and water works are completed, and the increased supplies of water from the private houses, from condensing engines, from manufactories, and from surface water, (which now sinks into the ground) are diverted into the new sewers, the quantity will be increased to five millions of gallons per diem. It would not, however, be wise to limit the size of the sewers for the passage of so small a quantity; the capacity of the main sewers should unquestionably be sufficient to render the necessity of having to enlarge them hereafter improbable from any future increase in the drainage.

"To provide against such a contingency I would, therefore, propose to make the main sewers of such a capacity as to admit of the free passage of 25,655,540 gallons per twenty-four hours: this would allow for an increase in the present estimated quantity of sewerage water (say 5,000,000 gallons per twenty-four hours) of 300 per cent., bringing up the quantity to 20,000,000 of gallons per twenty-four hours, and would always provide for the reception of the water flowing off the surface during heavy but not excessive rains; assuming that an area of one and a half miles by one mile, or about a thousand acres, would probably be the greatest surface from which such water would flow into the proposed sewers; and, taking a rain-fall of three-eighths of an inch in twenty-four hours, that would give a sum of 8,483,310 gallons; and supposing that as much as two-thirds of this quantity may find its way into the sewers, that portion would be equal to 5,655,540 gallons, which being added to the regular sewage proposed to be provided for would make up the total of 25,655,540 gallons per twenty-four hours, as before stated.

It will be observed that there are several serious discrepancies between these two statements. In one, the area from which rain water would flow into the proposed sewers is stated to be 1,000, and in the other

1,212, acres. The capacity of the same sewers is stated in one at rather more than twenty-five millions and a half, and in the other at twenty-eight millions. In one, the sewage is estimated at five millions *when the proposed sewers and waterworks are completed*; while in the other it is said to be calculated that the quantity will amount to five millions at the end of thirty years. In one, the sewers are said to be capable of receiving two-thirds of three-eighths of an inch of rain (equal to a quarter of an inch) in twenty-four hours, and this is called a *heavy rain*. In the second statement, the same sewers are said to be capable of taking two-thirds of one-and-a-quarter inches fall, in twenty-four hours, equal to five-sixths of an inch in depth.

The difference between the two statements is 15,993,769 gallons in twenty-four hours, as the capacity of the sewers for rain.

Another instance of the incompleteness of Mr. Wicksteed's plan is, that there is no reference made to the existing sewers; although much depends upon whether they are to form part of the proposed system, or to act independently for storm waters. From the nature of the proposed main sewers, and from the expressions used in the above description, where he speaks of the surface water, &c., being "diverted into the new sewers," and that they would "always provide for the reception of the water flowing off the surface during heavy but not excessive rains;" and, also, I think I might fairly conclude from the words—"in case of storms, or heavy rains and floods, the water, after all sewage has been washed out of the sewers, will flow past the reservoirs to the outfall" (printed Report, p. 21)—that all the branch sewers already existing, and to be constructed, are to communicate with the proposed main sewers.

Without, however, insisting that such is the intention of Mr. Wicksteed, I think it right to show what is the actual capacity of the proposed sewers for rain water, according to his own data, in order that your honourable board may judge of their suitableness, and of the propriety of a greatly increased outlay for such object.

It is well known as a general fact, that upon some ten days out of the twelve months, one-fourth of the whole annual rain is deposited in any district; that there is scarcely any district in which there are not five or six days in every twelve months yielding considerably more than an inch of rain in the twenty-four hours. A rainfall of three-eighths of an inch, *in an hour*, is not unfrequent; and repeatedly, during every year, half an inch and upwards will fall in an hour at Leicester.

It happens in all districts that there are rainfalls of an inch in an hour, and during heavy rain upon the surface of a town in a good sanitary condition, with the streets and courts all paved, and the cisterns and rain water butts abolished by a proper water supply, upwards of nine-tenths of such a fall would flow off the ground, instead of two-thirds.

These would, of course, be "excessive rains," such as I do not suppose Mr. Wicksteed to have intended to provide for, although he speaks of storms or heavy rains and "floods" flowing past the reservoirs to the outfall. I adduce the facts only to establish a standard, by the fractional proportions of which the capacity of the proposed sewers for the conveyance of rain water may be measured.

One inch of rain falling upon 1,212 acres (the area given to Mr. Wicksteed) amounts to 27,418,058 gallons; and, if his statement be admitted, that only two-thirds would flow off, the quantity would still be 18,278,705 gallons. The capacity of discharge per twenty four hours, stated by Mr Wicksteed in his printed report, namely, 25,655,540 gallons, is equal to 1,068,981 gallons per hour; and it would therefore require seventeen hours to discharge two-thirds of an inch of rain; and twenty one hours with the addition of sewage waters. The same in proportion with a less rainfall; and if it be said that this is an extreme case, the reply is, that these are not contingencies that may or may not arise, but certain facts that will happen, and the only consequence will be, that when the sewers cannot discharge the water and sewage received, it will be penned up, the sewers will be gorged from the engine sewer, all up the mains and under the town.

At twenty eight millions per twenty four hours (as stated in the written report), the capacity of discharge would be 1,116,666 gallons per hour; from which the hourly average sewer being deducted, there would remain a capacity of 958,333 gallons of rain water per hour. One twenty-eighth part of an inch of rain flowing off the surface in an hour, therefore, would gorge the sewers, being equal to 979,216 gallons, or 20,883 gallons more than their stated capacity.

It is not, however, less true that for sanitary drainage, the contemplated sewers are much too large, and as a consequence much too expensive. The capacity of discharge is 1,116,666 gallons per hour; while the sewage is only expected, at the end of thirty years, to be five millions per twenty four hours, or an average of 208,333 gallons per hour. The capacity, therefore, *at that time*, will be to the sewage in the proportion of 5.6 to 1: the maximum rainfall to the capacity of the sewers being, at the same time, in the proportion of 28 to 1.

All merely surface drainage water from roads, land unbuilt upon, fields, gardens, &c., should be excluded, so as to equalize as far as practicable the flow, and thus to economise the sizes of the main sewers, the power of the engines, and the costs of the system. No such economical adjustment can, however, be effected without a survey of the town in detail; so as to enable the engineer employed to determine what extent of rain water *must* be taken, and what *may* be excluded.

IMPOUNDING OF SEWAGE, &c., IN THE SEWERS, AND ITS CONSEQUENCES.

A reference to the parliamentary section will show that all the main sewers are united, and are at a great depth below the surface, from the point A to H in the Abbey Meadow, near the engines.

At the point H, and on the same low level, a sewage goes off to the engine well; but any surplus sewage more than can be taken by the engine sewer, or lifted by the engines, will be penned up, filling the sewers back into the town, until it has risen at the point H to a height of nine feet one inch, before it can flow off at all through the flood-water sewer by gravitation.

The following table will show the extent of this impounding recession, whenever the rainflow exceeds 1-66th of an inch in an hour.

T A B L E.

QUANTITY OF SEWAGE *impounded in the Main Sewers during rain before the Flood Water Sewer begins to act, and afterward until removed by the Engines.*

DESIGNATION. NAME OF SEWER.	Diameter of Sewer. Inches.	Length in Yards af- fected.	Condition of Sewers from Rain	Quantity of Sew- age Impounded. Cubic Feet.
Engine Branch Sewer	36	203	Full.	4,304.74
Main Sewer, H to A	56	764	Full.	39,202.17
" " A to F... ..	33	199	Full.	3,545.93
" " A to B.....	45	323	Full.	10,702.26
Frog Island Sewer, F to G	15	350	Full.	1,867.21
Part of Suburb Sewer.....	30	419	Full.	6,170.30
F round by St. Leonard's	30	406	Half full	2,98.943
Part of Eastern Sewer.....	24	465	Full.	4,556.14
" " "	24	261	Half full	1,229.92
Part of Western Sewer.....	39	240	Full.	5,972.95
" " "	30	206	Full.	3,033.67
" " "	30	406	Half full	2,989.42
		4,242		86,564.14

86,564.14 cubic feet is equal to 539,467 gallons.

It appears that the total quantity thus impounded will be 86,564 cubic feet—equal to 539,467 gallons. The length of main sewer entirely full at such times will be 3,169 yards. The tailing out, 1,073 yards more, will be on the average half full; together, 4,242 yards.

The total length of the main sewers, exclusive of the flood-water sewer, is 8,312 yards; so that more than one-half in length of all the main sewers will be affected during rain. This is as far as the plans and sections forwarded to your honourable board will enable me to state in figures, but is not the whole extent of the mischief. What is called "The Central Branch Sewer," and many of the secondary sewers, may, probably, be similarly affected.

Every cubic foot of the sewage and rain water thus impounded will displace an equal quantity of the foul and injurious gases generated in the sewers.

The testimony of the nose must have convinced everybody that drains, even when they have a free and open outlet, are more offensive during rain than at other times.

If such is the effect of the mere augmentation of current, in sewers where there is no impediment to the free discharge, what must be expected in Leicester, when about 90,000 cubic feet of such gas as is described in the report of the chemists, is driven back and discharged into the town upon every slight shower of rain?

If, with a complete plan of the town, the sewers had been adjusted to the sewage and water supply, with only so much surface water as might have been necessary, I should have apprehended no evil from the impounding, nor have objected to it at all below the basements of the build-

ings ; but the evil will consist in the fact that the sewage and air will be intermittent.

At one time, the stream may not occupy one fifth of the sectional area of the sewers, the remainder of the space being filled with foul air ; while in a few minutes the whole of such air would be displaced, and the sewers over-full of sewage and water.

It is necessary that this intermittent condition should be borne in mind, whenever the impounding of the sewage is alluded to.

Another consideration is, the points at which this gas will have the greatest tendency to escape. It is well known, that when the liquid medium in stench traps becomes saturated, these gases pass through it with very little impediment ; and hence the necessity of frequently renewing the water in such traps. At the time when these sewers become gorged, and the gases are being forced out, the rainfall which has caused the mischief will have just renewed the traps of the street gullies and court drains ; but not those of the house drains. Besides this, the higher temperature of the atmosphere in the houses decreases its density, as compared with the external air ; and therefore less resistance will be offered to the transmission of injurious gases from the drains into dwelling houses, than into the open air or any buildings without fires.

I cannot but fear, therefore, that the greater part of these pestilential emanations will escape into the dwellings of the inhabitants, and that the most serious consequences would ensue.

THE CENTRAL BRANCH SEWER AND DISCHARGE BY GRAVITATION.

Before treating of the proposed main sewers *seriatim*, I must again say a few words of this important sewer ; although it is omitted in the scheme before your honorable board. I have already stated, that the drainage area of the "Central Branch Sewer" is two hundred and twenty nine acres ; including about one-fourth of the population, and passing through the centre of the town.

The length of the line, as marked on the small plan, is 1,460 yards, and there appears to be a rise in that length, from north to south, of about forty six feet. Beyond the sewer, to the southern extremity of the drainage area, there is a further rise of about sixty feet.

The lowest point is 51.2 above *datum* and twenty feet six inches above the outfall, near Belgrave Mill.

It seems only reasonable at first sight, that all this part of the town, with such an ample fall, should be drained by gravitation ; and so avoid letting down a large portion of the sewage of the town into very deep and costly sewers to pump it up again. I am satisfied that this might have been done ; but it could not now be accomplished without the abandonment of the whole of Mr. Wicksteed's scheme, because the sewer into which this is to empty, near St. Margaret's Church, is twenty one feet ten inches deep, and only twenty nine feet four inches above *datum*. It passes under the navigation shortly after, conveying the sewage of nearly all the town ; and therefore all the levels, as well as the direction of the sewers, would require to be altered.

I think it not unlikely that a much less expensive course might have been taken, and suggested this while in Leicester, but it was urged by the

authorities that the south eastern side of the navigation could not be adopted without another act of parliament, or without additional powers.

I do not say positively that the main sewer ought to be taken in that direction ; but your honourable board will know that if such a course were desirable on sanitary grounds, there would be no legal difficulty in the formation of a district, which would include the lordship of Knighton for purposes of main sewerage, without taxing the inhabitants of that lordship, unless they were benefitted.

THE WEST MAIN SEWER.

This sewer is to be thirty inches diameter throughout. At what point of its course thirty inches may be a proper size, no professional man can determine, without a plan showing the number and sizes of the houses, and other buildings, &c., intended to drain into it.

But wherever that point may be, the part of the sewer above *must* be too large, and the part below, if any, too small. It cannot be that, *under the circumstances of this sewer*, the same size of sewer is necessary at C, where the sewer begins, as at St. Margaret's church, where it will have traversed a distance of 2,365 lineal yards, and received the drainage of at least a fourth of the town. The sewage alone from the houses &c., *gradually received*, from that area, irrespective of the rainfall, would be, according to Mr. Wicksteed's estimate, about one million and a quarter of gallons daily ; yet he proposes the same diameter, and form, and gradient, throughout the 2,365 yards.

If a brick culvert is required, I do not think that two rings, each of four inches and a half thick, are necessary. If radiating bricks were adopted, and the lower half, (from circumstances with which I am unacquainted) should require to be nine inches thick, the upper half would certainly be sufficient at four inches and a half thick.

The average depth of twenty feet eleven inches is too great ; and passing as it does for the most part through narrow streets, I am of opinion that the stability of many of the buildings would be endangered. An examination of the section, and of the coloured tracing, will show that the whole line of the sewer might have been raised fully three feet, the size, form, and gradient remaining the same, if necessary.

There are no levels of the basement stories of any buildings given ; but as far as appears by the sections, the main sewers thus raised would be below the deepest cellars.

Besides a proportionately less danger to the buildings, and a great diminution of the extent to which the sewage would be impounded during rain, the alteration in depth would effect a saving of at least one and sixpence per yard run in excavating ; and the adoption of a four inch and a half arch, for the upper half of the sewer, a further saving of not less than two shillings per yard for bricks, lime, labour, and diminution of spoil. Supposing the size and inclination of this sewer, therefore, to be the best, the saving in the two items mentioned would reduce the cost by the sum of £413 18s. 6d.

From St. Margaret's church to the top of Watling-street (marked B on the plan) this sewer conveys the stream from "the Central Branch Sewer," and is increased from thirty to thirty-nine inches diameter. The

remarks already made, as to the non-existence of the requisite data for determining the proper size of the sewer, are strictly applicable to this (and to all the main sewers); but supposing the size, form, gradient, and direction the best that could be adopted, three feet less in the depth, and a single ring of brick work for the upper half of the sewer, would effect a saving of not less than 4s. 6d. per yard,—equal to £54 upon only 240 yards in length of sewer.

THE EASTERN MAIN SEWER.

This sewer is described as extending from a point in the Humberstone-road (marked D) to the top of Watling-street (marked B), where it joins the west main sewer. The total length is 1,570 yards.

Supposing such a sewer to be necessary, I do not think the best course has been taken. If instead of going round by Brook-street, and Wood-boy-street, with a total length of 1,570 yards, it had been taken along Carlow-street, Milton-street, Narrow-lane, and Orchard-street, the total length would have been 1,270 yards.

At only 15s. per yard, the saving of 300 yards would have been £225. The additional cutting in the higher ground would have been nearly compensated by the fact, that, with the same gradient, the depth from the surface at the top of Watling-street (the point B), where it joins the west sewer, would have been eighteen feet three inches deep, instead of twenty feet eight inches.

The whole length of the sewer might have been further raised nine inches with advantage, and the junction of the east and west sewers would then have been seventeen feet eight inches below the surface, instead of twenty feet eight inches.

If it should be said that this would at all interfere with the branch sewers to be hereafter formed, the answer is, that this is one of the evils of working out partial plans. Your honourable board have no other plans or information whatever before you on the subject, and can only deal with the scheme for which you are asked to sanction the mortgaging of the public rates to the extent of £30,000.

This main sewer is also subject to an objection urged against the west sewer: its capacity is not graduated to its work.

The diameter is twenty-four inches from end to end of the 1,570 yards, although at B (Watling-street) it has received the drainage of apparently one-fourth of the houses in the town, and at D (the Humberstone-road) comparatively nothing.

This small sewer is also proposed to be constructed of two four-and-a-half rings of brick. I do not hesitate to say, that a single ring of radiating bricks is ample strength for a sewer of that size. I have constructed of four-and-a-half inches, many miles of greater diameter, that have been in use from ten to twenty years; and in no instance has there been any failure.

The difference in cost between single and double ring is at least 3s. 6d. per yard, and the saving in this item (taken only upon the shorter route) would be £222 5s.

The total saving upon the east main sewer, by shortening the distance and reducing the thickness of the brick work, would be £447 5s.

SEWER FROM B TO A ON PLANS CONVEYING CONTENTS OF
WEST, EAST, AND CENTRAL SEWERS.

The diminution of three feet in depth, already pointed out, would tend much (on the supposition that these sewers are the best that could be devised) to prevent the backing of the sewage under the town, during rains.

This sewer is dependent upon the others about the point B, and below the point A, leading to the reservoirs; and therefore I need not say more here, than that if the system were to be carried into effect, as proposed, the three feet less depth might be continued between those points, and it would be quite as safe to have the top of *an iron pipe* only nine inches below the bed of the navigation, as three feet nine inches.

This difference, in excavating at the average depth of more than sixteen feet, would not be less than 3s. per yard, and the saving upon 323 yards would be £48 9s.

THE SUBURB SEWER.

I have had much consideration with this sewer, and made inquiries while at Leicester which satisfied me that from the low level, the nature of the soil, and other circumstances, it would be a very difficult and expensive work. Much timber would have to be used to sustain the excavations; and I have reason to believe that a moving sand would have to be encountered and overcome. Taking all the contingencies into account, I do not think it would be completed for less than £2 per yard. In this amount I was confirmed by Mr. Harris, the local surveyor: with the exception of a small portion at the commencement, it is intended to be thirty inches in diameter and nine-inch work.

At £2 per yard, 2,298 yards would cost £4,596; but even taken at the average price given by Mr. Wicksteed, as for the whole of the main sewers, namely, 29s. 1d. per yard, the cost would be £3,341 13s. 6d.

From an examination of that part of the town, and inquiries as to the direction of future increase, I was led to the consideration of what possible utility this sewer could be when constructed. I find a small suburb of the town, about Great Holme-street and Augustine Friars, and another small suburb in the parish of St. Leonard's: the former of these would be effectually drained by an earthenware pipe, commencing at Dunn's-lane, passing under the river Soar, along Great Holme-street to the end, running thence parallel with the river, and under it again; then emptying into the west sewer at Friars'-causeway. Such a drain might, probably, commence with six inches diameter, and increase to twelve inches. The fall would be five feet six inches, when the west sewer was raised three feet. The length would be six hundred and seven yards, with a gradient of one in three hundred and thirty-one.

The St. Leonard's suburb might be similarly drained by an earthenware pipe, from the Ashby turnpike road, round by the Abbey-gate and under the Soar, to the point F on the plan. The length would be six hundred and seventy-one yards.

The two together would be 1,278 yards of earthenware pipe, instead of 2,298 yards of large brick culvert; and at the liberal estimate of 10s. per yard, would cost £639.

The saving in this sewer, on this estimate, would be £2,702 13s. 6d., at Mr. Wicksteed's average price.

FROG-ISLAND SEWER.

Of this sewer, and also of the one from F to A on the plan, I can only say that they are very much too large for the sewage, very much too small for the rainfall, and without possibility of adaptation to any combination of both. Besides which, they must depend upon any modification of the sewers above and below.

THE MAIN SEWER.

The fate of this very costly piece of work, amounting at a moderate estimate to £3,000, must depend upon the fate of the reservoirs, &c. I merely remark, therefore, that a great part of such expenditure might be avoided; and that, even if the works were to be executed, the three feet diminution of depth, already suggested, would take off more than £100 from the estimate.

At the velocity stated by Mr. Wicksteed, this sewer, if *free from impediments*, would have been capable of discharging 1,151,241 gallons per hour, or, additional to the hourly sewage, *one twenty-ninth part of an inch* of rain flowing off the surface of the town in an hour. But, inasmuch as during every slight shower (when only such a discharging capacity would be needed) it will be nothing more than a reservoir of impounded sewage, I cannot clearly see the utility of making its capacity greater than that of the engine branch sewer.

THE ENGINE BRANCH SEWER.

It will have been observed that the clear diameter of the main sewer, last described, is fifty-six inches; while that of the sewer leading from it to the engine, is only thirty-six inches. If the velocity had been proportionately greater, I should not have laid any stress upon this disparity in the size of the two; but I find a difference of only two feet velocity per minute, in favour of the engine branch sewer; and Mr. Wicksteed states that velocity to be equal. The sectional area of this sewer is 1017.87 square inches, and at the stated mean velocity of one hundred and eighty feet per minute (dependent, of course, entirely upon the engine), it would be capable of discharging 397,864 gallons per hour. If the engines be capable of taking a larger quantity than this, their action would undoubtedly increase the velocity, and, of course, the discharge.

THE FLOOD WATER SEWER.

I have already described, that before any sewage or water can be discharged by this sewer it must be impounded back in the main sewers of the town, until it rises to a height of nine feet and one inch. According to the data and velocity given by Mr. Wicksteed, this outfall sewer would be capable of discharging 854,407 gallons per hour. But before it could do that, the sewage must further rise to its whole height of three feet nine inches inside, making twelve feet ten inches altogether; and adding one-third more to the quantity of sewage impounded back into the town, and also adding one-third to the quantity of foul gas regurgitated into the houses.

With respect to this sewer, however, I find that there is a mis-statement as to the velocity, and that when full (that is, when the greater part of

the main sewers of the town are full of impounded sewage) it would have a velocity of three hundred and fifteen feet per minute, instead of one hundred and eighty feet, as stated by Mr. Wicksteed. At this rate, it would discharge 2,164,167 gallons per hour, which would be equal to nearly one-twelfth part of an inch of rain flowing off the surface of the town, exclusive of the average hourly sewage, which the engines would lift at the same time.

This is not proportioned to the capacity of the other sewers: they are incapable of conveying sufficient to fill it, either before or when the impounding system has reached its maximum.

This sewer differs in form from all the other main sewers. They are circular, but this would have straight sides and segmental invert and arch. I cannot but notice that while one of the circular main sewers (which is the strongest form for resisting external pressure) is provided with two rings of four and a half brickwork, although only twenty-four inches diameter, this, the largest of them all, is to have a nine inch arch, with the side walls thirteen and a half inches thick, resting upon an invert only four and a half inches thick.

REVIEW OF THE SEVERAL MAIN SEWERS.

On a general review of the proposed main sewers I think they are most objectionable; they are neither adapted for the sanitary drainage of the town, nor capable of taking the rainfall; and the cost of constructing would be wasteful and extravagant. But even if the proposed mode of draining the town of Leicester had been, on the whole, the best that could have been adopted, it might still have been carried out at much less expense, as the following recapitulation of the proposed saving in cost of construction will show:—

Saving in West Sewer	413	18	6
" "	54	0	0
" East Sewer	447	5	0
" Sewer, B to A	48	9	0
" Suburb Sewer	2,702	13	6
" Main Sewer	100	0	0
	<u>£3,766</u>	<u>6</u>	<u>0</u>

In considering this amount, it must be remembered that it does not involve any alteration of the size, or inclination of any of the sewers, except the suburb sewer; and yet it shows that a saving of nearly twenty-nine per cent. upon the whole of Mr. Wicksteed's estimate for the sewers, might be effected in the cost of only a part of them, and that such saving would be accompanied by the sanitary advantage of reducing greatly the intended impounding of the sewage, and the discharge of noxious gases among the inhabitants.

The following table shows the capacity of each of the proposed sewers, and its power to discharge rain water, even if there were no sewage to be removed. It will be observed that I give a greater discharge from each than Mr. Wicksteed, and that is proportionably more in favour of his scheme than the discharge calculated from his own statements.

The table also shows the quantity due from a rainflow of an inch, upon the several areas of the main sewers, given merely as a common standard of measurement.

TABLE,
SHOWING THE CAPACITY OF THE PROPOSED SEWERS TO DISCHARGE RAIN WATER,

If there was no Sewage to be Removed.

DESIGNATION OF SEWER.	Area Drained.		Quantity of Water per minute from a rain flow of an inch in an hour.		Length of Sewer.		Diameter of Sewer.		Area of Sewer.		Inclination of Sewer.		Capacity of Discharge per minute, according to Mr. Wicksteed's velocity.		Capacity of Discharge per minute, according to Mr. Lee.		Depth of Rain capable of being Discharged in an hour, according to Mr. Wicksteed's velocity.		Depth of Rain capable of being Discharged in an hour, according to Mr. Lee.	
	Acres.	Cubic Feet.	Lineal Yards.	Inches.	Square Inches.	One in	Cubic Feet.	Cubic Feet.	Cubic Feet.	Inches.	Inches.	Cubic Feet.	Cubic Feet.	Inches.	Inches.	Inches.	Inches.			
West Main Sewer, C to St. Margaret's	381	23,050½	2,365	30	706,86	488	883½	1,054						1-20ths	1,054	1-23rd				
West & Central Branch Sewer (St. Margt's to B)	610	36,903½	240	39	1194,59	626	1,493½	1,774¾						1-25ths	1,774¾	1-21				
Central Branch Sewer	229	13,853	1,460	Not stated.	Not stated.	Not stated.	Unknown.	Unknown												
East Main Sewer	227	13,773½	1,570	24	452,39	392	565½	637						1-24ths	637	1-20ths				
East, West, & Central Branch Sewers (B to A)	837	50,677	323	45	1590,43	733	1,988	2,369						1-25ths	2,369	1-21				
Suburb Sewer, to F.....	357	21,598½	{ 165 2,133	18 30	254,46 706,86	293	{ 883½ 221	1,054						1-26ths	1,054	1-23rd				
Frog Island Sewer	18	1,089	350	15	176,71	244	221	263						1-5ths	263	1-4th				
Suburb and Frog Island Sewers.....	375	22,687½	199	33	855,30	538	1,069	1,273½						1-21	1,273½	1-18th				
All the above Sewers united (from A to H) ...	1,212	73,364½	764	56	2,463,0	912	3,079	3,633½						1-24ths	3,633½	1-20th				

I now come to the consideration of the steam engines. Mr. Wicksteed says, in his written report, page 8 :—

"On the supposition that each engine is able to lift half the amount of sewage water expected at the end of thirty years, viz. 410,155 cubic feet in twenty-four hours, the average power will be equal to thirteen horses and a quarter; but, as two-thirds of the sewage may come down the sewers in twelve hours, the power should be equal to seventeen horses and a half for each engine. But in case of repairs, &c., the sewage may have to be raised the extreme height of thirty-one feet six inches: each engine should, therefore, be equal to twenty-two horse power."

In this description, all calculation of the "heavy but not excessive rains" seems to be omitted, and the whole discharge from such causes left to the action of the flood water sewer.

I cannot, however, forget that the engines are the only means by which the impounding process could be diminished, nor that they are also the only means by which the impounded sewage, to the extent of above half a million of gallons, is to be removed, on every occasion of rain flowing off the surface. It is necessary therefore to consider their power of removing the rainfall additional to the ordinary sewage, and to ascertain the length of time that would elapse, after each rainfall, before the impounded sewage would be removed, and the pressure taken off the foul gases in the sewers. The power of both engines is equal to forty-four horses, capable nominally of lifting 348,489 gallons of sewer water, &c., per hour, to a height of twenty-five feet; but here again I am placed in a difficulty from the discrepancy between the two reports, either of which Mr. Wicksteed may adopt at his convenience. At page 21 of the printed report, it is stated :—

"Under ordinary circumstances one engine will be employed to lift 5,000,000 of gallons per diem, at an average power of thirty horses; but in case of heavy rains or floods, the auxiliary engine may be used, if required, and the two worked to their full power to relieve the sewers in the town, and, together, they will be capable of lifting 15,000,000 gallons in twenty-four hours, if working night and day."

Taking the latter description of the power of the engines, I find that the average hourly quantity lifted would be 625,000 gallons. Deducting the average quantity of sewage during the same time, the utmost power of both engines would not exceed a rainflow of one *sixty-sixth part of an inch in an hour*.

Had the main sewer at H been three feet less in depth, and the engines been placed at that point so as to pump into the flood-water sewer during rain, the capacity of discharge by the pumps would have been four times as great.

THE RESERVOIRS FOR SEWAGE.

The two reservoirs for depositing and precipitating the fertilizing properties of the sewage, are proposed to be constructed in the Abbey Meadow, at less than three quarters of a mile from the town. They are to be ten feet deep, and Mr. Wicksteed says (written report, p. 10) "three feet in depth of this will be for deposit, and six feet for water." He gives the area of the reservoirs at mean-water line as equal to three acres, two roods, eighteen perches. The total capacity of these reservoirs is 8,525,376 gallons, and yet, with such an immense surface, the quantity is only one day and three quarters' expected sewage without rain.

The three feet deep of deposit would amount to 13,008 tons at seventy-five pounds the cubic foot, and the six feet deep of what Mr. Wicksteed calls "water," would amount to 26,122 tons—together, nearly 140,000 tons, all exposed so near the town to the action of the atmosphere.

I shall have hereafter to consider the proposed disinfecting operations.

At the very low rate of fifteen inches evaporation per annum, the quantity of fluid discharged into the air as vapour from the surface of these reservoirs will be 1,225,834 gallons.

I have no doubt this will be very much below the fact; but it gives an average per day of 3,355 gallons.

I must also remark, that for a considerable time during every year, the deposit will be in process of being taken out of one or the other of these reservoirs, and then the evaporation will go on both from the reservoirs and from the heaps of semi-solid filth. At such times, also, a large proportion of the sewage must be pumped to waste, in addition to the great proportion lost during rain.

The deposit in both reservoirs, at three feet deep, would be 388,506 cubic feet, equal to 14,389 cubic yards, or $7,194\frac{1}{2}$ cubic yards each.

Having shown the dimensions and capacity of these reservoirs, I proceed to consider the cost of emptying them.

One man would be able to cut, or scoop out, and another to raise, or wheel, about seven cubic yards per day, at one and threepence per yard. The wages would be high from the very offensive nature of the operation. This rate would be equal to the employment of eighty men for twenty-five and a half days, or a working month, upon each reservoir, and the cost of wages would be £449 12s. 1d., say £450 for each. Thirty-three per cent. for liquid evaporated from this quantity, would leave $4,796\frac{1}{2}$ cubic yards of dry manure from each reservoir. Taking yards for tons, which is sufficient for present purposes, Mr. Wicksteed must contemplate emptying both reservoirs each year, in order to obtain his estimate of 10,000 tons. The expense of labour in excavating the deposit, therefore, may be put down at £900 per annum.

I have no data by which to calculate the cost of the drying operations; but the evaporations, as stated by Mr Wicksteed, of thirty-three per cent. of fluid from the deposit of the two reservoirs, would add to the vapours already given off from the surface of the reservoirs the further large quantity of 806,994 gallons of fluid thus dissipated.

I think, however, it is intended by Mr. Wicksteed (printed report, page 12) that there will be 10,000 tons of manure collected in the damp state, which would leave only 6,667 tons when dried; in that case the quantity of liquor converted into vapour will be 3,333 tons, or 119,454 cubic feet, equal to an average of 2,040 gallons per day. This, added to the evaporation from the surface of the reservoirs, will make 5,395 gallons as the daily average.

PROCESS OF DEODORISING, OR DISINFECTING THE SEWAGE.

I now approach one of the most important parts of this investigation—the proposal on a large scale (that of a population of upwards of 60,000) to disinfect the sewage matter of the whole town, and to convert the manure into a dry and portable substance.

I may premise that the local authorities stated their reason for adopting this plan to be, the very serious complaints of the inhabitants of the town, and of the population of the villages below, as to the offensive condition of the river and navigation. At the time when the Town Council, as the Local Board of Health, went before Parliament to obtain their Act, they undertook to prevent the pollution of these streams. The question to be considered is, whether or not the proposed plan is one that will accomplish the object, and one which your honourable board should sanction.

As to the process which Mr. Wicksteed proposes, I think it better to quote his own words. At page 8 of his printed report, it is stated that one of the objects to be obtained by the system is "the diversion of *all* sewage, dye, and scouring waters from the river Soar, and the Leicester Canal."

The word *all* is put into italics by Mr. Wicksteed.

A second object is stated to be the removal of the sewage to such a point in the river below, that the process of collecting and disinfecting may be carried on without injury or annoyance, either to the inhabitants of the town itself, or to those of the adjacent villages; and that the process to be adopted in its disinfection be such, that the water, before it is returned into the river Soar (below the town), "*shall be in a state of at least as great purity as it was in the river ABOVE the town, before any sewage or dye water had contaminated it.*"

The agent intended to be employed by Mr. Wicksteed is lime.

The chemists spoken of by Mr. Wicksteed in his report are those selected and instructed by himself. They are eminent men, and their report is printed and enclosed in the same binding with that of Mr. Wicksteed. How far do their experiments bear out his statements?

Mr. Wicksteed speaks of a small quantity of lime only, but the chemists, in all their experiments, used a saturated solution of lime, in the proportion of one-third of the volume of sewage operated upon. He states that the liquid, after the use of lime, is free from bad odours and pure. The chemists, after the use of so large a quantity of saturated solution, say otherwise.

The statement of Mr. Wicksteed and the chemists appear so irreconcilable, that I feel compelled to place some of them in juxtaposition, in order that your honourable board may form a right judgment.

The first series of waters analysed contained dye water mixed with the sewage. They are called No. 1, 2a, 3, 4, and 5. Mr. Wicksteed's statements are interspersed throughout his reports: those of the chemists' extend from page 57 to page 71 of the printed report.

MR. WICKSTEED, p. 15.

"That by the mixture of a certain portion of *lime* (ascertained to be sufficient for the purpose) with the sewage water before it is exposed to the open air, or discharged into the depositing reservoirs outside the town, *any possible chance of injury or annoyance may be prevented*; for that the water flowing from the reservoirs into the river will be pure, is proved by the fact as-

MESSRS. AITKEN & TAYLOR, Chemists.

P. 58. No. 1. *Deposit by Lime Water.*

"When the water was mixed with one-third of its volume of a saturated solution of lime, it lost *much* of its offensive odour, and became speedily curdled.

"The residuary water of the lime process was rendered so clear by *filtration through paper*, as to look like common spring water. *It still had an offensive odour*, partly due

certained by the chemists, that, after it has undergone lime process, it is not only *free from noxious gases and bad odours*, but the carbonates of lime and organic matter that existed in the water *itself*, before it became mixed with the sewage, having been precipitated, it becomes *softer* than the natural water of the river into which it will flow, and therefore, chemically speaking, purer."

P. 27. "The process of purifying the sewer water, by means of lime, is at once so simple and so complete in its effects, that the water, after having been submitted to its action, may be returned into the river, with a certainty that it will be as pure as it was in its previously uncontaminated state."

P. 30. "They state that the effect of thirty or forty grains of LIME, upon an imperial gallon of water, was to render the most turbid sample clear in about twenty minutes.

"The lime precipitates the whole of the mechanically-diffused organic matter, and probably the whole of those which are dissolved."

Page 10. (Written report) "Waste water from the reservoir will pass into the river Soar at the east end, and the lime will have the effect of not only *destroying the noxious effluvia*, but also of depositing most of the carbonate of lime and organic matter."

There can be no doubt that the offensive odour remaining (after the use of a proportion of one-third saturated solution of lime) will, as the chemists state, disappear by free exposure to the air. In other words, it will obey the law of the diffusion of gases, and contaminate the atmosphere.

to the presence of some sulphuretted hydrogen, and partly to some organic matter in a state of decomposition."

P. 59. No. 2a.—"The *lime water* process was employed as in No. 1, with similar results."

P. 59. No. 3. *Deposit by Lime Water*.—"The water, as in the previous cases, became *clear and less* offensive after it had been submitted to the lime process."

P. 61. No. 4. *Deposit of Lime Water*.—"The filtered water contained carbonic acid and sulphuretted hydrogen. It could not be entirely deprived of the latter by lime, and still retained an offensive odour from animal matter, which the lime did not remove. *It will thus be perceived that the lime water removed only one half of the organic matter contained in this water.*"

P. 62. No. 5. *Deposit of Lime Water*.—"The weight of the dry deposit was 17.6 grains. It consisted entirely of combustible matter, deducting the weight of lime, and left no saline residue. The lime had, therefore, considerably augmented the amount of organic deposit in this instance. It had also rendered the liquid clearer and less offensive."

P. 64. Question 4.—"The time required for the deposit to take place when the water is at rest?"

Answer.—"The substance was as complete as it was likely to be in all the specimens, in a space occupying from two to four days."

Question 5.—"The proportion of lime required to cause the substances held in suspension to be entirely deposited?"

Answer.—"Lime Water was used in these experiments, and the proportion of lime employed amounted to from thirty to forty grains of lime to the imperial gallon of sewer water."

P. 65. Question 6.—"The appearance, nature, and value of the waters, after being submitted to the lime process?"

Answer.—"The water becomes much clearer, and on *filtration* almost colourless; some of the specimens, however, still retained an offensive odour, which disappeared by free exposure to the air."

It does not appear, therefore, that in this respect much credit is due to the lime, because at page 69, they state of a compound fluid, mixed of equal portions of sewage water (No. 1 to 7) with four measures of water, but without any application of lime, the offensive odours had, to a great extent, disappeared, after water had been exposed to the air twenty-four hours.

This second series consisted of sewer waters, marked No. 1 to 7 s.

MR. WICKSTEED'S STATEMENTS.

P. 31 "Upon this mixture of waters the chemists report, that the offensive odour was entirely removed, in a few minutes, by a small quantity of *lime*, but not by chloride of zinc, even when used in large quantities; and they subsequently found that this fluid had less power of removing the offensive effluvia than a small quantity of lime."

P. 10. (Written Report.) "*Liming and Deodorising.* It is proposed that the sewage water be deodorising by mixture with *lime*, by which means the noxious effluvia from the reservoirs will be destroyed."

P. 31. (Mr. Wickstead, quoting the chemists' report.) "That most noxious gas, the sulphuretted hydrogen, is entirely removed from it, and it may be fairly asserted that seven-eighths of the offensive effluvia of the water are entirely removed by the employment of lime."

CHEMISTS' STATEMENTS.

P. 66. "The offensive odour was entirely removed in a few minutes, by a small quantity of *chloride of lime*; but not by chloride of zinc, even when used in large quantities, and the mixture was preserved for a month. It was subsequently found that this so-called deodorising fluid had less power of removing the offensive effluvia than a small quantity of lime."

P. 67. "Deposit by *lime water*. The mixed water was heated with *one third of its volume of a saturated solution of lime in water*. The solid matters began to be precipitated in five minutes, and the precipitation was complete in half an hour."

P. 67. "*The residuary water of the lime process retains a fishy and disagreeable odour. It contains ammonia and sulphur (the latter combined with the lime as sulphuret of calcium):* that most noxious gas, the sulphuretted hydrogen, is entirely removed from it, and *perhaps* it may be fairly asserted that *seven-eighths* of the offensive effluvia of the water are entirely removed by the employment of lime in the proportion advised."

Of the compound and diluted sewage waters intended to represent the sewage, as it will be with a systematic water supply, and after the completion of the drainage works, we have the following:—

MR. WICKSTEED'S STATEMENT.

P. 32. "The effect of the *lime* process would be to precipitate both the earthy salts and organic matter contained in the river water, as well as in the sewer water, to which it was added."

P. 15. "The water flowing from the reservoirs into the river will be pure."

CHEMISTS' STATEMENTS.

P. 69. "The offensive odour had, to a great extent, disappeared after the water had been exposed to the air twenty-four hours."

P. 70. Deposit by *Lime Water*.—"The sewage water was mixed with *one-third of its volume of lime water*. The offensive smell was in great part removed. There was no trace of sulphuretted hydrogen, and the residuary water contained no sulphuret of calcium."

There is so much careful and ingenious hypothesis in Mr. Wickstead's statements, at pages 22 and 23, respecting the application of sewage manure by pipes, &c., that I find it useless to discuss the question. If his remarks be approved, he will be able to take the credit; but if disapproved, there is nothing to prevent him from repudiating the opinions expressed here. After having thus, to his own satisfaction, disposed of

the question of applying the sewage water of Leicester in a liquid form, it is interesting to find Mr. Wicksteed, at page 24, stating as follows: "At the same time, it is but right to observe, that the distribution of a *portion* of it over the Abbey Meadow, and the lands in the immediate neighbourhood, would not involve so great an expense; and in a commercial point of view this might be worthy of consideration, *were there no objection on the score of health.*" Perhaps the inhabitants of the borough would be able to arrive at a very fair conclusion as to the effect of such a distribution of the sewage water, by comparing it with effluvia arising from the sewage and dye water that is at present poured into the canal and river. I am fearful it would be merely removing the nuisance from the river to diffuse it more widely.

Mr. Wicksteed is therefore fearful of the consequences to the health of the inhabitants of the borough of Leicester, from the occasional discharge of sewage out of a hose pipe, which would not have an orifice more than an inch diameter;—with the liquid immediately absorbed and appropriated by the soil and vegetation, upon these very Abbey Meadows, where he recommends the construction of open reservoirs, holding above eight millions and a half of gallons, with an evaporating surface of nearly four acres of fluid, which his own chemists describe as being still offensive (even in the small portion used in their laboratory), after they had treated it *with a saturated solution of lime* equal to one-third of its own volume.

No one can read Mr. Wicksteed's statements without coming to the conclusion that *lime*, in the proportion of thirty to forty grains per gallon, is to be used as the disinfecting agent; and that the result will be, that the water in the reservoirs, and when turned into the river, will not only be inoffensive, *but pure—more pure even than the river Soar above the town before contamination.*

On the other hand, nobody can read the chemical report of Messrs. Aitken and Taylor, without perceiving that, in every instance of their seven analyses of the sewer water, they used a proportion of *one-third the volume of the saturated solution of lime*, and that, after the operation, the water *remained offensive.*

They state this as a fact, with respect to every one of their experiments, except an extra one in which they treated the sewage with *chloride of lime*; and then *only* was the offensive odour "entirely removed." In quoting this instance at page 31 of his printed report, I regret to say that Mr. Wicksteed has omitted the word "*chloride*," and given to the lime only the credit of the improvement.

I need not dilate upon the immense difference between putting thirty or forty grains of lime into a gallon of sewage, and mixing the same quantity with one-third its own quantity of saturated lime water, which becomes of course at once perfectly incorporated with the sewage. Even if the whole of its offensiveness had been removed by the experiments of the chemists, Mr. Wicksteed has no right to expect a similar result without adopting the same process.

But the offensiveness was not destroyed by the lime water. We have

no reason to believe that the process would be conducted so perfectly upon five million of gallons per day, as upon four gallons in the laboratory of professional chemists; or that lime alone would produce the same effects as saturated solution of lime, with which to accomplish even what was done by the chemists.

I have already stated the great expense of removing the deposit from the reservoirs. I am unable to estimate the cost of the drying, packing, &c.; but forty grains of lime per gallon, applied to five millions of gallons of sewage per day, would amount to 4,660 tons per annum; and, at the low price of twelve shillings per ton, delivered, the cost in this article alone would be about £2,800 per annum. At the price given me as the cost of lime at Loughborough, namely, fifteen shillings per ton, the amount would be £3,500 per annum.

It is stated by Mr. Wicksteed, at page 30 of the printed report, and by Messrs. Aitken and Taylor, at page 65, that the value of the deposit as manure, "is generally speaking in a direct ratio to the quantity of organic or combustible matter thrown down by the lime." It becomes, therefore, important to ascertain what that quantity is.

It appears that twelve samples of sewer water were taken, and treated as two series; five of which contained dye water, and seven without any stated quantity of such matter. It would have been much more satisfactory if Mr. Wicksteed had given the date at which all the samples were taken, the hour of the day, and the state of the weather at the time. No such information, however, is furnished. He states, of the second series (page 30), "Samples were procured from each sewer, taken every hour in the day, and mixed together." If this means that equal samples were taken from each sewer, at every hour of the day, it should have been so stated; as the subject is too important to admit of uncertainty of expression.

There is nothing else given, I believe, as to the manner, or time of taking the samples; and yet it will be obvious, that the sewage would be in a very different state during the period from nine a.m. to one p.m., from what it would be during the period from five p.m. to nine p.m. It is equally certain that a very different compound would be produced by the mixing of samples, taken throughout a day when a large proportion of the inhabitants were washing their household linen, from that produced by the mixing of samples taken on a Saturday, when house-cleansing only is chiefly done, and cooking at the *minimum*.

So, again, as to the state of the weather at the time. Before rain, the sewage flowing would have the largest proportion of matter in chemical solution, and the smallest proportion in mechanical suspension. The flow during the earlier part of a fall of rain would bring down deposit from the drains, in suspension in water; and the result of samples taken then would be that nearly all the contents would be obtained by spontaneous subsidence. About the time when rain ceased, and for a considerable time afterward, the sewage would be much diluted, and the mixed compound of a very different character.

These remarks I have considered necessary, in order that your honourable board may judge of the weight due to only one single experiment made by Messrs. Aitken and Taylor, with a mixture of equal portions of the second series of samples, diluted with four measures of water taken from the river Soar, and intended to represent the Leicester sewage, *as it will be*. In this instance, the combustible matter spontaneously deposited was twenty-four grains to the imperial gallon, while that thrown down by one-third volume of saturated solution of lime, was fifty-four grains.

Upon this isolated result, produced by a re-agent which Mr. Wicksteed does not intend, and cannot employ, namely, lime water, in the proportion advised,* *and with all the uncertainty as to the circumstances under which the samples were taken*, Mr. Wicksteed ventures to base the financial success of his manure scheme, and its claims for approval by the Town Council of Leicester and your honourable board.

Taking, therefore, in the first instance, as an illustration, the proportion given above, and bearing in mind that the value of the sewage is in the ratio of combustible or organic matter, I find that 24-54ths of the value, or 4-9ths of the whole, is due to spontaneous subsidence; and 30-54ths, or 5-9ths, due to the lime water. From the quantity of manure estimated by Mr. Wicksteed, namely, 10,000 tons, it will be necessary to deduct the lime which has been purchased and added. This was the mode of proceeding adopted by Messrs. Aitken and Taylor in their experiments, and is undoubtedly proper. The residue is 5,340 tons due to the sewage waters, and, as 4-9ths, or 2,373 tons is owing to spontaneous subsidence, there remains 2,967 tons arising from the use of lime water "in the proportion advised" by the chemists.

But to get this 2,967 tons, 4,660 tons of lime are required to be bought and mixed with 1,825,000,000 gallons of sewage; and the whole fluid being discharged after subsidence and deposit, the additional 2,967 tons of manure, *plus* the 4,660 tons of lime, and *minus* the large quantity lost during rain, would be secured; and being prepared by the further process of turning, drying, evaporation, and packing, would be ready for the market; and being sold, would probably more than pay for the lime, even if it did not pay anything for the labour and the capital sunk. Spontaneous subsidence alone would yield four-ninths of the quantity of organic or combustible matter, and consequently of money value. Of course I do not recommend such a system, but the process would have been much cheaper; though, perhaps, a little more objectionable on sanitary grounds. This, it appears, would be the result of Mr. Wicksteed's scheme, under the most favourable circumstances, with the use of one-third saturated lime water. But I am not satisfied that so important an undertaking should be based upon a single and very artificial experiment, and I therefore prefer taking the broadest basis which the information furnished will admit of.

The following statement shows the results of all the experiments made

* See Chemists' report, page 67 of printed report.

by Messrs. Aitken and Taylor, and, I think, is, therefore, more to be depended upon:—

DESIGNATION OF ANALYSIS.	Combustible Matter.	Combustible Matter.
	Spontaneous Subsidence. Grains per Gallon.	One-third Saturated Lime Water. Grains per Gallon.
FIRST SERIES.—1 to 5.—Waters Mixed	47.04	56.90
SECOND SERIES.—1 to 7 s.—Waters Mixed	108.50	139.00
" " 1 to 7 s.—Equal portions Mixed, and diluted with four measures of River Water	24.00	54.00
Total	179.54	249.90
Average per Gallon	59.85	83.3

The proportions of combustible matter, or in other words, the proportionate value as manure, appears from this statement of the chemists, to be, for spontaneous subsidence, about 60-84ths, or 5-7ths; and for the lime water alone, 24-84ths, or 2-7ths.

Deducting the lime as before, I find that the quantity claimed by spontaneous subsidence is 3,814 tons, out of 5,340; leaving only 1,526 tons out of the 10,000 due to the lime water. This would have to pass through all the homœopathic transmutations already described, before it would become fit for the market, and realize as many pounds sterling; against which must be set off all working expenses, and interest on capital. I have only to add that there are many adjunctive arrangements of a costly nature omitted from Mr. Wicksteed's estimates, and that some of the particulars of the estimate separately named, and then clustered into one sum, would cost more than he has stated.

RECAPITULATION.

I think it has been shown that there is no proper survey upon which alone any efficient and economical system of drainage of the town can be devised; that even for purposes of main sewerage the scheme before you is very incomplete; that the proposed main sewers in the town are neither fit for the sewage alone, nor for the rain water, nor for the two combined; and that they would be unnecessarily expensive, even if unobjectionable, on other and strictly sanitary grounds of consideration.

That every slight shower, even if the sixty-sixth part of an inch in an hour, would cause more than half a million of gallons of sewage to be impounded in the main sewers, under the town, displacing and driving back into the dwellings the same quantity of noxious sewer gases. That a great part of the town, at least, might have been drained by gravitation.

That the reservoirs, and the drying process together, will convert on the average, 5,395 gallons of sewage daily into vapour, contaminating the air. That Mr. Wicksteed has misquoted and misstated the report of the chemists, and neither can nor does propose to use the same re-agent for disinfection as was used in all their experiments; and that, notwithstanding

ing the use of lime water by them, in the proportion of one-third the volume of sewage, the fluid remained offensive.

That the whole of the works connected with the engines and reservoirs, and the so-called process of disinfection, would be enormously expensive, and would inflict incalculable evil upon the health of the inhabitants of the town.

That it is very doubtful if the lime-water or lime-process would pay its own expenses, even as against spontaneous subsidence in these immense reservoirs, irrespective of any sanitary considerations.

CONCLUSIONS.

For the reasons above named, and fully discussed in the body of this report, I cannot advise your honourable board to sanction the mortgage of the public rates of the borough of Leicester for the execution of this scheme; and I recommend that, for the protection of the Local Board and the preservation of the health and lives of the inhabitants, you should altogether refuse such sanction.

I have the honour to be,

My Lords and Gentlemen,

Your obedient Servant,

(Signed)

WILLIAM LEE,
Superintending Inspector.

The General Board of Health,
&c., &c., &c.

LETTER

OF THE

GENERAL BOARD OF HEALTH TO THE LOCAL BOARD.

The General Board of Health,
Whitehall, 13th February, 1852.

SIR,

I am directed by the General Board of Health to acquaint you, for the information of the Local Board of Health of Leicester, that they have again had under their consideration the plan of proposed drainage of Leicester, which has been submitted to the General Board for their approval, with the view to their sanction of the mortgage of the rates, to enable the Local Board to raise funds, to the extent of £35,000, for carrying out these and other works.

It having been made a matter of complaint that between five and six months' delay should have taken place in coming to a decision on this subject, I am to revert to the causes which have chiefly occasioned the loss of time in arriving at a conclusion, with respect to the application of the Local Board for this mortgage.

The memorial of the Local Board, dated the 14th of August last, was received on the 22nd of that month, but without any accompanying plans which would exhibit the proposed scheme. In reply to the General Board's application, a general plan and sections were transmitted; but on entering upon the examination of the scheme, these were found to be quite insufficient. Other plans were received from Mr. Wicksteed, on the 22nd September, in reply to the Board's further application; but as these afforded no additional information on the points required, the subject had again to be laid aside until the receipt of further plans and estimates, which came to hand on the 3rd October. On the further consideration of the information thus afforded the General Board were enabled, on the 22nd of November, to communicate to the Clerk of the Local Board the main points of objection to the scheme which had been submitted; but the information which was even then before the General Board would not admit of their coming to any conclusion, as to whether the plan proposed was capable of those modifications which would realise the best and most economical results for the town. Although they had great doubts upon this point, they felt it necessary to direct that one of their Superintending Inspectors should visit Leicester, with the view to obtain the further information required. Mr. Lee proceeded accordingly to Leicester, for this purpose, on the 26th of November last.

The General Board have to regret that, owing to a very pressing and urgent demand on Mr. Lee's attention subsequently, there should have

been about six weeks' delay in the presentation of his report; but the General Board must observe that the necessity for Mr. Lee's visit, the consequent delay, and the lapse of time which previously intervened, and which are inseparable from the repeated laying aside and resuming of any object of inquiry, would never have occurred at all, had the Board been put in possession, in the first instance, with that amount of information, without which it is absolutely impossible for any engineer to lay down a matured and satisfactory scheme for so important a subject as the drainage of the Borough of Leicester.

I am now to acquaint you that the General Board, having had under consideration the further information submitted in Mr. Lee's report, received on the 10th instant (copy of which I am to transmit to you), not only find their former objections to the proposed plan very fully confirmed, but arrive at the conviction that it is incapable of those amendments which would render it satisfactory.

The General Board regret that they are compelled to withhold their sanction for the mortgage of the rates, for carrying out this plan of drainage, for the following reasons:—

1st. Because it is incomplete, and, having been prepared on insufficient plans and information, not only is there no security afforded that the partial lines of drainage are the most judicious; but there is, on the contrary, abundant evidence to prove that their direction is not well selected, and that they would be inefficient and unnecessarily costly.

2nd. Because, instead of leading the whole refuse of the town into sewers at the lowest levels, merely to be pumped up again, the larger proportion might be conveyed so as to discharge by gravitation; thus not only effecting a saving in the dimensions of the work, but avoiding a perpetual tax upon the ratepayers for unnecessary engine power.

3rd. Because, even if the sewers were properly laid out, they are neither properly graduated, nor properly adjusted to the work which they would have to perform.

4th. Because the proposed mode of dealing with the refuse would be attended with the utmost risk to the health of the population, and would be of very questionable expediency in a financial point of view. It would commit the Local Board to a vast speculation, which the most favourable results of chemical experiments in no way justify, and which, in case of failure, would entail a most serious lasting tax upon the inhabitants.

5th. Because, of the £35,000 for which application for a mortgage is made, no explanation is afforded; nor does any estimate appear to have been prepared with regard to £5,000; and because the whole of the partial works proposed might be much more efficiently carried out, and the beneficial results more certainly attained, at a very considerable saving in their estimated cost of *thirty thousand pounds*.

The General Board deeply regret the inconvenience to which the Local Board will have been put by the preparation of so imperfect, so wasteful, and so unsatisfactory a scheme; and by the necessity which the general board consequently feel for declining to sanction a mortgage for its execution.

The General Board are fully alive to the great anxiety of the Local

Board of Leicester to proceed with the important duties which devolve upon them, and to realise for the borough the great benefits of the Public Health Act, at the earliest possible moment.

The desire of the General Board can only be identical with that of the Local Board on this point; and, therefore, although fully admitting the accuracy of Mr. Stone's remarks, in his letter of the 2nd October last, the General Board cannot consent that the great responsibility which is thrown upon them under the Public Health Act—a responsibility which is now generally admitted to be one of the most important provisions for the security, not only of the ratepayers but of the local boards themselves—should be exercised merely as a matter of form, and without the fullest consideration.

I am to direct your attention to the views of the General Board upon this subject, set forth in their general report of 1849, pages 61 to 63.

The General Board entertain the hope that the Local Board of Leicester, in the consideration of the points of objection to this defective plan of drainage, which are now laid before them (and I am to direct your particular attention to the detailed grounds of objection set forth in Mr. Lee's report), will fully agree that there is abundant cause for withholding consent to any mortgage for its execution, and that it will be greatly for the interests of the borough that it should be abandoned.

I am, in conclusion, to add that being most anxious that the Local Board should arrive at the most beneficial results, the General Board will at all times be ready to afford them every assistance and advice within their power, upon any points connected with this or any other branch of their duties, which they or their officers may desire to lay before them.

I have the honour to be,

Sir,

Your obedient Servant,

HENRY AUSTIN,
Secretary.

REPLY

TO A

REPORT TO THE GENERAL BOARD OF HEALTH,

ON A SCHEME FOR THE DRAINAGE OF LEICESTER, AND THE CONVERSION OF THE SEWAGE WATER THEREOF INTO MANURE, BY WILLIAM LEE, SUPERINTENDING INSPECTOR.

TO THE CHAIRMAN OF THE SEWERAGE AND HIGHWAY COMMITTEE OF THE LOCAL BOARD OF HEALTH, LEICESTER.

London, February 28th, 1852.

SIR,

I received from the Town Clerk a letter dated the 24th February, inclosing the Superintending Inspector's report, and giving me the opportunity of writing a reply to it, for which I am much obliged.

I now beg leave to forward you the following reply, merely prefacing it by the observation that it is more easy to find defects in a scheme than to supply a more efficient one; and that I trust, in the following remarks, you will find that I have abstained from personalities, which are as undignified as they are unnecessary in making a plain statement of facts, or in arguing upon a scientific subject.

REPLY.

The Superintending Inspector states that :—

"The Town Council of Leicester, as the Local Board of Health for that borough, having, under the powers of '*The Leicester Sewerage Act, 1851*,' and the '*Public Health Act, 1848*,' proposed a scheme for the main sewers and outfall of the sewerage of the said borough, and other works," &c.

You, Sir, will at once perceive that the words in italics are of importance, as they imply that the proposed plan for the sewerage of Leicester was not devised until the passing of the Leicester Sewerage Act, 1851, and therefore not brought under the notice of the General Board until some time after that act had passed, whereas the fact is otherwise.

The Town Clerk commences a letter dated September 14, 1849, and addressed to me in the following words :—

"I am desired by the Town Council to inform you, that the Public Health Act having been applied to Leicester, they are desirous of having a plan for the effectual drainage of Leicester submitted to them by some engineer, in whom the town would place confidence, previously to constructing any new works."

On the 25th of September, 1849, I attended a meeting of the Highway and Sewerage Committee, when the following instructions were handed to me :—

“At a meeting of the Sewerage and Highway Committee of the Local Board of Health, held at the Town Hall, Leicester, on the 25th of September, 1849, it was moved by Mr. Crossley, seconded by Dr. Shaw, and carried;

“That this committee instruct Mr. Wicksteed to report fully upon the drainage, sewerage, and collecting and disinfecting the produce of the sewers, and also the supply of water to the town, both for the purposes of sanitary cleansing, and also for domestic use, either from one or more sources; and also an estimate of each portion.”

In explanation of the above resolution, the committee informed me that the plans and estimates as regarded the sewerage of the town, were to provide for the drainage of every street, court, and alley, but not for the connections with private houses, or other premises, with the street sewers—in other words, the *house drainage*.

Upon the 3rd of October, 1849, I again visited Leicester, and made a personal survey of the district all round the borough, and upon that occasion it was suggested, that as the determining the position for the outfall of the sewerage, and the locality from which a supply of water was to be obtained, were points of great moment, they ought not to be finally determined upon until the committee had given the subject their most serious consideration; and that therefore it would be better that I should make a *preliminary* report before commencing detailed plans, specifications, and estimates.

On the 12th of March, 1850, my *preliminary* report was presented and read by me to your committee, and by them ordered to be printed.

In the beginning of April, a large number of these reports were printed and circulated, and an act of parliament was applied for in the session of 1851, for enabling the Local Board to carry into effect the scheme of sewerage recommended by me.

The Leicester Sewerage Act having received the royal assent, I was informed by the Town Clerk that the Highway and Sewerage Committee wished me to furnish them with a sufficient estimate and description of the proposed works, to lay before the Local Board, that they might be submitted to the General Board of Health, upon their applying for their sanction to raise the necessary capital. Upon the 14th day of July, 1851, I made the report to the committee, which is referred to in the Inspector's report as my “*written report*.”

Upon the 18th September, 1851, the Town Clerk instructed me to send certain plans to Mr. Austin, secretary to the General Board of Health, showing by lines the direction of the proposed main sewers.

Upon the 22nd September, I transmitted these plans to Mr. Austin, accompanied by the following note :—

“By order of Mr. Stone, Town Clerk of Leicester, I beg leave to forward you four sheets of the large Plan of Leicester, on which the lines of *main sewers* are shown in vermilion.”

Upon the 3rd of October, 1851, in consequence of instructions re-

ceived from the Town Clerk, I forwarded two smaller plans of the town, and an estimate, accompanied by the following letter :—

" SIR,—By the desire of the Town Clerk of Leicester, I beg leave to forward two plans and an estimate for the proposed works, which I trust will be found sufficient to afford you the required information. The bearer, Mr. Ralph, has been my chief assistant in this business, and will, I trust, be able to afford you any explanation of the plans that you may require; and should you deem a *personal interview* desirable, I shall have much pleasure in attending any appointment you may wish to make with me.

" I am, Sir,

" Your most obedient Servant,

" THOS. WICKSTEED.

" Henry Austin, Esq."

&c., &c., &c.

To this offer of affording to Mr. Austin, or any of the Inspectors, the opportunity of obtaining, personally, any explanation of my report or plans they might require, I received the following verbal reply (I should observe, that Mr. Ralph, being aware that I should have to inform the Town Clerk what reply I had received, made a note of the exact words in his memorandum book immediately on leaving the offices of the General Board of Health) :—

" He is very busy and cannot see you now: he thinks nothing else will be required; but if there is, will communicate with Mr. Wicksteed."

Since which time I have received neither written nor verbal communication on the subject of my plans, from either the secretary, Mr. Austin, the Inspector, or any other official of the General Board of Health.

On the 27th of January last, however, the Town Clerk informed me, verbally, that the Inspector had been in Leicester, which he had left about six weeks previously, informing the Town Clerk at that time, that he should make a point of putting himself into communication with me before making his report, which he then proposed to accomplish in a fortnight. I have, however, neither seen nor heard from him in any form whatever. Such have been the circumstances preceding the report of the Inspector upon my plan, to some of the details of which I am now about to direct your attention, for the information of the Local Board.

The Inspector says :—

" On receipt of such instructions" (viz. to visit Leicester) I visited Leicester on the 26th day of November last, and have to regret that two months should have elapsed before the presentation of my report."

You, Sir, will not fail to observe that, from whatever cause it may have arisen, the time elapsed from the date of my last communication with the secretary of the General Board, viz., that of the 3rd of October, 1851, and the date of his letter to the Town Clerk, withholding the sanction of the General Board to my plan, viz., February, 1852, was as nearly as possible four months and a half.

In reply to the Inspector's remarks under the head, " No Survey showing buildings of town,"* I beg leave to observe, that however desirable

* It will hardly be credited, after such a heading as this, that the plan supplied to me by the Local Board upon my first visit, to enable me to report upon the sewerage of the town, was one drawn to the large scale recommended by the Health of Towns Commissioners, viz., eighty eight feet to one inch, or sixty inches to a mile: in this plan the prin-

it might be *eventually* to have such a plan as is proposed by the Inspector, I do not consider it either desirable, or necessary, to incur such an expense at present; being of opinion that the improvement of the drainage will be completely effected by the carrying out of the resolution of the committee quoted in the Inspector's report, viz., that the committee "undertake that the details shall be supplied from time to time as the sewerage or drainage of the different streets shall be determined upon," with which resolution the Inspector appears perfectly satisfied; although it is merely carrying out the original intention of the committee; for you, Sir, will doubtless recollect that this question was discussed at the interview I had with the committee on my first visit to Leicester, in September 1849; and, moreover, that the following were the views held by the committee and myself at that time (and there is nothing in the Inspector's report which leads me to alter them), viz., that the effectual removal of the sewage of Leicester, though all-important, could not be carried out but by means of works of a very expensive nature; and that while the complete accomplishment of the work might be very desirable, yet it must be proceeded with gradually, in order that the town might not be overburdened with rates; provision being made that those parts which were immediately necessary for the prevention of disease, should be accomplished at as early a period as practicable. It was therefore considered that the first step to be taken would be, to make an intercepting sewer, skirting the lowest parts of the town, to prevent the existing sewers discharging themselves into the navigation, and that this intercepting sewer should be extended to an outfall at a distance from the populous parts of the borough.

Such, in fact, are the sewers called *main* sewers in my report, and laid down upon the parliamentary plans.

The next step to be taken would be to connect the existing branch sewers, provided upon inspection they were found to be suitable for an improved system, or, if not, to make new branch sewers through all the main streets of the town; and, thirdly, to connect the small drains from courts, alleys, and houses, with these branch sewers.

For the first, I am prepared to state that the plans and sections already in the possession of the Local Board are quite sufficient to enable an engineer of experience to design the works that have already been proposed to be constructed; and it will be time enough to add to them gradually (as suggested by the resolution of your committee) as the works shall be car-

cial buildings and the position of the sewer grates are shown, and also that of the bench marks made in taking the levels for the contour lines, which are drawn upon the plan at every two feet increase of elevation, in the streets, and at four feet in other parts. This plan was prepared for the Local Board, at a considerable expense, by Mr. Flint, an eminent architect, well known in Leicester.

In taking the levels, and making the survey for the parliamentary plans required by the standing orders of the house, the surveyors employed by me had an opportunity of checking its accuracy, which, so far as their work extended, proves to be complete.

I have never met in other towns with so complete a plan, prepared previously to an engineer's inspection, as this is. The first thing, generally, that an engineer has to do is to prepare such a plan before he can proceed to give advice.

ried out; and I feel quite assured that in this assertion I shall be borne out by the highest professional opinions.

The mathematical accuracy which is implied in the supposed necessity of such a complete plan, is impracticable. If Leicester consisted of a certain number of streets, a certain number of houses, and a certain number of manufactories; and if the water and sewage passing from these houses and manufactories never varied in quantity, hour by hour, day and night, throughout the year, then, in such a hypothetical condition of things, there would be no difficulty (having first ascertained the flow per minute from each house), in adjusting the size of every drain, from the smallest to the largest that could ever be required, in strict proportion to the duty each would have to perform.

Under such circumstances, indeed, the plan of minute particulars would be necessary, before a single step could be taken to ascertain the dimensions of *any proposed sewers*, mains, submains, or branches; but as such a case never has occurred, and never will, it is quite unnecessary (however well it appears in a report) to have recourse to such expensive accuracy in the outset.

The Inspector reports that :—

“ There are no proper data upon which to adjust and decide the specific sizes, depths, and inclinations of the proposed sewers. The fitness of each for the work to be done can only, therefore, at the best, be matter of probable conjecture, instead of being the result of exact calculation.”

This is not in accordance with the fact. Before I determined the proper sizes for the proposed main sewers, I had obtained all the data that were necessary, and have made no conjectures whatever, from want of such a plan as the Inspector states to be absolutely necessary.*

The Inspector, in continuation, states :—

“ No plan or section is given of any such works, except that a red line is laid on the contoured tracing, and one of the small printed plans, showing the direction of what is called the ‘ central branch sewer,’ and the area to be drained by it is stated. I find, also, a statement in the printed report that the diameter is to be twenty-seven inches. Your honourable board will be surprised to find that while the sewer, three hundred and fifty yards in length, from a small district of eighteen acres, called Frog Island, only partly built upon, is included among the ‘ main sewers’ of the scheme before you, the ‘ central

* In the first report of the minutes of evidence, taken before the Sanitary Commissioners in 1847, Captain Yolland, of the Royal Engineers, who was called in to give evidence as to the plans required for sanitary purposes, gives the following replies (page 183):—

Question.—“ You have heard and read descriptions of the requirements for sewers. Would not it be possible to make skeleton plans to facilitate that work, and get out the levels with increased rapidity?

Answer.—“ No question of it.

Question.—“ Can you judge the proportionate rate of time?

Answer.—“ One-fourth of the time.

Question.—“ Which would give the altitudes?

Answer.—“ Which would give the altitudes of the streets and along the roads, but not the plan of the rears of the houses, the gardens, enclosures, &c.

Question.—“ Would that be sufficient to enable an engineer to judge where a drain should be carried up?

Answer.—“ It would.”

branch sewer,' as it is called, is entirely omitted; and yet it will be 1,460 yards in length, through a line of principal streets, and is intended to receive all the sewers from a complete drainage area of 229 acres of land, nearly all of which is built upon; containing at least one fourth of the population of Leicester, including the markets and all the centre of the town. I shall have to allude to this sewer again hereinafter, but must state now, that when you are called upon to exercise the great responsibility imposed upon your honorable board by the legislature, this most important sewer should not have been omitted from a scheme intended for the main sewers of the town."

In this sentence, as in many other parts of the Inspector's report, the unfortunate circumstance of his not having availed himself of the opportunity of obtaining explanations from the engineer to the Local Board, appears prominently: had he done so, he might have been informed, first, that the Local Board had not thought it proper to incur the expense of preparing contract drawings and plans of any of the works, until they were in a position, by having the means of raising the capital, to offer the work to contractors; but, nevertheless, that the engineer had caused such surveys, levels, and drawings, to be prepared as enabled him to give the estimates he has done. He might also have learnt that the sewer, which is stated in the *preliminary* report to be twenty seven inches (owing to the alteration in the position of the outfalls determined upon by the Local Board previous to their application to parliament, in consequence of the representations of the inhabitants of Belgrave, and which involved a re-arrangement of the scheme—a circumstance which seems to have been entirely overlooked by the Inspector)—is now no longer the central *main* sewer, but, being a branch sewer, is to be made of reduced dimensions.

Having overlooked the circumstance of there being *two schemes*, the Inspector is continually falling into the error of comparing the statements made in my preliminary report of March, 1850 (which suggests a plan for the consideration of the Local Board, but afterwards modified for the reasons aforesaid) with the report I made in July, 1851, upon the modified plan; for the execution of which *latter* scheme they made their application to parliament.

The Inspector, however, takes these two reports; assumes that they refer to the same scheme; and gravely points out the discrepancies between the detailed statements in the one, and the detailed statements in the other. Without reference to the question of the fairness of *thus* commenting upon the plans of a professional man, who was considered by the Local Board to have sufficient experience to design their works, it is unfortunate that he should have made this error *in limine*, and which runs through the whole of his remarks; as, if he had obtained proper information before he presented his report to the General Board of Health, it may fairly be presumed it would have been of a very different character to that which has induced them to reject the memorial of the Local Board.

The reasons for adopting the lines of main sewers shown on the parliamentary plans, have already been given. Frog Island, being a district by itself, topographically speaking, must be provided for, small as it may be, as well as the larger district; although, on account of its small area, the dimensions of the sewer may be smaller than a branch

sewer draining a much larger district. It is, nevertheless, according to the scheme of the Local Board, a *main* sewer; but whatever name may be given to it, I think your Town Clerk will inform you that it was necessary to show it on the parliamentary plan, and include it in the parliamentary estimate; while it was not necessary, and would have been objectionable on the score of expense, to show on the plan the branch sewers, how much greater soever they might be in length, or in size; and, however important this central branch sewer may be, it is not more so than other branch sewers, and cannot be compared in importance with the main and outfall sewers, which are the fundamental portion of the whole scheme.

When a plan, however, representing the drainage areas was applied for, it was thought best to show this intended line of branch sewer; as, otherwise, *it might* have been suggested that the Local Board intended to exclude this important district from the improvements which the *existing* sewers might derive from the proposed plan; but the question how far the *existing* sewers will be sufficient, and how much *new* sewer must be substituted, will be determined when this portion of the general plan has to be considered.

In support of my opinion as to the comparative importance of main and branch sewers, I will quote the Inspector. He says:—

“It is right to say that Leicester is a difficult town to drain, so far as concerns the *main* sewerage; but when the *general* plan of *outfall* and *principal* sewers shall have been settled and adopted, the secondary or *branch* sewers will be *exceedingly* simple. I think I have met with no town in which the *details*, including the *house drainage*, admit of more economical and efficient arrangements on the principle of back drainage.”

The Inspector then proceeds, under the heading, “Mr. Wicksteed’s Description of his Scheme,” to make a comparison of my two reports; the published preliminary report of March 1850, containing suggestions as to what might be done, and the written one, in July 1851, containing a description of the plan finally adopted by the Local Board, and for which they have obtained parliamentary powers.

He first observes, that in my preliminary report I speak of the drainage area as about 1,000 acres, and in the written report as 1,212 acres. The simple answer to this is, that, in the first, it was calculated from plans and data which were sufficiently accurate for the then purpose; in the second, the area was taken from more accurate data, which had been obtained in the interval. He remarks that in the first report the capacity of the sewers is taken at twenty-five millions and a half of gallons per twenty-four hours, and in the second at twenty-eight millions.

If the Inspector had further stated that the diameter of the outfall sewer was finally determined to be fifty-six inches, instead of fifty-four inches (the proportionate areas of the two sizes being nearly as twenty-five and a half to twenty-eight), it would have shown that there was no discrepancy, but merely a modification, made when the position of the outfall was altered, and which after consideration was adopted as an improvement.

He then states that :—

"In one, the sewage is estimated at five millions, *when the proposed sewers and water-works are completed*; while in the other it is said to be calculated that the quantity will amount to five millions at the end of thirty years."

I do not understand what discrepancy there is in this statement; as, throughout the first, or preliminary report, thirty years is the time repeatedly mentioned for which provision is to be made. The omission (if the Inspector considers it one) of those words in this particular part of the report, did not mislead the Local Board, to whom it was addressed; nor can I conceive that it would mislead any one, who had taken even a cursory view of the preliminary report. If the estimated quantity of five millions of gallons for thirty years, is to be provided for, the works cannot be considered as completed until such provision is made. The Inspector further says that :—

"In one, the sewers are said to be capable of receiving two-thirds of three-eighths of an inch of rain (equal to one quarter of an inch) in twenty-four hours, and this is called a *heavy rain*. In the second statement, the same sewers are said to be capable of taking two-thirds of one and a quarter of an inch fall in twenty-four hours, equal to five-sixths of an inch in depth.

"The difference between the two statements is 15,993,769 gallons in twenty-four hours, as the capacity of the sewers for rain."

The discrepancy here is of the Inspector's own making, and does not exist in the statement he quotes. In the *last* report, the assumed quantity of sewer water is taken to be five millions; in the *preliminary* report it was taken at the same; but a hypothetical case of its possibly increasing to twenty millions, in course of time, was also put—the difference between the five millions given in *both* reports, and the hypothetical case of twenty millions in the *preliminary* report, being fifteen millions, as mentioned by the Inspector. The difference in the totals of the twenty-five and a half and twenty-eight millions has been already explained; they are now finally calculated to deliver twenty-eight millions of gallons when required. If the quantity of sewage water in the first instance flowing into the sewers, be one million of gallons per twenty-four hours, then the surplus capacity will be equal to twenty-seven millions. When that quantity increases to two and a half millions, then the surplus capacity will be equal to twenty-five and a half millions. When it is increased to five millions, which it is assumed it may in thirty years,* then the surplus will be equal to twenty-three millions: and should the increase, at any future period, amount to three hundred per cent., then it will be equal to twenty millions, according to the hypothetical case given in my *preliminary* report; and *then* there will be a surplus capacity of eight millions only. If it be found necessary to increase that capacity, in all fairness the expense should be incurred by the succeeding, and not by the existing, generation of ratepayers.

* As it is not known what increased demands may be made for water in private dwellings under an improved system, or what increase of manufactories requiring large quantities of water may take place, or what increased demands may be made by existing manufactories, the period of thirty years can only be taken as mere assumption; and ten or twenty years might as well be taken without altering the question of the capacity of the sewers.

As regards my expression of "heavy" rain, I am not aware that it requires much observation; but, it will be seen, on reference to page 40 of my printed report, that according to Mr. Burgess's table, the *greatest* quantity of rain that fell in one year at Great Wigston, from 1835 to 1848 inclusive, was thirty-six inches and three quarters, equal to an average of one-tenth of an inch per diem; or, calculating upon one hundred and seventy-five rainy days in the year, which is the average number given by Luke Howard, as the result of his observations for thirty-four years in the neighbourhood of the metropolis, it would be on the average one-fourth of an inch per diem.

Although no special reference is made in the report to the existing sewers, the Local Board are fully aware that my instructions were not to consider them specially. It was known that many of them were in an imperfect state; that many of them could not be used in an improved system of sewerage; but that, when the new *main* sewers were completed, such of them as were found suitable could be connected with the *new* sewers, and so far the outlay for new ones rendered unnecessary; the Local Board being desirous of ascertaining what was the extreme probable sum that was likely to be required to make a complete system of sewerage of every street in the town of Leicester, and being perfectly aware that in every case where the old could be adapted to the new, to such an extent would the estimate of cost be reduced.

As regards the question, whether in the scheme proposed by me, the sewers were intended to carry off all the rain water that might fall in an hour, or whether they were intended merely to take off what was literally nothing but sewage water, I beg leave to say, that for neither of these objects *only* was the scheme devised.

The capacity of the sewers for sewage only, upon the assumptions in my reports, is equal to five millions of gallons in the twenty-four hours.

The capacity of the sewers now proposed to be made will be equal to twenty-eight millions.

The capacity of sewers to carry off two-thirds of two inches of rainfall per hour—the greatest rainfall observed by the late Dr. Dalton—must be above eight hundred and eighty-two millions.

Again, taking the area of my largest main sewer (fifty-six inches diameter) as equal to seventeen square feet, then the size for the *sewage only*, assuming the same velocity in each case, would require to be only three square feet, or *twenty-four inches in diameter*; and the area required for eight hundred and eighty-two millions would be five hundred and thirty-eight square feet, or *above twenty-six feet in diameter*.

I have selected a capacity between the two extremes, which may be thought by some to be sufficient, and by others too great; but I doubt whether any will consider it too small.

If, however, we take the Inspector's capacity for the sewers, according to the data given in his report, namely,

"It happens in *all* districts that there are rainfalls of an inch in an hour; and during heavy rain upon the surface of a town, in a good sanitary condition, with the streets and

courts all paved, and the cisterns and rain water butts abolished by a proper water supply, upwards of nine-tenths of such a fall would flow off the ground instead of two-thirds"—

then, the capacity must be equal to the discharge of five hundred and ninety-seven millions in the twenty-four hours, requiring a sewer with a sectional area of three hundred and sixty-four square feet, or *twenty-one feet six inches in diameter*, which would be the size required for the main sewer upon the Inspector's data!

Further, although the Inspector calculates upon nine-tenths of the rainfall flowing off the surface (and all his calculations are based upon this assumption), instead of two-thirds only, I do not feel assured that *my* estimate even is not too high, when the following facts are taken into consideration—that out of 1,212 acres of drainage area, about 664 are suburban, and only 548 are urban; that a large portion of the latter consists of gardens and fields in the town itself; and that the soil is very absorbent, and very unlike either slated roofs or paved streets. In addition to which, who would ever think that the water which has to flow over a considerable space of ground *before* it reaches the sewers, will run into them at the same rate, or nearly so, that it falls naturally into a pond, without having any obstacle to contend with?

The Inspector next adverts to what he terms the impounding of the water in the sewers during floods, and its consequences; and he states, very properly, that when there are floods in the river, at the tail of Belgrave Mill, there will be a certain amount of water in the sewers, which he estimates, with an appearance of great accuracy, at 86,564 and 14-100ths cubic feet, and he states positively that—

"Every cubic foot of the sewage and rain water thus impounded, will displace an equal quantity of the foul and injurious gases generated in the sewers."

If such be the case, then the proposed velocity of the water in the sewers will not, as I state it will, prevent deposits taking place. The sewers must in such a case be full of foul gases insoluble in water; and a body of water, equal in area to the size of the sewers, must rush in *from the Belgrave mill tail, and not from the town*, to drive the gas into the town, instead of the contrary being the case, namely, that there will be a constant stream of water flowing from the town to the outfall at Belgrave mill tail; carrying the sewage water, under those circumstances, in such a diluted state that, even if the possibility of there being *time* for decomposition could be supposed, it could not possibly have any noxious effect upon the inhabitants of *Belgrave* (not of Leicester).

In a report of the Inspector, lately published by the General Board of Health, speaking of the liquid manure at Mr. Robert Hervey's farm, near Glasgow, he states, "that he perceived a considerable stench both about the pumping establishment and elevated tanks on the farm." This he attributed to the want of dilution with water, and he adds "If two or three times the bulk of water were added, and the fluid laid on more frequently, stench would be almost entirely avoided." If such be his opinion as to strong farm-yard liquid manure, the Local Board need not fear any ill effects from the sewage water—diluted, as it will be, under ordinary circumstances; and still less, when the dilution is so enormously increased

as it will be, when the sewers are "*gorged*" with rain water, to the extent suggested by the Inspector; for it must be borne in mind, that whether full or not there will always be a strong current *from* the town.

The Inspector further observes that—

"The testimony of the nose must have convinced everybody that drains, *even when they have a free and open outlet*, are more offensive during rain than at other times."

It is not fair to compare the testimony of observations made on drains badly constructed (with *fall insufficient to create a constant current*, and also insufficiently supplied with water, and in which deposit will of course occur, after a flush of rain water has stirred up the deposit), with the sewers proposed to be laid down by the Local Board. Such comparisons cannot strengthen his assertion, and therefore the observations of the Inspector, with regard to "*pestilential emanations*," are entirely without foundation.

The Inspector, by his observations upon "*the central branch sewer and discharge by gravitation*," seems to think he could have proposed a better plan than mine, but does not "*say positively that the main sewer ought to be taken in that direction*."

It is a matter of opinion and judgment, and the Local Board must decide in which of the two opinions to place their confidence: as, however, he seems to attach much importance to this portion of my plan, I must trouble you with some further remarks.

He states that the fall of this sewer from north to south, in a distance of 1,460 yards, is about forty-six feet; but he does not state that this sewer, at the south end, must pass under the railway, the surface of which is above sixteen feet below the surface of the road, which would make a difference in his estimate of the fall.

Again, he says that the lowest end, near St. Margaret's church, is "*about twenty feet six inches above the outfall near Belgrave mill*"; but he does not state what depth the bottom of the sewer, at that point, must be below the surface of the ground, or he would have found the useful fall between the two points to be only half of what he states. Having thus supplied the data upon which he grounds an opinion, he makes the following remark, viz.:—

"It seems only reasonable, at first sight, that all this part of the town, with such an *ample fall*, should be drained by gravitation, and so avoid the letting down a large portion of the sewage of the town into very deep and costly sewers, to pump it up again. I am satisfied that this might have been done, but it could not now be accomplished without the abandonment of the whole of Mr. Wicksteed's scheme; because the sewer into which this is to empty, near St. Margaret's Church, is twenty-one feet ten inches deep, and only twenty-nine feet four inches above datum. It passes under the navigation shortly after conveying the sewage of nearly all the town, and therefore all the levels, as well as the direction of the sewers, would require to be altered."

To test the practicability of an independent main sewer from St. Margaret's church to the Belgrave mill tail, for the purpose of separating the sewage of this elevated district from that of the lower districts, I beg to call your attention to the following statement, namely:—This sewer is intended to be twenty-four inches in diameter, and the velocity of the water in it is to be one hundred and eighty feet per minute. Sup-

pose the top of the sewer to be eight feet, and therefore the bottom of the sewer to be ten feet, below the surface of the ground, at St. Margaret's church, then, to preserve the velocity, the level of the bottom of the sewer, at the outfall, must be six feet below the level of the surface of the water at Belgrave mill tail. Upon examination of the parliamentary plans, you will see that the bottom of the main sewer proposed by me, at its junction with the engine branch and flood sewers, is seven feet eight inches below the level of the water. The difference is one foot eight inches; and, in both cases, when the ordinary sewage water is passing down, recourse must be had to steam power. I may also remark, that this sewer would have to pass under the navigation through a syphon, as the level of the inside top of it would coincide with the level of the water in the navigation.

I may here remark, that if the size of the sewers proposed by me is too large, and that one-fourth of the area would be sufficient, and that this sewer, therefore, was only twelve inches in diameter, instead of twenty-four inches, then the bottom of the outlet at Belgrave mill tail, below the level of the water, must (in consequence of the greater friction through a smaller sized sewer) be twenty feet; and in this case, also, the sewage water would have to be raised by artificial power, as in my proposed sewers—only it would be twenty feet instead of seven feet eight inches.

The Inspector, however, afterwards hints at a new line for the direction of this central sewer (which is, in fact, the one originally suggested by me, but afterwards abandoned when the site of the outfall was altered), in the following words:—

"I think it not unlikely that a much less expensive course might have been taken, and suggested this while in Leicester; but it was urged by the authorities, that the south eastern side of the navigation could not be adopted without another act of parliament, or without additional powers."

"*I do not say positively that the main sewer ought to be taken in that direction, but your honourable board will know,*" &c., &c., &c.

To test the practicability of getting rid of the sewage water from the central and elevated parts of the town, by this proposed line, I beg to observe as follows:—

Supposing, as in the former case, that the bottom of the two feet sewer is laid ten feet below the lowest surface of the road in Belgrave-gate, which is opposite to Britannia-street; and supposing the line it follows to the outfall at Swan's nest, to be the one I proposed, namely, along the Belgrave mill footway, and under the navigation to the outfall; then, to preserve the same velocity, the level of the bottom of the sewer at the outfall must be eight feet below the level of the surface of the water in Belgrave mill tail, or four inches lower than the bottom of my main sewer at the junction before named; and should a twelve-inch drain be adopted in this case, as in the other, the bottom of the sewer at the outlet must be nineteen feet below the level of the water in Belgrave mill tail; and in this case, also, artificial power would have to be resorted to. But assuming, for the sake of argument, the attempt to be made of discharging the sewage water into the natural outfall, by gravitation, then the top

of the sewer, by the time it had reached Britannia-street from the outfall, owing to its ascending gradient would be within a foot of the surface of the Belgrave-gate road. It would, therefore, have to pass under the Willow Brook and Belgrave-gate sewer, by means of syphons; and the sewage water in the latter, being below the level of this new sewer, would have to be carried off by some other means. Again, if a twelve-inch sewer were employed, the level at Belgrave-gate would be several feet above the roadway.

I trust the foregoing remarks will show to you and the Committee, that the plan I have proposed has not been laid before you without consideration; and so prove the truth of the observation I made in the commencement of this reply, that it is easier to find defects than to apply remedies.

The Inspector, observing upon the west main sewer, states—

“This sewer is to be thirty inches in diameter throughout. At what part of its course thirty inches may be a proper size, no professional man can determine without a plan, showing the number and sizes of the houses, and other buildings intended to drain into it”;

but, when he proposes a telescopic sewer, he will find it necessary to have some other data to enable him to work out the theoretical diminution, in capacity as the drainage area decreases. Besides “a plan showing the number and sizes of the houses intended to be drained into it,” he must have, in addition, a correct statement of what quantity of water is used in each house and passes from it, and the same information as regards manufactories: and he must make a condition that when he has proportioned his sewer, the houses shall not be allowed to increase the quantity of water for baths, washing, or other purposes; that the manufactories shall not increase the amount of business they are then doing, if an increased quantity of water should on that account be required; and, also, that no new manufactory where water is used, shall be erected in that district. He must also provide that the town shall not extend further than its present limits, unless the extended portion can do without sewerage; and unless all these conditions are observed, this mathematical sewer will have to be taken up in a few years, and a larger one laid down. As it is at present proposed, the sewer may be extended as the district extends, within certain limits.

The Inspector does not state what additional fall of sewer would be required, if the telescopic plan were to be adopted.

With respect to using one ring, or two rings, of brickwork for the main sewers; though I think, provided the contractor were to be watched in the laying of every brick, and each brick were selected, that then one ring might be strong enough, yet, I think in a *deep sewer*, it would be extremely imprudent, for the sake of a comparatively small saving, to run the risk of a failure and create a stoppage in the sewer, which would undoubtedly “inflict upon the inhabitants” the evils that the Inspector has prognosticated from the *gorging* of the sewers.

When the Inspector talks of raising the whole of the sewer three feet, and thus saving excavation, has he calculated what falls would be necessary for the branch sewers, or anticipated the possibility of an extension

at a future day? If not, he is not in a position to give an opinion at all. As to the diminution in the danger to the buildings in the narrow streets, which he anticipates, but which I do not, as proper precautions will be taken to prevent any risk, a difference of three feet, at the depth the sewer will be laid, will make no appreciable difference in the risk to the buildings.

With regard to his observations upon the eastern main sewer, they are very similar to those he has already made on the western; excepting, that he purposes to shorten the line by adopting a different course, and thus, as he states, effecting a certain balance of saving in the cost of the sewer, between the extra depth of excavation and the shortening of the length; but, in the event of that district increasing, he is removing the main sewer to a distance from it, and consequently increasing the cost of the branches.

As to the capacity of this sewer, and the comparison between it and the west sewer, I would suggest to the Inspector, that if he had stated that the gradient of the large size was one in four hundred and eighty-eight, and of the smaller one in three hundred and ninety-two, that the area to be drained by the larger size was three hundred and fifty-five acres, and by the smaller two hundred and twenty-seven acres, the want of proportion would not have appeared. The Inspector will find, upon further examination, that all the *main* sewers are proportioned to the area of the district, and the obtainable fall or gradient.

I believe the line proposed by me is the best, and I see nothing in his suggestion to make me alter my recommendation to the Local Board.

With regard to the suburb sewer—its construction, and the direction it ought to take, were subjects of much consideration; and upon taking into account the avoidance of crossing under the navigation, in a crowded part of the town, to bring it to the east side, to be carried again under the navigation to its ultimate destination on the west side—the extra depth it would have been necessary to have laid the western sewer, to have received it with sufficient fall—the consideration, that if that suburb was properly drained, the number of manufactories would increase upon the west side of the navigation, especially as the eastern is already occupied;—these, and other considerations discussed with members of your Committee, previous to going to parliament, and after it had been resolved that (at the instigation of the inhabitants of Belgrave) the site of the outfall should be altered, induced me to select and recommend this line; and, looking to the future requirements of that out-district, I believe, upon the whole, it is the best line, although the necessity for so large a sewer as the one proposed may not be felt until the district has been more fully built upon. I certainly should never have thought of laying *main* drains, of six inches and twelve inches in diameter, for a district that is acknowledged, from its present unhealthiness, to require draining as much as any part of Leicester.

As regards the Inspector's observations upon the Frog Island sewer, as to its size being too large and too little, is he aware that there are in that district large manufactories, which discharge large quantities of water into the navigation, and which quantities will undoubtedly increase?

Referring to his observations upon the main sewer, I have merely to remark, that his use of the word "*fate*" seems as if he had formed a pretty correct opinion of what the purport of the General Board's answer to the application of the Local Board would be—even before he had concluded his examination of my plan, or presented his report; but when he states that he cannot clearly see the utility of making the sewer more than three feet in diameter, instead of fifty-six inches, or less than half its area, he surely cannot have calculated the capacity of the sewers that will be discharged into it.

As respects the engine branch sewer, he does not seem to be aware that it was for the purpose of carrying off *sewage* water only; and not as an outfall sewer for rain water, passing down in such a volume as to dilute the ordinary sewer water, and render it perfectly innoxious and incapable of polluting the river into which it is intended to flow, through the flood sewer; between which waters, namely the one flowing through the flood sewer, and the water in the river at the outlet during flood times, there will be no perceptible difference. What the Inspector means by increasing the velocity of the water in the three feet sewer, whose sectional area is seven square feet, so as to carry off the water from a fifty-six inch sewer, whose sectional area is seventeen square feet, I do not pretend to divine; but why he should think it necessary to calculate, how a three foot *branch* sewer to the engine well will not take off the water from a fifty-six inch main sewer, full of water, when the terminus of that main sewer is an outlet fully capable of taking the largest quantity that will ever pass down it, I cannot conceive; as there is nothing in my reports, or plans to indicate that such was ever contemplated.

In the *ordinary* state of supply of sewage water from the town, the engines will remove it at a considerably lower level than the natural outfalls afforded; upon *extraordinary* occasions a larger quantity of surface drainage water will be allowed to flow into these sewers, and then it must pass off to the natural outfall.

The proposed new main sewers, under these circumstances, will afford relief to the borough in flood-times; and will form a great assistance to the natural outlets already existing, for the escape of surface water, and which it has always been intended to retain, so far as they can be rendered available; and of this the Inspector might have been informed, if he had asked me for any explanation.

If it be desirable to give more assistance than is now proposed, the main sewers may be made as much larger as the Local Board think right, having reference to the expense thereof; and as the question of carrying off the whole of the storm waters is one which, I presume, no prudent board will ever contemplate seriously; so, the question of the sizes of the main sewers, must be one in which the amount of money that can be prudently expended, in affording relief to the town, under such circumstances, must form a grave consideration.

In reference to the sewers being full of water during flood times, that is a question entirely dependent upon the level of the *natural* outfall, and not upon the judgment of any one; unless (which I hardly suppose probable) the Local Board would think of erecting steam engines, to pump

off that portion of the flood waters which passes through the sewers, for the sole purpose, apparently, of lifting it up to the natural level of the floods, instead of allowing it to find its own level, which would be that of the floods.

As far as the sanitary effect upon the town is concerned, I differ with the Inspector; for I repudiate, as the General Board in their late reports, and the Inspector also, have repudiated in strong terms, the notion that sewage water, when largely diluted, has any deleterious stench whatever; and if there is no "*stench*," where are the "*pestilential gases* to inflict an incalculable evil upon the health of the inhabitants of the town," to be met with? On the contrary, the effect of the sewers being occasionally filled with a large quantity of rain water, will be to improve its salubrity. But to put this question fairly before the Local Board, which I think the Inspector has not done (not understanding my plans, and not taking the trouble to ask me for an explanation of them, before he ventured to condemn that which he does not understand), the Local Board will be aware, that according to the scheme proposed by me, and adopted by them, the amount of sewage water, estimated from the best data that could be obtained without incurring a great and unnecessary expense for greater accuracy in detail, was five millions of gallons per twenty-four hours, at the end of thirty years; although, as before observed, future events may alter this assumed period of time, and it must be borne in mind, that this five millions of gallons of sewage water is not the sewage water of the town in its present concentrated state, but largely diluted, as it will be, when the town is properly supplied with water. This five millions, however, of sewage water is to flow into sewers, which, in extraordinary cases, are carrying down with them twenty-three millions of gallons of rain water; thus further diluting the already diluted sewage nearly five times; and *this* sewage water, not running as the Inspector would imply, into a stagnant reservoir *underneath* the town, but into a stream constantly running *from* underneath the town, at a rapid velocity, capable of *scouring out* and removing any deposit. Is it within the bounds of probability, under these, the real circumstances of the case, that gases should arise, when both the material and time for decomposition are wanting? The Local Board are, in fact, providing a flood sewer for the town, which will form an *additional capacity* to the already existing outlets for surface water, equal to about a million of gallons per hour.

When remarking upon the flood water sewer, if the Inspector could have pointed out a lower natural outfall in the neighbourhood, it would have been much more to the purpose, than describing a state of things which cannot be altered without an enormous, and in my opinion, totally unnecessary expense in artificial power.

He talks of sewage being "impounded back" into the town, and foul gases being "regurgitated" into the houses. As I have before stated, *if* the flood waters came into the main sewers, at the outlet at Belgrave, and gradually rose like the tide in a tidal river, the sewage might be "impounded back"; and then, being in a state of comparative quiescence, decomposition *might* take place, and gases *might* be evolved; and, if they were, would rise naturally to the highest outlet. The term "*regurgita-*

tion," I do not understand, as it is applied; but as the facts will be diametrically opposite to this, namely, that the sewage water and rain water will *run in together*, and be mixed together at the *town end*, and flow in a constant stream to the outfall at Belgrave, I think it will be difficult to convince the ratepayers that the awful events predicted by the Inspector will ever take place.

The Inspector observes:—

"With respect to this sewer (*viz.*, the flood water sewer), however, I find that there is a mis-statement as to the velocity, and that when full (that is, when the greater part of the main sewers of the town are full of impounded sewage) it would have a velocity of 315 feet per minute, instead of 180, as stated by Mr. Wicksteed. At this rate it would discharge 2,164,167 gallons per hour, which would be equal to nearly one-twelfth part of an inch of rain flowing off the surface of the town, exclusive of the average hourly sewage which the engines would lift at the same time.

"This is not proportioned to the capacity of the other sewers; they are incapable of conveying sufficient to fill it, either before or when the impounding system has reached its *maximum*."

The Inspector here charges me with a mis-statement, for which there is more apparent reason than in the many other cases occurring in his report. It is a fact, that in my report, I class this flood sewer with the other main sewers, when speaking of an uniform velocity of one hundred and eighty feet per minute. This sewer, however, should have been excepted; and if he had thought fit to apply to me for an explanation, he would have probably found reason to qualify his expressions.

This sewer I considered more as bringing the outfall nearer to the main sewers, than as a continuation of them in the same proportions; and whether it should be more capacious than the sewers leading into it, is a question of judgment. I consider it better, from its form, that it should be more capacious, and that the velocity should be reduced in it. The velocity must, however, depend upon the difference in level between the water (brought down by the sewers in the town) in the shaft during flood time, and that of the water in the river at the outfall, which is always varying as the level of the flood water varies. If the level is higher in the river than calculated upon, the velocity will be less; if lower, the velocity will be greater. The inclination of the bottom of the sewer, which would give a velocity of two hundred and seventy-six feet per minute, does not necessarily govern the velocity in a sewer in such a position; it must depend upon the difference of the two levels, as before stated. As this sewer is used during floods only, the velocity might sometimes be as great as the Inspector states; provided the town sewers brought down a sufficient quantity of water to supply it. If not, then it will not be so great, and the pressure upon it will consequently be less; and as the forms I have considered best adapted to this sewer is not so strong as the circular, and as the depth of earth over it, from its position, will not be nearly so great as in the other deep sewers, I consider it an advantage to have a less velocity.

As to the question of the four-and-a-half inch invert, as it will be laid on a base of concrete, I consider it sufficiently strong.

As to the Inspector's repeated observations concerning the strength of one ring of brickwork, and there being no necessity for two, if it

were a question between two rings and three, or three and four, I have no doubt that we should agree that two rings would be strong enough, in cases where three have been introduced; and, as far as the mathematical question of strength goes, I have no doubt that three inches in thickness would be quite as efficient as four inches and a half, in many cases; but, as a practical man, I should be fearful, that in the course of time the joints might be washed out, and the sewer would fall in; and therefore I would prefer two rings, so that the joints of one may overlap those of another. I know, in answer to this it may be said, that if the joints are well filled up, either blue lias or Roman cement is stronger than the brick itself, and that, therefore, the brick would give way before the cement could be washed out; but I have also had this experience, that although the engineer may specify that none except the best cement and best bricks shall be employed, and the contractor may be the most respectable person, and desirous of carrying out the specification literally: yet, in practice, most probably it would not be done. However, if it were, I believe the extra cost in labour, of selected materials, and extra supervision, would far outbalance the work done in two rings, in what is *commonly* called the best style. I ask whether, in the construction of the *deep main sewers* (which from their position are more inaccessible than the flood sewer, and which, therefore, it is most important should be made lasting), it would be prudent to make a trifling saving in the outlay, when it is considered, that especially in this portion of the sewers, a stoppage would be attended with the most serious inconvenience, and injury to the health of the district? As regards the flood sewer, it will be accessible to inspection and repair, if necessary, at all times excepting during floods.

In the Inspector's review of the several main sewers, he expressed an opinion that they are most objectionable, and states that by reducing the brickwork, &c., a saving of £1,063 12s. 6d. may be effected, which will amount to about eight per cent. upon the estimate of £13,000, for sewers alone. The remaining contemplated saving of twenty-one per cent. depends upon whether the suburb sewer is to be executed or not; or whether the Inspector's guess at the cost of it is correct, or otherwise. It further depends upon whether the plan proposed by him to be substituted will be adopted, and if so, whether his estimate of the cost is sufficient. You will, probably consider it unnecessary for me to remark further, upon the Inspector's supposed sanitary advantage of reducing the depth of the sewers, and consequently reducing the quantity of water remaining in them after floods.

As regards the Inspector's calculations upon the discharge of water from the sewers producing a greater discharge than I have assigned, I beg to refer you to page 19 of my preliminary report, in which it will be seen that I calculate on a delivery from the same sized sewer of one hundred and twenty-eight cubic feet per minute, which will be according to Captain Vetch one hundred and forty-two cubic feet per minute, according to Mr. Hawksley one hundred and forty-seven, and according to Mr. Lee it would be one hundred and fifty-one. For the reasons therein given, I think it most prudent to abide by my own calculations.

With respect to the table showing what quantity of rain the sewers will carry off, you will probably think that this question has been sufficiently discussed in previous parts of this reply.

As to that portion of the Inspector's report in which he remarks upon the engines, and their power of raising rain water, I have merely to remark that as he says:—

“But here again, I am placed in a difficulty from the discrepancy between the two reports, either of which Mr. Wicksteed may adopt at his own convenience.”

I take leave to adopt the latter one, which describes the scheme that was placed before parliament in preference to the preliminary report, which, as before stated, contains *suggestions* only for the consideration of the Local Board, and to state, that these engines are not intended to carry off the twenty-eight millions (or, according to the Inspector's estimate, thirty-three millions) of gallons per twenty-four hours, which the sewers are calculated to carry off to the natural outfall, without the intervention of steam engine power.

Before leaving this part of the subject, I may state, in a few words, upon what the Inspector's objections appear to me to be founded, and upon which he bases his statements of projected savings. His chief objection is that the sewers, as proposed by me, are neither so small that they will carry off sewage water only, nor so large that they will carry off storm waters.

Secondly, he asserts that when the sewers are running full bore, with the addition of rain water to the sewage, that in this extraordinarily diluted state pestilential gases will flow in an *opposite* direction to the current of the sewer water, and thereby endanger the health of the inhabitants.

Thirdly, to relieve this imagined defect he proposes to raise the whole line of sewers three feet. By this he would not reduce the imaginary danger, but, on the contrary, would increase it; for there would be less rain water in the sewers to dilute the sewage, while the engines are emptying the sewers of the accumulation of water, *after* the floods have subsided. His assertion that the proposed sewers are that amount too deep, is entirely an assumption; and he has given no proof in its support.

Fourthly, he states his opinion that one ring of brickwork in a thirty inch sewer is sufficient, and that two rings are unnecessary, and that, by an alteration of this, combined with the raising the level of the sewers, a saving of eight per cent. may be effected on the cost of the sewers.

Fifthly, upon a survey of the district through which the line of the suburb sewer is proposed to be carried, he thinks it is unnecessary to go to the expense of the plan proposed for obtaining a means of thoroughly draining this damp district, and proposes a drain which “commences with six inches diameter, and increases to twelve inches.”

With the fall he gives, the six inch will be capable of delivering nineteen cubic feet per minute; and the twelve inch, one hundred and eight cubic feet per minute. With the sewers proposed by me, the first portion will deliver three hundred and eighteen cubic feet per minute, and the

latter eight hundred and eighty-three cubic feet per minute. Such is the difference between me and the Inspector; but after reading the report on the preliminary inquiry made at Leicester by Mr. Ranger (whose authority was highly esteemed, until lately, by the General Board of Health) to the General Board, dated April thirteenth, 1849, and which report you placed in my hands on first consulting me, it appears that *he* considered the thorough drainage of this suburb of the greatest importance to the health of the inhabitants, after receiving evidence of the highest medical authority, and personally surveying the district.

Should the present Inspector be replaced by another Inspecting Superintendant, it is possible that the new one might either agree with Mr. Ranger, or differ from both. Under such circumstances, I do not know how the Local Board is to act; unless they rely upon their own judgment, founded upon an intimate knowledge of the locality, combined with the necessary professional advice.

If, however, the Inspector is correct in his opinion, and in his rough estimate of the cost of the two plans, then a further saving, which forms from two thirds to three fourths of the total amount of saving he proposes to make, would be effected.

To proceed with the Inspector's report, taking the section of "Reservoirs for Sewage," here it is again unfortunate, that before making his report he did not ask me for explanations; as he might have been informed, that in consequence of a new process for manufacturing, which I have lately patented, the necessity for such large reservoirs is dispensed with, and that, if such process be adopted, the size of the proposed reservoirs will be considerably less than an acre, instead of three acres two roods eighteen perches, as originally intended. Even should they be made the original size, I deny most positively that any "*pestilential gases*" will arise from them, or from the deposit at the bottom of the reservoir. In this statement I am supported by the first chemical authorities of the day; and I can hardly imagine the Inspector himself would continue to assert the contrary, when, even without the process of deodorization having been effected, he has reported, as before referred to, that when the sewage is so diluted, "*no stench*" arises from it, and therefore no gas is evolved, when it is exposed on meadow lands; in fact, this is the liquid which without deodorization, he proposes to distribute over large areas in the immediate vicinity of populous towns.

After this, I should perhaps mention, that in September last I forwarded to Mr. Lee, and other Inspecting Superintendents, and to the officials of most of the principal towns in the kingdom, a copy of a pamphlet published by me, descriptive of my patent process; the receipt of which he acknowledged, and therefore could not, when he made his report, be ignorant of its existence.

That this pamphlet might be considered worthy his perusal and attention, would perhaps be best shown by my copying, in this place, the letters I received from Arthur Aikin, Esq., the father of British chemistry;

from Dr. Alfred Swaine Taylor, and from Robert Stephenson, Esq., M.P., expressing their opinions as to the value of my process:—

“Chemical Laboratory, Guy’s Hospital,
September 15th, 1851.

“MY DEAR SIR,

“We have read with great attention your pamphlet, describing the patent process for producing solid manure from sewage water, and think that the plan which you proposed for collecting the sewage of towns, and speedily converting it to a profitable and useful manure, excellent.

“The chemistry is properly explained, and the descriptions clear and intelligible.

“We can state of our own knowledge, and from our own experiments, that by your process the nitrogenous organic matter, as well as the phosphoric acids, dissolved or undissolved, would go down and be retained in the solid deposit; while the water, after the precipitation is completed, will be discharged in a limpid state, and free from the offensive matter which it previously contained.

“The avoidance in your patent process, of long exposure to the air, and the absence of artificial heat, ensures the separation, in the best manner, to prevent loss of the fertilizing matters contained in the sewage water.

“We consider your process has, in fact, these advantages over every other plan which has been proposed—it provides for the immediate and rapid sewerage of a district at all periods; it prevents the contamination of a river, or other sources of water supply, by removing all noxious animal and vegetable matters; it provides for a speedy deodorization, separation, and drying, of the solid and useful parts of the sewage; and, lastly, it furnishes to the agriculturist a cheap and useful manure in a concentrated form.

“Wishing you success in a practical form,

“We are, yours, very truly,

“ARTHUR AIKIN, F.L.S.

“ALFRED S. TAYLOR, M.D., F.R.S.

“*Professors of Chemistry in Guy’s Hospital.*

“T. Wicksteed, Esq., &c. &c. &c.”

“Guy’s Hospital,

“November 24th, 1851.

“DEAR SIR,

“The opinions which we gave you on the fifteenth September last, regarding the action of lime on sewer water, and the nature of the deposit, is not based upon *any theory*, but on an extensive series of *experiments* occupying our time for *three months* in the winter of 1849, and made on large quantities of sewer water supplied from Leicester.

“The lime certainly does not destroy the organic matter (containing nitrogen and sulphur), to which the fertilizing properties of the sewage deposit are commonly, and we believe justly, ascribed. We found, by direct experiment, that when the sewer water contained an ammoniacal salt *dissolved* (resulting from putrefaction) a small quantity of ammonia was set free; but lime, except when the dry deposit is heated to a *full red heat*, will not cause the nitrogen to be converted to ammonia, or occasion loss.

We have estimated the value of your deposit, as it is precipitated by lime from sewer water, and, chemically speaking, its value is not in the least degree deteriorated by the use of lime as the precipitating agent.

“Much of the lime used is converted to carbonate of lime (or chalk), by the carbonic acid contained abundantly in all sewer water. It is this finely divided powder, in the act of precipitation, which locks up and entangles the organic matter, so as to carry it down with it, a portion of the organic matter entering also into combination with part of the lime. In some hundreds of experiments, we found that the quantity of organic matter, thus precipitated by lime, was nearly double that which could be procured by spontaneous subsidence. We further found that lime would throw down the organic matter in from a quarter to half an hour; while mere spontaneous subsidence produced only half the amount of deposit, from the same quantity of sewer water, in twenty-four hours.

"When lime was used, the offensive smell was almost entirely removed; when spontaneous subsidence was resorted to, the water was just as offensive, after forty-eight hours, as at the commencement of the experiment.

"The statement that '*lime destroys ammonia*,' or the elements of ammonia, in such precipitation, is contrary to fact. The lime is in great part converted into chalk in the operation, and this conversion deprives it *pro tanto* of the power of setting free ammonia, even from ammoniacal salts; since caustic lime, and not carbonate of lime, is required to do this.

"But whether the lime, used for precipitation, remain partly or wholly as such; or whether it be partly or wholly converted to carbonate of lime during the process, we affirm that it exercises no injurious influence on the organic matter carried down with it, so as to deprive it of its fertilizing elements—nitrogen and sulphur; and that, if it be admitted that sewage possesses any manuring properties whatever (on which we offer no opinion from agricultural experiments), those properties are retained uninjured, and in a concentrated form, in the deposit obtained by your lime process. When ordinary sewage water is used as such, for manure, any salt of ammonia contained in it in a dissolved form, is inevitably lost by diffusion and volatilization.

"The sewage refuse must, after all, whether employed as sewage water or as a deposit by your lime process, owe its fertilizing properties mainly to the organic matter (containing nitrogen and sulphur), and not to the small proportion of ammoniacal salt which happens to be occasionally dissolved in it.

"As there seems to be some strange misrepresentation regarding the action of lime on organic matter, we would refer you to some experiments of Dr. Taylor's, on the action of this substance on animal matter, performed in 1849, and published in the *Medical Gazette*, on January 4th, 1850.

"Dr. Davy, brother of Sir Humphrey Davy, who has given some attention to agricultural chemistry, has also experimented on this subject, both in reference to animal and vegetable substances, and has confirmed Dr. Taylor's results, which are entirely opposed, as matters of experiment, to the hypothesis of the destroying influence of lime.—(See Dr. Davy's Paper on this subject in the *Medical Gazette*, January 25th, 1850).

"As you now propose to make so much use of lime, you will, I am sure, be interested with the results of these experiments which were performed by Dr. Davy and Dr. Taylor, separately, without any knowledge or suspicion that they would throw any light on the sewage manure question.

"Dr. Taylor was consulted in reference to the effect of the lime used in burying the body of the man murdered by the Mannings, in the Borough, and succeeded in keeping a beef-steak five weeks by the aid of lime, and there was no loss of nitrogen or sulphur—*no ammonia destroyed*.

"It is a practical agricultural question, whether much or little lime, or carbonate of lime, will counteract the manuring properties of substances mixed with it. As chemists, we should think not. Has it ever been known that a little chalk, mixed with dung, destroyed the manuring properties of the dung? You must remember, that in your dry composition, the lime will be chiefly as chalk, and therefore harmless.

"We are,

"Yours, very truly,

"ARTHUR AIKIN,

"ALFRED S. TAYLOR.

"T. Wicksteed, Esq., &c. &c. &c."

"Paris, October 28th, 1851.

"DEAR SIR,

"From my connexion with the Metropolitan Commission of sewers, my attention has been frequently directed to the question of obtaining from the liquid sewage the valuable manure which it is universally admitted to contain; but no plan with which I was acquainted appeared to me sufficiently simple and efficacious to lead me to the opinion that it could be carried out with advantage.

"The application of liquid manure always appeared to involve such a large amount of capital, as to render it quite abortive, and at all events of extremely limited utility.

"Your proposal to precipitate, by lime, all the useful salts, and then to separate the solid precipitate from the liquid, by centrifugal action, appears to me to remove almost every difficulty which all former plans had to encounter, in the shape of extensive settling reservoirs. This, you will remember, was my chief objection to your first proposal; but the mechanical means which you now suggest will, I feel convinced, clear the way to success; and I congratulate you on having suggested a means at once so simple and efficacious."

"Yours faithfully,

"ROBERT STEPHENSON.

"Thos. Wicksteed, Esq., 40, Coleman-street, London."

After the perusal of their letters, you and the Committee will perhaps think it unnecessary for me to answer that portion of the report referring to the effects of lime as a deodorizer; especially as so much of it is personal, as regards myself, and the eminent chemists engaged to analyze the sewer waters for the Local Board. Two or three points, however, I think it necessary to remark upon. The Inspector more than insinuates, that in my preliminary report, in embodying the statements of the chemists, I have given a dishonest version of their meaning. In reply, I have merely to observe, that before my report was presented to your Committee, it was perused very carefully both by Mr. Aikin and Dr. Taylor, who gave me full authority to append the remark which will be found at page 55 of my printed report, viz., "*Since writing the foregoing report, I have submitted it to Mr. Aikin and Dr. Taylor who have expressed their full concurrence in all the statements and opinions offered therein upon chemical matters.*" If, therefore (which I am certain there is not), there was any real discrepancy between my version and their statements, this expression of their opinion ought at once to have removed all doubt of any want of candour on my part.

Again, as regards the Inspector's insinuation that there is a difference between lime water and cream of lime, and therefore that my assumption, that so many grains of lime in the form of cream of lime, is the same as if it were so many grains of lime in the form of lime water, is inaccurate,—I beg leave to add the fact, that from experiments tried by Dr. Taylor, since his analysis of the Leicester sewer waters, he finds that lime acts better as a deodorizer, in the form of cream of lime, than when the lime is as diluted as it is in lime water. The question is, however, not as to the quantity of water with which the lime is diluted, but whether the proper quantity of lime be in the water.

Respecting the statement of the slight authority upon which the chemists have arrived at their conclusions, I think their letters hereinbefore quoted will clearly show that it is founded on error.

In reference to the Inspector's general condemnation of my process, which he neither understands, nor about which has he taken the trouble to ask me for any explanations, I will merely observe, that the process he proposes, of distributing liquid manure *upon the large scale*, has been *proved to be a decided failure*, in a commercial point of view, by the late Liquid Sewage Manure Company, whose works were in the neighbourhood of the metropolis.

After perusing the foregoing statements, I trust you and the Committee will consider, that the recapitulation of assertions made without

authority, and the use of gross and unprofessional language (which latter never strengthens an argument) will not, in the slightest degree, confirm their opinion of the value of the Inspector's report; or that the conclusions he draws at the end of his report, are supported by either facts or reasoning.

As regards the general question of estimate and expense, I may be permitted to say, that in presenting my preliminary estimate, it was considered, like all other preliminary estimates before the expense of making detailed drawings has been resorted to, as one representing the extreme probable cost of the works contemplated by the Local Board; and as it had not been considered wise to incur the expense of making detailed drawings before going to parliament, it was thought safer that the amount of estimate should not be reduced, although it was well known to you, that instead of being exceeded, as had been anticipated by some parties, it would most probably be considerably reduced. If, however, the General Board had stated that detailed and accurate estimates, founded upon detailed and accurate drawings to be submitted to the inspection and judgment of parties with qualifications unknown to the Local Board were required, then it might have been as well for the Local Board to have taken into consideration the advisability of employing, as their professional adviser, one of the Superintending Inspectors who are deputed by the General Board to report on the schemes of civil engineers; and who might be expected to advise them to adopt a scheme, however objectionable in an engineering point of view, still perfectly in accordance with the views of the General Board of Health and their officers.

I believe that I have now given an answer to most of the Inspector's strictures upon my scheme. If I have omitted any points which you and the Committee think important to be answered, I shall be very happy to give them my attention: the Inspector's report is very voluminous, and it evinces a stronger desire to condemn without reflection, than to treat the subject with candour and fairness.

Apologising for the length of this reply,

I am, Sir,

Your most obedient Servant,

THOMAS WICKSTEED,

Engineer.

and the use of gross and unprofessional language (which latter never strengthens an argument) will not, in the slightest degree, confirm their opinion of the value of the Inspector's report; or that the conclusions be drawn at the end of the report, are supported by either facts or reasoning.

As regards the general question of estimates and expenses, I may be permitted to say, that in forwarding my preliminary estimate, it was considered, like all other preliminary estimates before the Board, as one representing the estimate of the works contemplated by the Local Board; and as it had not been considered wise to insert the expense of making detailed drawings before going to Parliament, it was thought better that the amount of estimate should not be reduced, although it was well known to you, that instead of being exceeded, as had been anticipated by some parties, it would most probably be considerably reduced. If, however, the General Board had stated that detailed and accurate estimates founded upon the plans and sections drawings to be submitted to the inspection and inquiry, and sent to parties with preliminary estimates to the Local Board were required, then it might have been as well for the Local Board to have taken this consideration into consideration of expediency, as their present estimate would have been the subject of criticism by some of the members of the Board, and who might be expected to object to it on a point of estimate, however objectionable from a technical point of view, still necessary in accordance with the views of the General Board of Health and Local Boards.

I believe that I have now given an answer to most of the Inspector's questions upon my estimate. If I have omitted any points which you and the Committee think important to be answered, I shall be very happy to give them my attention: the Inspector's report is very voluminous, and it evinces a stronger desire to ascertain without reflection, than to treat the subject with candour and fairness.

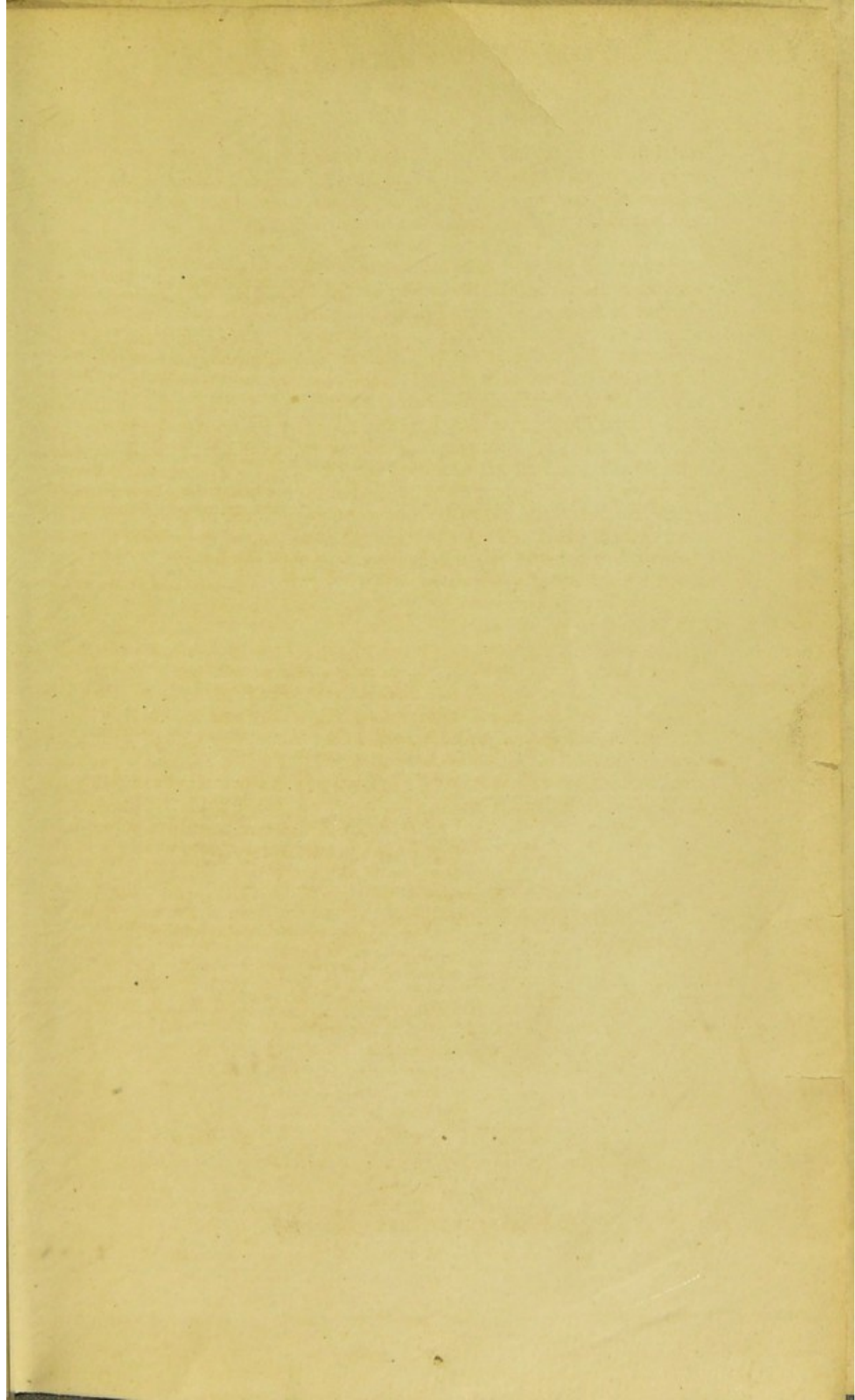
Accepting for the length of this reply,

I am Sir,

Your most obedient servant,

THOMAS WICKSTED.

Inspector.



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