Commentaries on the report of the Royal Commission on metropolitan sewage discharge, and of the combined and the separate states of town drainage / by Edwin Chadwick.

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OF THE

ROYAL COMMISSION ON METROPOLITAN SEWAGE DISCHARGE,

AND ON THE

COMBINED AND THE SEPARATE SYSTEMS

OF

TOWN DRAINAGE.

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EDWIN CHADWICK,

Chief Executive Officer of the First General Board of Health.

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COMBINED AND SEPARATE SYSTEM.

Condemnation of the combined system of drainage.

LORD BRAMWELL and his colleagues, in their last report on the pollution of the river Thames, declare emphatically that "the condition of the river is a disgrace to the Metropolis and civilisation," and, in their opinion, that the public interest requires that a "remedy should be applied with the least possible delay." The Reporters further declare, "We are strongly of opinion that it would be wrong to delay proceedings on this account" (a question as to the mode of applying the sewage), "and that freeing the Thames from pollution must be undertaken as a work to be done and paid for, whatever the cost may be."

This is a decided condemnation of a large system, "the combined system," with which condemnation most disinterested and independent judges will fully concur as being inevitable under the actual conditions previously condemned by the commissioners as being "a nuisance." The subject is submitted as peculiarly deserving the attention of the sanitary authorities of Paris and on the Continent, where the same system of throwing sewage into rivers, or into the sea, has been proposed on the example of London. I commend it also to the authorities of the United States, since at Boston and other places, there the health authorities have been led to follow it, and the people are now complaining of the nuisance created from it by the pollution of their rivers. The same question is presented for consideration by them as to the course that may be taken to effect this object with efficacy and economy, and with the avoidance of such further waste as that already incurred, namely, of an expenditure of six millions of

money for the purification of the Thames, as a primary means of promoting the health of the Metropolis.

I, for one, have a particular respect for the judgment of Lord Bramwell, as well as of one, at least, of his colleagues whom I know, especially if their judgment had been based on the whole of the relevant evidence had been brought before them.

Omission of material facts as to the separate system.

It will be found, however, on examination, that large amounts of relevant evidence and conclusions, to which it is now proper to refer, have not been brought before his Lordship or his colleagues. Their account of the proceedings for the purification of the Thames and of the sanitation of the Metropolis omits all notice of the proceedings of the Metropolitan Sanitary Commission, and of their reports, with the evidence, fully substantiating each one of their conclusions, wherein it was recommended that "the rainfall to the river" should be protected from the surface sewage of the streets and roofs; nor can such special reports have been seen, wherein it was proved that the scales of sizes of sewers and house drains up to that time in use were such as to occasion stagnation and diffuse deleterious gases. Neither is any notice taken of the Metropolitan Sanitary Commission's examinations of the marsh surfaces contiguous to the Metropolis, or of the provisions for their removal. Nor is there any reference made to the important action that followed on that report in the consolidation of the eight separate Metropolitan Commission of Sewers under unity. Nor is there any notice taken of the ordnance survey obtained for the whole of the Metropolis. Nor of the trial works instituted by that Consolidated Commission, by which the expense yet referred to as an insuperable obstacle to the house drainage of the Metropolis prepared "for the separate system" was reduced by three-fourths: nor is there any notice of the ascertained cost of the results in blocks of buildings in London, and in provincial towns under the separate system, showing that three houses and three districts might be drained well at a cost heretofore incurred for draining one ill.

It would appear that neither his lordship nor his colleagues had brought before them the special report of the General Board of Health on the water supply of the Metropolis, which proposed to place the water supplies of the Metropolis under unity, which might then have been accomplished, and the pollution of the river avoided, for one-fifth the expense that will now

be required for the prevention of further waste and loss. The Commissioners do not appear to have been aware that the evidence collected by that Board—published in minutes on the drainage of houses and lands on the separate system of "circulation in place of stagnation"—was corroborated, by the reduction of death-rates by one-third through the operation even of only rudimentary works. Indeed, the reports of a Commission of enquiry instituted after we had left, displayed similar material omissions from half information.* It will be proper to point out some of the erroneous conclusions, heretofore disproved, to which the Commissioners appear to have committed themselves in consequence of their apparent omission to consult these public documents. On a competent examination of these reports, and of the account of the preparatory trial works which followed them, the Commissioners would have seen that a very complete measure was prepared for the purification of the houses as well as the sewers of the Metropolis, and also, in its proper order, the river.

Evidence of the superior economy of the separate system

I wish now to call attention to some errors in fundamental particulars into which the Commissioners have been led by the imperfect information placed before them. In speaking of the separation of the sewage from the rainfall, they state: "We have not overlooked the "well-known views of Mr. Edwin Chadwick on the "matter. One of our body has already expressed an "opinion in favour of the separate system." "In that "opinion he abides, and other members agree with him." "But the expense, trouble, and annoyance make it "impracticable now to offer to the metropolitan "drainage generally—the system which was rejected "when the present arrangements were made." That is to say, the separate system of self-cleansing house-

Erroneous statement of Mr. Chadwick's view.

* *Vide* first Report of the Metropolitan Sanitary Commissioners, with minutes of evidence, 1848, and second report, same year. Report of the General Board of Health on the supply of water to the Metropolis, with appendices of minutes of evidence, 1850. Minutes of information on the drainage of land forming the sites of towns, and on the drainage of suburban land; issued by the General Board of Health, for the information of local boards of health, 1852. Minutes of information for the drainage of dwellings, and the sewerage of towns; issued by the General Board of Health, 1852. Minutes of information from the General Board of Health, to local Boards of Health, for the practical application of sewer water and town manures to agricultural production, 1852. Report of the General Board of Health on the administration of the Public Health Act, 1854; also reports of the consolidated commission of sewers.

drains and self-cleansing sewers, which would relieve the houses and the towns from the putrid emanations which now pervade them. How little my Lord Bramwell and his colleague can have known of my views, may be shown by one of the chief assumptions of their report, wherein it is stated correctly that the sewage may be taken roughly at one hundred and fifty millions of gallons daily, but they appear to have been uninformed of the fact that I got examinations made as to the run of the sewers on the "dry days," when it was proved that at least three-fifths of the water supply was pumped into the Metropolis in mischievous waste, and this waste still continues. At Manchester the water supply was the same as in the Metropolis, namely, thirty-two gallons per head; but it has, by care, when placed on a public basis, been long reduced to twenty, and is now reported to be about seventeen gallons, with a greater proportion of large consumers and manufacturers than in London, and that on other experiences there is good ground for belief that on a public footing and under unity a greater reduction of waste may be effected, and the consumption, by self-closing taps and meters, be brought down to one-half; thus affording the means of reducing the intake from the rivers in that proportion; and of lessening the companies' separate establishments; and of effecting administrative economies in that proportion; and, in that surer proportion alone, of lessening the demand for spring supplies. I got the late Sir William Clay, then the chairman of the Grand Junction and the Southwark and Vauxhall Water Companies, to ascertain the actual consumption of water at his own mansion, at Chiswick, where there was a profusion of water butts on each story, besides coach house and stables. He would not make it more than thirteen and a half gallons per head; whilst on one of his companies, the distribution per diem was then at the rate of three hundred gallons per head. Lord Bramwell and his colleagues say: "No one doubts, as a general principle, the value of human excreta for fertilising land. It had," they say, "been shown, by careful estimates of competent authorities, that in one hundred tons of average sewage, London sewage, the ingredients had a manurial value of 17s. 7d., or a little over 2d. per ton. Allowing thirty gallons per diem for each individual, or say fifty tons per annum, that would give an annual value of 8s. 9d. per individual, so that the sewage from

Vide the report of the General Board of Health, pp. 122 and 123.

Great practical economy of waste of water omitted.

a population of 4,000,0000 would, at that rate, be worth £1,750,000 per annum." But if the water-waste of the Metropolis be reduced by one-half, or to fifteen gallons per diem, the value of the manure would be proportionately augmented.

His lordship and his colleagues have been led further into error by a correct course of reasoning on partial data, for they take human excreta as the chief sewage matter of towns, whereas the River Pollution Commissioners had shown that between the sewage of a town which was "non-watercloseted," and one that was "watercloseted," there was only a difference of one-fifth ; and sanitary engineers find that in tanks appropriated to the reception of kitchen slops is to be found higher putrefactive decomposition after stagnation than in tanks for the reception of the contents of waterclosets. And hence, where drains must be provided for the removal of all the kitchen slops, the general economy (in lower-class houses) of joining on to them the drains from the waterclosets.

Large error as to the bulk of sewage.

From one end to the other of the report there is, however, only one condition of sewage recognised—"putrid sewage," the product of stagnation, and the residue of decomposition. It denotes the present low state of sanitary information, that none of the papers read at the Healtheries by chemists and professed sanitary engineers, except that communicated by Mr. Rogers Field, recognised any other condition than that of putrid sewage, which, when discharged into rivers, kills fish ; whilst there is the condition of fresh sewage, the result of proper work, which feeds fish. They might, moreover, have been informed that fresh sewage, from self-cleansing house-drains and self-cleansing sewers, is of at least one-third higher productive power than when in a state of decomposition. A sewage farmer took from a Corporation the sewage of a town on the presumption that the whole town was drained, as part of it then was, with self-cleansing drains. But he justly complained of the admixture of putrid sewage from the ill-drained portions, and claimed compensation ; and I believe he would have maintained his claim for a depreciation of more than one-third by the incomplete drainage, had he gone into Court. I was interested in the results of an effort made for a sewage farm at the camp at Aldershot, the sand there being so dense that it appeared to be like an effort to irrigate paving stones. On going to the farm, I at once pronounced that the camp was ill-drained. Had I seen the plan of drainage, I

was asked? No, but I knew that it was ill-drained from the smell of putridity at the outfall. The farmer at once affirmed as much, and complained that he was perplexed and damaged by the flushes of stagnant and putrid sewage instead of fresh sewage, a damage which justified his claim to an allowance on its account from the War Office, which I believe him to have applied for and obtained.

Fundamental principle of liquefied manure or sewage culture.

I beg to state that my view on this subject (of sewage application) has been based on the dictum and practical experiences of the greatest vegetable physiologist of the century, De Candolle, who declared it as an axiom that the future of agriculture would depend on giving food and water to plants at the same time. Mr. Smith, of Deanston, the author of thorough drainage, and one of the greatest practical agriculturists of our time, who acted as one of our Assistant Commissioners, declared to me that the waste of the farmyard manures in Scotland by putrefaction was equal to another rental.

Escape of the finest materials of production as pestilential effluvia.

Right hon. gentlemen serving at the Local Government Board, who have been driven to restrict their attendance there, and do as much as they can at home, from experience of the foul sewer gases pervading the offices of that department, such as it is, of the Local Government Board; and also members of Parliament—who have been assailed by the foul smells which they have experienced near the seat of legislation, which are proved on examination to come from the stagnant deposit in the large sewers—may be informed that what they experience is the escape of the finest materials of production, to the extent of millions of tons of guano lost to agriculture, with an increase of heavy sickness and death to the population. If Lord Bramwell and his colleagues had been aware of the difference between the products of stagnation and those of circulation, they would, I expect, have seen that the most immediate means for purifying the river were by works for the purification of the sewage flowing into it, which would be earlier available than the distant works of intermittent filtration that they have proposed, and are more pressingly due to the relief of the population. Of their relative economy I shall speak hereafter.

Erroneous citation of this. Craigentilly meadows as typical of the separate system.

I must, however, beg to point out some further errors into which his lordship and his colleagues have been led.

The case of Craigenteny meadows at Edinburgh is presented as the leading case on which the "separate system" rests. It was never so used by me. In the first place

it was on the old method of distribution by submersion over levelled planes. In our minutes of information it was objected that irrigations by this method with plain water were creative of marsh surface, and productive of rot in sheep, and of ague and rheumatism in men. In the case of the Craigenteny methods these consequences are avoided by the general circulation of the sewage, and a very constant sweeping breeze from the sea. But we objected to the plan on account of the enormous quantity of sewage used and wasted, sixty inches in the year, to do that which, by other methods, might be better accomplished by one-fifth of that quantity properly applied. In consequence of the enormous quantity of the dilution, it appeared that the value of the manure distributed in those meadows was only a halfpenny a ton. The sewage there is worked by gravitation alone ; and then it is asked how can it be supposed that it will pay to lift and move the enormous quantity of the sewage of the Metropolis at a halfpenny a ton, and will it pay at that price ? Certainly not ; but it would not be necessary to lift one-sixth of the quantity, and the value of the manure to be lifted would, by avoiding the waste, be some eight times greater than is assumed by the objectors.

Cost of outside distribution of fouled water ; the reflex of the cost of the distribution of pure water

I took it, as it may generally be taken, that the cost of removal, and of the external distribution of fouled water to every part of a field, need not exceed the cost of the removal and external distribution of pure water into the highest common varying heights of the field of distribution in a town and urban area like the Metropolis. But I have found even engineers of water companies unaware of what that cost is. In London, the cost per diem of bringing water from some fifteen miles of distance, of filtering it, and all other expenses, is three-fourths of a farthing for thirty or thirty-two gallons ; and one-third of that fourth is reducible by the consolidation of the Companies, of which the Commission has taken no account. At the time of my service I ascertained that the working cost for raising 87,000 gallons 100 feet high was a shilling. Since then, by the progress of improvement, I learn from the Messrs. Quick that they are proposing to supply Amsterdam by steam power, which, with not very large engines, raises 150,000 gallons 100 feet high for a shilling. Lifting liquefied manure to heights may be effected at a cheaper rate on a large

scale than could be accomplished if the manure were raised in a solid form.

The report treats of the application of liquefied manure by a process of "irrigation as by the application of ordinary agricultural knowledge," by which it is admitted it "was sometimes very effective," but it appears to be assumed that "only agricultural knowledge is available to the purpose."

Error as to ordinary agricultural knowledge being applicable to successful sewage farming.

Now the "ordinary agricultural" knowledge is really inapplicable, and is the source of the failures in sewage farming which it is assumed does not generally pay. But "the ordinary agricultural knowledge" is founded on the practice of dressings with solid manure, once, or even twice a year. The most successful practice with liquefied manure is not "ordinary agricultural practice," but horticultural practice, the practice of special plant feeders by dressings, according to the growth of the plant, often given even twice a week. A farmer, a first-rate practical proficient in the ordinary agriculture of Scotland, told me that it took him more than a year to understand the working of a liquefied manure farm; and then he found that the produce was so great as to be beyond the capacity of his sheds to store it, or of any stock he had got to consume it; besides the liquefied process quickened production in mangolds, or in other roots, to unwonted bulks, at a time when there was no market for them, and hence much loss. It is only after much practice that the inconveniences of an immense but untimely production are obviated, and they are only to be expected to be obviated, not by "ordinary agricultural practice," but on a large scale, by very special horticultural skill, when such transformations of produce will be effected as horticultural practice has effected in the plants of luxury. Our best guides in sewage or liquefied manure farmers were experienced plant feeders —horticulturists of whom Sir Joseph Paxton was the most distinguished.

In such hands, by horticultural feeding, the carrot has been made a new plant, with finer saccharine matter and a new aroma. The celery is most excellent. The rhubarb is made to exceed itself; it has been used for champagne, and it might be made a "Temperance champagne," such as that which satisfies Dr. Richardson. I have had good specimens of still hock from it. At Reading ninety tons of mangolds have been obtained to the acre. At Dantzic such gigantic cabbages have

been produced as have never before been seen in Germany. At Paris I prevailed upon the late Emperor to order some trial works to be made with sewage manure, when the first produce, though the sewage was not of the best sort, was an enormous amount of grass. An Academician pronounced it to be gross, and unfit for the food of cattle. I appealed from the judgment of the Academician to the judgment of a cow on the point. A cow was selected, and sewaged and unsewaged grass was placed before it for its choice. It preferred the sewaged grass with avidity, and it yielded its final judgment in superior milk and butter of increased quantity. It is with such raw material of production that the superior Legislature has allowed the vestral local authorities of the Metropolis to pollute the river; and it now seeks to throw into the sea the milk of some two hundred and fifty thousand cows, or about one cow's supply for every two houses! for such results have been obtained.

I may cite an instance of which I have recently been informed of the application of the sewage of an educational institution (that of the district school of Sutton, Surrey, comprising nearly two thousand inhabitants) to fifteen acres of land, delivered fresh, and without the smell of putridity, which yields a net profit of £400 per annum, or nearly £20 per acre. With laboriously collected expositions of principles so full and so clear, and with such varied practical instances of their application, as will be found in the information we circulated in 1852, it is impossible not to express regret at the almost retrogade state in which the administration appears to stagnate. By this time almost every large institution of the kind throughout the country has presented an example and served as a school of advanced agriculture. It is illustrative of the relaxed state of administrative arrangements that this last cited example of economy has gone on for years, without attention or instructional pressure for its general adoption; and that at the very next similar institution, the sewage which might have served on a farm as valuable for the instruction of the boys in advanced agriculture, is thrown away to the pollution of the next stream. I am informed of greater examples of intelligent administration presented at some of the county lunatic asylums

* *Vide* statement of the duties of a central authority, page 78 of a paper I have recently published setting forth the principles of a new centralisation for the people (Longmans & Co.)

which illustrate the ignorant and weak assertions of engineers, who are not agriculturists, whose declaration is that the highest order of agricultural production, obtained at the lowest working expenses "does not pay"—as it certainly is not likely to do in their hands, or in other than of a high order of specialists. I have received from the Health Department of the United States, at Washington, the following example worked out by Mr. Benezette Williams, an engineer there, of the application of the separate system to a new town called Pulman, of 8,000 population, at a short distance from Chicago. The sewage is discharged fresh from the houses and conveyed by engine power through a pipe three miles long to a sewage farm, where, as it is received, no noxious odours can be detected from it, and it is at once taken up by the soil and the growing vegetation before any decomposition can commence. "The farm produced during the last season 200,000 heads of cabbages, 18,000 bunches of celery, besides 100 tons of hay and a great deal of other sorts of farm produce. It has a dairy department stocked with fine Holstein cattle, and has paid an excellent return upon the investment." The marked effect of the purification of the houses and the streets by the separate system is the reduction of the death rate to little more than 7 per 1,000; or little more than one quarter of the death rates of the American cities. The community, it is to be observed, is very largely a temperance community, but I venture to state, that, if to the purification of the houses and the streets, could be added the purification of the persons by habitual hand to foot washing with tepid water, of the workpeople as well as the children, which, by Mr. Doulton's apparatus, may be effected at a cost of a tenth of a penny each bath, and in five minutes of time, with an addition of one-fifth to the power of ordinary food rations, the general death rate would be reduced by at least another fourth; or to what it is brought to, with children of a low physical type of our district schools of three in a thousand; or to what it is brought down to with the population of a low physical type in prisons: that is to say, from diseases of spontaneous origin within those institutions. Altogether, the working of sanitation under the separate system in the Pulman city may be commended to close attention, and the widest promulgation in the way of example. I am informed that an important example of a separate system is in progress for Baltimore.

The Pullman case.

I have hitherto dwelt on the chief omissions, as they appear to me, in the report of Lord Bramwell and his colleagues. I now proceed to offer observations on the leading points of their text.

"We have," they state, "pointed out that one of the difficulties attendant on the treatment and disposal of town sewage, is the excessive and irregular dilution with water."

"In the ordinary plan of drainage, the sewers have to carry away both the sewage and the rainfall. This followed, naturally, from the manner in which the drainage system arose." That was, I venture to say, carelessly and without system. "The sewers already existed with the object of draining away the refuse water, and when the house refuse was submitted to them, it was thought that the dilution would be an advantage, as tending to flush the noxious matters well away, and keep the sewers clean."

The terms of this passage present the continued recognition of the false idea that town sewage is essentially "noxious." Before stagnation and putrid decomposition it is not noxious.

When the channels for removal, whether house drains or sewers, are properly formed, they are self-cleansing, and the removal is effected before detention and stagnant decomposition takes place. But it is to be borne in mind that stagnant detention requiring constant systematic flushing is erroneous. The provision for flushing is only needed under a correct system, to guard against occasional accidents.

"But it was soon seen," the Commissioners proceed to say, "that this would lead to a difficulty affecting the disposal of sewage, and as early as 1854, before the systematic drainage of London was undertaken, a proposal was made to adopt what was called the 'separate system,' providing independent channels for the sewage and the rainfall respectively, to facilitate the separate removal of each according to the aphorism, 'the rainfall to the river, the sewage to the soil.'"

This statement, I venture to say, presents a very imperfect knowledge of the subject, as it would lead to the supposition that the separate system was only propounded in 1854, and propounded then for the first time, as a new project; whereas the address of Lord Morpeth, as to the sewage of Westminster, delivered in April 1848, was based on antecedent experiences of the separate systems in a number of towns—then

some ten in number, which experiences, thus obtained, served as ground for general instructions as to the working of the separate system, and the results were set forth in elaborated minutes of information on the drainage of the houses of the Metropolis and towns, on the application of sewage to agricultural productions, and on the drainage of land, which were issued in 1852, and are now out of print and sought for at high prices. Supplementary as to the water supply of the Metropolis in 1850, Lord Bramwell and his colleagues thus proceed :—

"But to do this the application of the separate system would have required the remodelling of the whole of the house drainage, a work which, on account of its enormous expense, could not be thought of." I am unaware of any report made of the examination of such expense, or of its being then thought of ; because if it had been then, it would have been found that it would be a means then, as it must be now, of the reduction of the enormous expenses of a low sanitary condition. From an examination I got made of the expenses of the lost labour of the wage classes from excessive sickness and premature mortality, made from the Registrar-General's return for the Metropolis in 1841, it appeared that these expenses could not be less than two millions with its then population; since which time it has increased from 250,000 to 520,000 houses. In illustration of the way of speaking on the subject, it may be mentioned that since that time, and under pressure attributed to me, there has been an enormous expenditure on the introduction of water closets in substitution of cesspits. The average expense of cleansing the cesspits was £1 per house ; but the proper expense of its substitute was only 5s. per house, and the proper working expenses only 6d. per annum on a public footing. The proper expenditure for water carriage was altogether a great economy of three-fourths of the previous expenditure. The expenses of sickness and loss of work to the present increased population of the Metropolis cannot be less than between three and four millions annually. The expenditure for the separate system is taken by the Commissioners at twenty pounds per house, or at ten millions. I believe that although there has been some increase of expenditure in the house fittings, as self-cleansing taps, that estimate will nevertheless be found to be largely exaggerated, but it would amount to an expenditure of a quarter of a

million annually for an effective reduction of a money account for preventible sickness and premature mortality which Sir J. Paget estimated for the United Kingdom at twenty millions, but which I estimate at twenty-five millions, or for the Metropolis at between three and four millions annually. The cost of the combined system, which they have condemned as a failure, has been six millions, and four more is stated to be requisite to carry the sewage farther to the sea, to prevent further nuisance ; the houses of the Metropolis, which the separate system would have relieved at that cost, being left unpurified.

The Commissioners' report goes on in these terms. "Moreover, the necessity of separation was not generally believed in, and there were doubts and difficulties as to whether there would be sufficient fall in the sewers to secure the passage of the sewage if they were not flushed by rainwater ; indeed, it is manifest, from what happens in some sewers when large accumulations of sewage are washed out by heavy rain, that the fall in those sewers is not sufficient, and that they would be choked without this flushing."

This may be taken as perfectly true. But if our report on the Metropolitan Sanitary Commission and our report on the supply of water to the Metropolis be examined, it will be found that on the converging system, which we took from the low-lying fen districts of Lincolnshire, no natural falls are wanted ; that any falls that are needed are anywhere obtained almost from any depth to any adjacent height. At the several sumps to which the sewage converged, provision was made for receiving the surface filth, or the sewage of the streets, and saving a large quantity of manure until the rain water ran clear, or the tail of the storm, when the water would have been discharged into the river. At this time all the sumps would be worked from one centre by the telephone.

As to the subsoil drainage of the Metropolis and its sites, extending over the contiguous marshes, the expense of the fen districts, and the converging system, was consulted, when it was found that the average expense did not exceed 2s. 6d. per acre, all expenses included. Calculating, however, we said that the expense of pumping the soil water or waste pipe water, in addition to the rain fall, would occasion a cost twelve times greater than is incurred in agricultural fen districts, or 30s. per acre, covered with houses,

per annum ; and as there are in the Metropolis about twenty houses to each acre, and as the operation would extend to about half the Metropolitan area, the annual expense spread over the whole area would be 9d. per house per annum." (Report of the General Board of Health, 1850, p. 280.) The effect of this work would be as if the site of the house were raised above the level of the site at high water some fifteen or twenty feet, effecting a large economy of furniture, as well as of health, from the reduction of damp, and invasion in the lower districts from excrement sodden sites ; and further, from the application prepared for the drainage on the separate system of the Eastern Marshes, the Metropolis would have been relieved from a large proportion of the fogs and the malaria that afflict the population at times from thence.

This forcibly corroborates what I have often stated, that the owners of immediately contiguous land have not always the monopoly of position they suppose for the exaction of extraordinary rents owing to the presumed necessities of the public. On the question whether sewage farming pays, it is unfair to interrogate the farmers, who commonly feel that they are not obliged to answer questions which no one has a right to put. This is felt by the corn factors of Mark-lane, who send out agents to estimate the quantities on view, which they do in practice very accurately, and bring back returns of average yields of 32 bushels per acre, whilst the official returns do not give more than 26. The question has commonly to be resolved on view. How, with the lowest cost of distribution, (*i.e.*, a half-penny or a penny per ton of fresh liquid manure) lower than any possible cost of the distribution of solid manure, and, with extraordinary crops, four and five-fold those got by solid manure, can it be held that sewage farming is not a paying occupation when the farm is fairly equipped ? Letting of cuttings at twenty-two, twenty-four, and even forty pounds per acre, help to elucidate the question. I have, indeed, received, confidentially, admissions, corroborative of the conclusions obtained on a view. Beside extortionate rents, often three or four-fold, there has commonly been extravagant works that are not taken into account, in the ques ion whether sewage farming pays. At the outset of the system, I particularly advised that trial works should be carefully made with the water cart, or with sewage distributed by hand, on plots of the land intended to be used, in

order to test its receptivity, and the extent of machinery required. I do not remember an instance where attention was paid to this advice, and, as a consequence, great waste of machinery was occasioned. I gave it particularly as respects Rugby, and there it was found that the sewage might have been utilised on less than one-third of the area for which distributory machinery was provided, and consequently there was a waste of two-thirds more than was necessary, besides the extra expense of working it on an area two-thirds greater than was required. On almost all sewage farms there has been the like error as to the extent of the receptivity of the soil. Moreover, the works have been laid out expensively, by engineers not conversant with agricultural economy,—all of which goes to the evil reputation of sewage farming, as not paying.

Added to the losses from gross ignorance as to the specialities of the works for the cost of which there has been inadequate protection provided to the ratepayers, there is commonly gross ignorance on the part of the local vestral authority as to the specialities of liquefied manure farming. This is displayed in placing in a charge which requires very high special ability, men at the wages of common mechanics; ignorant men, who would not be intrusted with a common agricultural farm, for dealing with it. Nevertheless, in 1878, Mr. Peregrine Birch gave an account, which he had up to that time collected, of fifty instances of profitable sewage utilisation, stating that there were, indeed, at that time, upwards of one hundred owners and occupiers of land in Great Britain who were using sewage, and that farmers had in some cases bid largely increased rents for its use in their rudimentary methods, and were getting very eager for it. Sir Robert Rawlinson and Mr. Clare Sewell Read reported that sewage farming was, under fair conditions, a profitable investment; and one inquiry, made at the instance of the Royal Agricultural Society, showed that the health of the people living on the sewage farms was above the average. I expect to receive some more recent information on this topic. In the several chief examples of the more successful management of sewage application, these results will, I expect, be found to be attained, that, whilst the yield by the ordinary culture is as one, market-garden culture is as three and a half; but the liquid manure culture is as five or more. It

Comparative results of proper liquefied manure culture.

is to be recommended that a complete examination should be made of the conditions which the Commissioners have been led to overlook, such as those of the difference between fresh and putrid sewage, and the internal conditions of the great preventible water waste, and consequent excessive dilution of sewage in the centre of the Metropolis; and also the excessive charges for land and work—overlooked conditions which have led them to prefer the plan of intermittent filtration, with its reduced area of production by two-thirds to one for the utilisation of the sewage; that is to say, from the lamentably gross ignorance prevalent amongst those who undertook to deal with the subject as to the extent of the evils to be prevented, and their disregard of the measures prepared for their prevention and reduction. I cannot but regret that through excessive preoccupation his lordship should apparently be unaware of the enormous expense of insanitary conditions, or of the power of sanitation to remove them ;—that he should be apparently unaware of such evidence of sanitary power as the complete extraction by it of the gaol fever, which once killed judges, and that sanitation has now made prisons, as was declared by Sir R. Christison, then Chief Medical Inspector, "the healthiest places in the world."

At the outset of our early sanitary inquiries, the only conditions of sewage met with were those of putridity. I was led to collect scattered instances of distribution by permeable subsoil drains. But examples of the surface distribution of fresh sewage appeared to remove satisfactorily the objections attaching to the surface distribution of putrid sewage, and to be comparatively so cheap that I gave up my research as to the subsoil distribution. In the application of fresh sewage to the land by the hose and jet, it is mischievous waste to apply more than will meet the immediate receptivity of the feeding ground of the plant, as, owing to supersaturation, it must then escape into the subsoil land drains and discolour them. Any smell lasting more than a few minutes, or any stagnation on the surface, denotes unskilful management and waste. Nevertheless, a French horticulturist, M. Charpentier, has developed the method of subsoil distribution satisfactorily, and, as appears to me, demonstrated its practicability for application under given circumstances, as for parks and gardens in towns, at a cost for

Examples of available subsoil irrigations.

the apparatus of £16 per acre. Since then an American engineer has demonstrated the practicability of a method of subsoil irrigation for trees at an expense of only £6 per acre. On examination, I expect it would be found that these methods would have the advantage over the common methods of distribution by intermittent filtration, which is set down at an average cost of £70 per acre, with an inferior production.

In some twenty-four towns and places where the adoption of the measures of our Board that were prepared for London was effected, the self-cleansing house drains and the self-cleansing sewers on the separate system, as at Dover, Croydon, and in a number of others, the death rates, which had been upwards of twenty-eight per 1,000, were reduced to fourteen, fifteen, and sixteen per 1,000 : leaving much yet to do in the reduction of the deaths from overcrowding, and of excessive infantile mortality in the school stages of life. The general expenses of these works were three-pence-halfpenny per house per week, inclusive of a constant water supply, by which the insurance charges against sickness of about eighteenpence per week, for an average family of the wage classes, were reducible by more than two-thirds.

As to the expenses of part of the preventive works, viz. the self-cleansing sewers, Sir Robert Rawlinson stated at the Social Science Congress, held at Liverpool, that "supposing that a sewer did not exist in the Metropolis, then according to the cost of the public sewers in other places named in the table herein appended, the money required to sewer the whole of the Metropolis, to include outlets, should not exceed £1,396,333 6*s.* 4*d.*, that is, for instance, £3 18*s.* 8*d.* each, that being the average for the nine towns named in this table" ; that is to say, involving a distributed charge within a penny per house per week for a self-cleansing sewer, retaining no deposit, and needing no flushing except for the case of accidents. Under the Consolidated Metropolitan Commission of Sewers, several blocks of houses, of the large classes chiefly, were drained completely, including the necessary closet plans and traps. On these experiences estimates were got out of the chief classes of houses to be dealt with. Of the first of these classes, the middle-class house, the expense spread over thirty years was 6*s.* 9*d.* per annum, or less than 3*d.* per week. Of the greater number of houses, those of the large

The enormous expense of premature mortality and preventive disease and preventive mortality overlooked.

classes, the rate would be about one-half that. The price of labour has advanced since that time, but it is presumed that, under unity of administration and contracts on a large scale, the average cost of the house drainage would not now exceed 5*s.* per house per annum, or 1½*d.* per week. It will be seen from the return annexed that the estimated annual charge for the sewage of Westminster is about 5*s.* per annum. In work on the large scale of the Metropolis, it is probable that machinery may be much used for the earth-work. On the whole, the charges of the separate system of sewers, as well as of the house drainage works, would be met by an average charge of £10 per house, or 10*s.* per annum ;—that is to say, about one-half the charge for the great majority of the houses—that the Commissioners have been led to assume. The estimate of the Board of Works for carrying the sewage of the Metropolis further, to be rid of the river pollution and throwing it into the sea (including the sustenance of two hundred thousand cows), is stated to be four millions, in addition to the six millions already spent on the combined system ;—that is to say, an addition of expense that would, on the separate system, have sufficed for the purification, by self-cleansing drains, of every house, and by self-cleansing sewers, of every street in the Metropolis. But this estimate of four millions is from the authority which, having estimated three millions for the purification of the river alone, have spent six, with the result of producing a condition which Lord Bramwell and his colleagues justly pronounce to be a "disgrace to the Metropolis and to civilisation."

Responsibilities for *mala praxis.*

If the like misfeasance and malfeasance had occurred to a private individual, it may be asked how long further work would be continued in the same hands, and what would have been the legal remedy to him, as for *mala praxis?* And his lordship may be asked to consider of the securities to be provided by measures for the administration against wastefulness or ignorance of the funds of the Metropolis.

Of the measures of amendment needed, measures for the protection of the labour of legislative preparation and of successful administration may be specially recommended ; and measures of redress for libels injurious to the public as well as to the individual officer and to his proper public position.

The report of Lord Bramwell and his colleagues

gives a very imperfect account of the progress of the drainage of London, on which it states that one of the difficulties attendant on the treatment and disposal of town sewage is the excessive and irregular distribution of water. But this, they say, would lead to a difficulty affecting the disposal of the sewage; and as early as 1854, before the systematic drainage of London was undertaken, a proposal was made to adopt what was called the "separate system,"—providing independent channels for the sewage and the rainfall respectively, to facilitate the separate disposal of each according to the aphorism, "the rainfall to the river, the sewage to the soil." But they aver that to do this effectively would have required the remodelling of the whole of the house drainage, which, from its enormous expense, could not be thought of. Moreover, the necessity of separation was not generally believed in.

The separate system a means to large owners.

His lordship and his colleagues emphasise their conviction as to the importance of retrieving the evil done; and they state that, "Looking, however, to the fact that sewage does contain elements of value, and that the aggregate value of the metropolitan sewage is undoubtedly very large, we think the possibility of realising some of the value should be borne in mind in devising plans for its disposal. And it is clear that our present knowledge points to the application to the land as the most probable mode by which this can be done. But we are strongly of opinion that it would be wrong to delay proceedings on that account, and that the freeing of the Thames from pollution must be undertaken as a work to be done and paid for, whatever the cost may be."

Misplacement of measure of prevention.

I have been surprised at a local authority, instead of being required to purify the houses first, being allowed to proceed for the application of the putrid sewage for a farm near here, which created a furious opposition from adjacent owners and occupiers; an opposition which was successful; and the district was allowed to be saddled with an expense of forty thousand pounds for the contest. An impression, if not created, has been confirmed, by the proceedings for the combined system, that sewage is, and must be, essentially a state of putridity, and a nuisance to be got rid of at any cost. The strong impression created was that suburban property must certainly be depreciated by the contiguity to a sewage farm. This impression may be prevented by

the consideration of the correct conditions of water carriage for the cleansing of towns. In this country, however, in ordinary weathers, decomposition is not developed until after the third day. With properly arranged water carriage, the putrescible matter is at once received and diffused in cold water, which arrests decomposition; and it is removed from the town at the rate of some two miles an hour by self-cleansing drains and sewers. At Croydon, when it was visited by the members of the Sanitary Congress, the surveyor was asked (the town being all water-closeted) in what time the sewage got on the land from the farthest part. The answer was, in two hours, and that, if properly managed, on the field, not in a state of supersaturation, but of immediate chemical combination. If those who entertained repugnance to putrid sewage farming had been taken to see properly conducted, fresh sewage farming, such as we should have ensured, they would have seen that the possible nuisance from it was much less than from the solid manuring of ordinary agriculture, and especially of market-garden farming, which is never objected to. On the separate system, purifying the houses first, we in the Metropolis should certainly have had the whole of the sewage of the morning on the land, in chemical combination with the soil before evening. In Paris, which is on a narrower area, it ought all to be out in half a day; and so in New York and Boston, and in our larger Indian cities. The state of science and of administration may be tested in a town by the nose. Lord Bramwell and his colleagues say that it is a disgrace to civilisation that the river is not purified. It is submitted that it is a greater disgrace to civilisation that the houses and the streets are not yet purified.

This is part of the original declaration of the misleading railway engineers, who undertook the sanitary work, —that the first thing for the improvement of the health of the Metropolis, before attending to the purification of the houses or streets, was the purification of the river. But we found on examination then, as may be found now, that the condition of the river, bad as it was, had really very little appreciable effect on the general health of the Metropolis. For such effect must have been manifest in the increased death rate of the population immediately contiguous to the river, and on the population in the ships on the river. We had, however, the sites of cholera and epidemic attacks

marked on a map, when it was found that the course of large covered sewers or ditches was very much marked by the cases of epidemic attack clustering around those channels. But when we come to the open river, the immediately contiguous houses were remarkable for their exemption. Mr. Rawlinson gave evidence as to the occurrence of similar exemptions of contiguous riverside houses on some river in the north. The comparative exemption of the line of contiguous houses on the Thames which ought, in the engineers' and the Commissioners' imagination, to have been the most severely ravaged, was accounted for by the great sweep of wind and the dilution of any emanations upon it. Had the river been stagnant, another result would doubtless have been found. If, however, the purification of the river were a first object for the Metropolis, the way to do it would surely not be continuing the discharge of putrid sewage into it, and increasing the difficulty of getting it out of it, by the continued mischievous waste of three-fifths of the pipe water pumped into it to waste, at an extra expense of pumping it out again. The course of the defence of the existing conditions of the river, that the accounts of the smells from it are exaggerated, are condemnatory of the course of proceeding with the river as if it were the first object for sanitation.

The river not the chief source of disease.

The Commissioners agree that for the future the separate system is to be preferred, but they do so in terms which display insufficient appreciation of the principle. As to the assumed expense of the sandy land, available in sufficient quantities for its adoption, it is to be admitted that five, and even eight fold rents have been exacted as a tax owing to the necessities of populations, for land, for improved dwellings, and sanitary arrangements. Of ordinary land, as against bare land, two-thirds of rent I hold to be interest on capital, and an improved price is in equity defensible when land is taken for public purposes. But the Property Defence League may well consider whether such "large unearned increments" ought not to be discountenanced as a dangerous weapon in the hands of the owners of landed property against the public interest.

Excessive charges for land for public use.

Lord Bramwell and the Commissioners, by insisting on the immediate prosecution of the minor measure for the sanitation of the Metropolis, have been led, by default of previous information, to start *de novo* on their first erroneous impressions: and by im-

plication to justify the previous erroneous course of delaying for it the larger and more beneficial measure of the drainage of the houses, whilst on a proper plan the whole work might be proceeded with simultaneously.

Extensive applicability of sanitary work as relief work in times of distress.

It is important to observe at this time that, as a rule, two-thirds of sanitary work for towns is earthwork; and it may be pointed out that it is especially available as a beneficial source of relief for existing distress amongst able-bodied labourers, many of whom, it is stated, belong to building trades. I have been heretofore assailed, amongst other things, as advocating the suppression of all outdoor relief. In my report on the reorganisation of the local administration of the relief of the destitute, I distinctly set forth outdoor relief by beneficial public work as a sound and eligible source of relief on extraordinary occasions. On the occurrence of the cotton famine in Lancashire, when (the separate and disunited Union organisation having broken down) a course of labour, by cutting the deep drains for several of the towns, was organised by the chief sanitary engineer for the Central Board, Sir Robert Rawlinson, who provided the labour as a relief for 40,000 men, a million and a half of money was lent to the localities, on the security of the rates, for its execution. He saw to the execution of the work, with the assistance of Mr. Arthur Arnold, the present member for Salford. Only 7,000 of the men took work; many of them cotton spinners, who continued at spade work after the distress had passed. The rest found work elsewhere by the assistance of their friends. The whole of the money has been repaid. The example may be commended for other cities and to foreign Governments,—only, instead of the organised superintendence being confined to the trunk lines, it should comprise the complete apparatus of house drains as well as of main drains or sewers. I would tender the advice to foreign Governments and to local authorities, that they should take no plans of their own, or of their own officers, as they would expose themselves to such errors as have befallen this Metropolis, and that it would be safer to prescribe the *ends*, and invite plans and contracts, for the application of the means; as of plans for the clearance of houses and streets from foul smells, by the complete application of the separate system of water carriage. By this method they would get the

Advice tendered to foreign Governments

work done far better, quicker, and cheaper, by persons who were responsible and practised in them, than they could do such work themselves. The contractor should be required to keep the apparatus in good action for a given period.

To invite competition for the attainment of ends.

Separate plans might be invited for the application of fresh sewage to a given tract of irrigation. But such plans could only be obtained under unity by a superior administration, with the aid of successful specialists on sanitary science, demonstrated by successful work. The principles of the work are simple, but the execution is difficult, and requires very careful and skilled superintendence, which, so far as relates to the irrigation works, they might probably obtain from the officers of their *corps de genie*. In general, civic legislation and local administration may be tested by the nose.

The internal ventilation of the Metropolis has been improved by the widening of streets, and its sanitation by the extensive removal of ill-conditioned populations, and driving them into dwellings in less evil conditions in the suburbs. London has of late been much improved by the active work of sanitary inspectors in the removal of conspicuous and delared nuisances. Nevertheless, had not the preparations for the separate system been set aside by the disastrous and most unsound measure described, it may be found on due examination there will be little room left for doubt that, with the means that have been brought to bear on the work, in about five years the death rate of the Metropolis might have been brought to the level in which it was brought in the chief provincial cities, where the separate system has, by very rudimentary means, reduced it to about fifteen in a thousand. The cost of the separate system, applied generally with very rudimentary means in those towns, at an average weekly cost of $3\frac{1}{2}d.$ per house per week, may be presented with the variations of the cost of labour and of materials since then, as the cost of the application of the separate system to the majority of the houses of the Metropolis for the future, and then contrasted with the immense cost of the preventible sickness and premature mortality which it would remove, of full six deaths for every thousand, and of twenty cases of sickness and of lost labour for each thousand of the population.

The course of prevention, based on trial works under the Consolidated Commission for the Metropolis, was nearly this : We, of the Consolidated Commission

of Sewers, were prepared to begin with the heavily death-rated districts and houses; first, with those districts where the death-rates were as high as thirty in a thousand, as some of them now are; and not with the houses of the well-to-do, as in Tyburnia, and other districts where the death-rates are not more than eleven in a thousand, where there is the least need, and generally the greatest difficulty and expense of preventive work. The sewage, carried through self-cleansing sewers—if it were necessary—pending the preparation of the land, would have been carried there fresh instead of putrid: and this would have largely reduced the pollution of the river. The plans for the purification of the river by the application of the sewage to land have all been in neglect of the drainage of the houses; and, on the assumption that the sewage would be in the common condition of putridity, have left out all consideration of the houses, and of stagnation and putridity there, and have hence excited violent and successful opposition. Had the alteration of the common conditions of putridity been provided for by due attention to the water carriage from the houses, the opponents might have been taken to the places where the sewage is applied direct and fresh, in a state far less offensive than the common applications of solid manures, to which no objection is now made. Our plan, on a consideration of the condition of the Metropolis, was not to carry the whole of the sewage in one direction, but radiating out in several chief directions. After a study by the German engineers, as pointed out by M. Mille, the engineer-in-chief of Paris, the principle of that plan has been adopted for Berlin, and is in course of execution, as far as relates to the plan of conveying to sumps great radiating gutters for that metropolis, but with some errors of the adoption of a part of the combined system, and consequently as yet without the reduction of the death-rate due to a correct principle. A plan for conveying the sewage of Westminster to a sump was got out under the Consolidated Sewers Commission, with the view to its being pumped in the direction of the market gardens at Putney, and onwards to the direction of Ounslow. One of the largest market gardeners of the Metropolis, occupying between three and four hundred acres of market garden at Isleworth, not knowing what was in preparation, had written a paper to the Government, recommending the general application of the principle of which he had made trial and found it, as he declared,

Course prepared for the application of the separate system.

Radiating plan prepared

inferior to the market-garden culture. We had, however, special trial works contemplated for a basis of our operations on the subject. Plans were got out for the entire house and street drainage of Westminster for conveyance to the sump.

Estimated cost of the separate system.

I append extracts from a charge to a jury of the Consolidated Commission of Sewers by Lord Morpeth, the chairman of that Commission, which is illustrative of the increase of administrative force obtained with economy under unity for the whole of the Metropolis. Though the prices of all the works may have varied since that time by the increased cost of labour, yet the relative economies of the system would remain. The plan of dealing with the river first (and the house not at all) by the combined system for the conveyance of rain and storm in the same channels, moved mainly by the positive authority of the eminent railway engineers who led Lord Palmerston to believe that the cutting of a canal across the Isthmus of Suez was impracticable. The preparations made under unity for the whole of the Metropolis were frustrated by the adoption (as to the branches) of disunity under thirty-six vestries. The economies prepared under unity, by trial works, showed, as stated then, that three houses might be drained well at the cost of draining one ill, or at a cost of about five shillings per annum, the same as the annual cost of the self-cleansing sewer. The estimate of the expense of the self-cleansing pipe-sewers for the whole of Westminster and the eighteen miles of street was £18,000. For a mile of street from Victoria Street and Parliament Street to Whitehall, two cheap pipe sewers, or one each side, would have sufficed. It was forewarned that deep turned sewers carried through slippery strata and old buildings to be strutted up would involve extra cost. That mile, carried out in the "natural method," determined upon by engineers, none of whom, so far as I am aware, have ever drained a town, or a street, or a house, has cost upwards of one hundred and fifty thousand pounds, and it is yet a sewer of deposit—an extended cesspool.

Actual cost of the combined system.

At the consolidated commission of sewers we had trial works made which were deemed sufficient and satisfactory to ascertain the results for the distribution of the sewage direct to the land. The distribution of sewage by the jet over growing crops being objectionable, I conceived a method of distribution by flexible

pipes with lateral apertures as movable carriers, which was successful as a means of distribution at the roots of the plants, more evenly and with less of power : but that method has hitherto escaped attention. We had not advanced in getting out complete plans for ulterior distribution, when the unity of administration and the work was set aside, and the functions of the branch distribution were imparted again to the thirty-six vestries, and the distribution by trunk mains to their representatives on the Board of Works. To that Board were presented plans for taking up the sewage at the outfalls, in the condition in which it then was, of putridity (and no other condition was then thought of, or, it may be said, is yet thought of), and distributing at such a distance, forty miles over sands little occupied, not to be a nuisance. One plan proposed by Sir Charles Fox was for the distribution of the sewage over two hundred and fifty thousand acres of sandy land. Another plan, proposed by Colonel Hope, V.C., and Mr. Hemens, and the Hon. Mr. Napier, was for the distribution of the sewage of the northern part of the Metropolis over twenty thousand acres. In answer to the question why it was proposed to carry it so far as forty-four miles, Colonel Hope said, "We consider it very desirable to take the sewage as far from London as possible, in order to prevent the possibility of any nuisance arising from it :" that is to say, on account of its putridity. The estimated cost of the culverts and channels for carrying it that distance was twelve hundred thousand pounds, or fifty thousand pounds a mile.

Exclusive regard to conditions of putridity.

The plan we had prepared on the separate system implies the distribution of *fresh* sewage, which, as to offensiveness, is much less than the practice of common agriculture, with top dressings of solid manure, and that may well be distributed in immediate contiguity to habitations. It was proposed to radiate outwards in short lengths, at greatly reduced expense, on the plan which has, on the study of German engineers, been adopted, and, as stated, is in course of execution for the relief of Berlin on the principle we had prepared of conveying the sewage to sumps, from whence it would be ejected, by engine power, by steam power, and would have been, and would yet be, at about one-half the expense of the combined systems which the plans to which Lord Bramwell and his colleagues yet appear to tend as of final necessity.

Of the plans of which I have myself initiated the

principles, I expect that there have been wide variations in the details of their applications. I would now propose to have them examined, by competent and independent authority, for local information. An examination of that kind, where separate systems are at work, would have greatly facilitated the objects of Lord Bramwell and his colleagues. It has been assumed, as a common factor, that an acre will be required to utilise the sewage of every hundred of population, and that fifty thousand acres will be required for the reception of the sewage of the Metropolis. I expect that on the consultation of experiences on the separate system, the receptivity of soils for the purpose will be found to be much greater than has been supposed, and that a smaller area, less perhaps by one-third, would suffice for the Metropolis. Besides farms of an extraordinary productive power, the fresh liquefied manure principle of culture would serve for the institution of parks and pleasure grounds in advance of any that horticulture has yet attained.

An examination of the local experiences by a competent officer, with the instructions, "Look at what has been expended; estimate what ought to have been expended, or what now would be expended; then consider the yields obtained, and the working expenses, and what ought to be the pecuniary yield," would have relieved Lord Bramwell from the erroneous conclusion which he has enunciated—that sewage farming will not pay. Of one sewage farm—which has passed as one of those that does not pay, and might well do so, as it is on a close, hard, and impermeable sand, which presents the promise like irrigating paving stones, that had all to be broken up and disintegrated at great expense, and with some buildings that might have served for a farm ten times larger—I obtained the private accounts; that involved a charge of £3 5*s*. per acre; working expenses, £10 an acre, or total charges, £13 5*s*. per acre;—the total yield from the farm produce, sold at very low wholesale prices, averaged £20 per acre, to which is to be added the keep of a number of cows, probably of one-fourth more, even with very inferior sewage; but which, with fresh sewage and under improved conditions, would be largely augmented. As I have stated, Sir Robert Rawlinson and Mr. Clare Sewell Read have, after a special examination, reported that sewage farming does pay, but state the conclusion in qualified terms, in which sewage farmers do not agree.

It will appear that whether the sewage is to be thrown into the sea to feed fish, or to be thrown on the land to feed plants, it is of first-rate importance that it should be obtained before and delivered fresh, or before the waste by composition has commenced ; but how is it to be obtained fresh but by the purification of the houses on the separate system, as we recommended ? This is a particular point wholly overlooked by Lord Bramwell and the Commissioners, and by the Select Committee of the House of Commons, which examined the subject in 1864.

It is true they advert to the separate system, but they say that is not to be thought of on account of its expense, and they accept as the account of the expense the statement, entirely exaggerated, of those to whom the condition is due, and entirely overlook the enormously greater expense of sickness and death which, as I have shown, is entailed by the combined system. They say that the condition of the river is a disgrace to the Metropolis and to civilisation. But they appear to be for leaving it to be removed by those by whom that condition has been produced and continued, and despite the condemnation of the Select Committee of 1864, by whom it was declared that "the practice of throwing the sewage into the river was productive of much evil, and it is imperatively necessary that such practice should be discontinued."

It will appear clearly now, notwithstanding the highly offensive condition of the river produced by the combined system, that it is altogether a minor evil compared with the low sanitary condition of the houses of the wage classes, which constitute the greater evil and the real disgrace to civilisation.

The report, however, concludes to the removal of that really lesser evil "at whatsoever cost," during which time the greater evil, the preventible disease and death, will have to go on, really unheeded. It has gone on despite innovations of practical officers, of which the following is an example, given by one of them in a pamphlet published eight years ago.

Continued disregard of condemnation ten years ago.

Whilst the system of works, notwithstanding condemnation by the Select Committee, were prosecuted and regarded as complete by engineers of high position who had never drained a house or street, and were really, so far as appeared, destitute of any knowledge of sanitary principle ; by officers practically concerned in house and town drainage work, the system was regarded ten years ago very much as expressed by Mr. Edward

Monson, C.E., Surveyor to the Acton Local Board, London, in a pamphlet he published in 1875 on the prevention of the present nuisance from the sewage and silting up of the Thames. Condemnation of the combined system.

"The metropolitan system," said he, "of main drainage is a big thing—quite American in its way; with big pumps and engines, and a big lot of sewage, which, when discharged into the Thames, is a big nuisance. And the idea of concentrating all the sewage at one point is a big blunder; and the flooding of the low-lying district during a storm is a big blot which might have been avoided. In short, combined drainage means: payment for unnecessary engine power, unnecessary storage room, unnecessary cost for sewers, unnecessary cost for works, and unnecessary cost for labour. But when all this is done, and, notwithstanding all the extra cost and trouble, the works are not so efficient as those of the separate system. And the storm-water being admitted, the sewage is very irregular in quantity, being greatest when it is least wanted for irrigation, and when it is most difficult to dispose of.

"Taking the country through, hundreds of thousands of pounds have been spent in the first cost of works for the combined system of drainage; but, notwithstanding this—looking at the cost and difficulty of treating and disposing of enormous volumes of sewage which has no commercial value; looking at the pollution of streams and also at the scarcity of water which has been so severely felt, and looking at all the facts of the case—the author concludes that—as in the 'Railway Battle of the Gauges,' notwithstanding the original outlay, and notwithstanding the cost of the alteration, the broad has been altered to the narrow gauge—so, in the matter of sewage, sanitary authorities, who have got a combined system, will be compelled to keep the rainfall free from sewage, and that, subject to various modifications, the separate system of drainage will be universally adopted. And the author predicts that even London, which has spent its thousands upon the combined system, and is spending thousands to maintain it, will even yet be compelled to modify its works and adopt the separate system."

Helpless condition of the Metropolitan population under Vestra Government.

It is illustrative of the deplorable state of the government of the Metropolis, that in utter disregard of the condemnation of the practice by the Select Committee of the House of Commons twenty years ago, and of the

continued expression of such opinions as the one last cited, the immense waste of time and money in a condemned course should have been carried on without notice or interruption, until the appointment of the last Royal Commission and its report, and so with repeated reports of Commission after Commission against the continuance of the present system and of its water supplies.

It might have been expected that some opinion would have been expressed by Lord Bramwell on the administrative conditions under which the evils have occurred; on the wastefulness of ignorance; and on the necessity of securities for the responsible application of science for the protection of the public in future administration.

As to measures of amendment, I may mention that under the Metropolitan Sanitary Commission plans were prepared for the early remedy of one portion of the general evil, the great sewers of deposit which infect the air of the Governmant offices, and for protecting them by proved arrangements for the prevention of stagnation in those sewers, at no greater expense than that incurred by the intermittent cleansing of them by hand labour.

The proposal to apply sewage for the feeding of fish

Sir J. Lawes proposes to throw the sewage into the sea, as a means of augmenting the productiveness of the sea fisheries. To whatsoever extent that were practicable it must, to feed fish, be with fresh sewage, only to be obtained on the separate system. It was an early experience that, in streams where putrid sewage was discharged, the fish disappeared; but on the proper drainage of the houses, and the freedom of the stream from putrid pollution, the fish re-appeared. Where, for want of other provision, fresh sewage has been discharged into streams, extra quantities of fish have certainly appeared at the sewer mouths. It was matter of speculation, had the houses been purified by self-cleansing drains, and the sewage discharged fresh into the river, whilst the farms were in preparation there, what would have been the effect on the river fishery. But nowhere have I seen or heard of any evidence of any effective competition of the productive power of the sea with that of the land. I have been informed that two shillings per acre is the settled rent of a sea fishery near the Irish coast; but fifteen shillings per acre is stated as the average rent of Irish land. Sir J. Lawes

states that he raises about a ton an acre of wheat on his land in the year; but he cites a statement of Professor Huxley, of the case of a ton of fish being raised from the sea in a week. This must be at the expense of many other acres in the sea, or under very exceptional circumstances.

I may observe on Sir J. Lawes' statement of his yield, which is by the application of solid manures, that liquefied manure farms yield a third heavier crops than he obtains. But the case might be worth examining, whether it can be worth while to send it to the sea, as proposed, at double the estimated cost of its direct application to the land.

In the order of measures to be accomplished "at any cost," it will, I expect, appear, upon competent examination, that it will be the relief of the most heavily death-rated classes and districts, originally provided for; and that the original plan of the direct application of the fresh sewage to the land will be found to be far more economical, apparently by one half, than the plan proposed of carrying the outfalls farther.

Putrid sewage injurious to fisheries.

On the omitted point of the quality of the sewage discharge into the rivers, Mr. F. Lamborne Flower, Major Sanitary Engineer of the Lee Conservancy Board, has written to the *Times*, "as having almost daily experience of sewage outfalls for the last fourteen years, and being the only officer in the kingdom in sole charge for sanitary purposes of an entire watershed;" he begs permission to state that, "if sewage is to be utilised as food for fish, it must be delivered in a fresh and not in a decomposed condition, and also be free from chemical refuse or improper chemicals used for sewer treatment. Fish thrive at a sewer outlet; but those taken near a foul drain rapidly become putrid." Even trout, among the most fastidious of fish, may be seen close below the outfall of the Croydon sewage water, after much of it has been irrigating the land.

Before the Select Committee on Sewerage of 1864, Mr. W. Efennell, the Chief Inspector of Fisheries, attended, and represented that if the sewage of towns were *not* allowed to go into the river, the numbers of fish would be greatly augmented, and the revenue improved.

Mr. Oldham Chambers, Secretary to the National Fish Culture Association, writes: "What can be more deplorable than the state of the Thames at the present

day, to say nothing of other rivers, whose exudation of malodorous, pestilential fumes is yearly increasing, and may at some future time be the means of prostrating London with the fatal choleraic disease which has lately devastated Egypt and France? In regard to river fish, the poisonous effluvia emitted has caused their complete extirpation in a large number of instances, their paucity reflecting in an unmistakable manner upon the governmental control of this country!"

Mr. Charles E. Fryer, of the Fisheries Department of the Home Office, writes to express a hope that those responsible for the state of the Thames will not be induced to delay their plans for purifying the river, on the ground that the fisheries will be benefited by its removal. He questions the need of such sustentation for fish, and says, "The fishery of all others that has shown the most marvellous growth is the Scotch herring fishery, which has always been prosecuted far from the influence of sewage discharge, and is every year being carried on more and more successfully at a greater distance from the shore. If sewage or any other artificial stimulant were required to maintain the productiveness of any of our fisheries against possible 'exhaustion,' the herring fisheries would surely have been the first to show signs of the need."

It may be submitted to those interested in the subject of the fisheries to have examinations made as to the effect of different sorts of fresh as well as of other sewage on the culture of fish at the outfalls, but for sanitary purposes the following conclusions may be taken as established:—That putrid sewage is injurious to fish; that to be of benefit, sewage must be delivered at the outfalls fresh; but that it has escaped the notice of the Commissioner that it can only be obtained fresh for that or any other purpose by the drainage of houses as well as streets, by self-cleansing drains and self-draining sewers, on the separate system we proposed.

The distribution of sewage by irrigation may have to be regulated, to avoid interference with gathering grounds for the collection of water supplies, the most eligible of which are commonly in the least productive land. In the study of land drainage, I was led to observe at the outfalls the superior quality of the water delivered by the subsoil drains, and that they constituted superior filters; and I was led to propose this method for the collection of supplies for the Metropolis from the two hundred miles of the Surrey sands, from

whence, and from perennial springs led through the subsoil drains, of soft water from perennial springs, it was estimated that a superior supply of double the then consumption in the Metropolis could be derived. But the mode of collection which Messrs. Quick are now applying with advantage for the collection of water from the sounds of Amsterdam was then treated as wholly insufficient, and not to be relied upon, and plans were prosecuted for bringing supplies from Wales and from the Lake districts, *i.e.*, of collections from the surface washings of peaty surfaces, which are now proved to occasion dyspepsia, and unpotable at some periods from the infusions of peat. But the subsoil method of collection by permeable channels—elongated and most perfect horizontal filters that supersede filter beds or house filters—has lately been begun by the engineers of two of the companies, with eminent success. Mr. L. Harrisson, one of the local inspectors of the Local Government Board, has prepared a paper, in which he proposes collection from chalk strata by this method, on which he descants as saving filter beds and the expenses of filtration ; and he might have added of second domestic filtrations, few of which are or can be really efficacious. The supplies obtainable from the Surrey sands would have saved all the then intakes from the river which, if purified from the house sewage, cannot be purified from what may be called land sewage, the surface washings of cultivated and manured lands, as well as from the surface washings of peaty and common lands. He shows, what I have always stated, that supplies may be obtained from chalk strata that will supersede all the intakes from the river. But it is omitted to be noticed that the water from the Surrey sands would not be of more than four degrees of hardness, and would be of superior softness : whilst the chalk collections would be sixteen degrees of hardness, which, however, may be greatly reduced, as it is now at Canterbury and other places, with brilliant success at little expense. We were well aware, however, that there were other sandy strata at no great distance from the Metropolis, from which soft water supplies were obtainable, but we deemed those from the Surrey sands sufficient at that time. The whole might now be well re-examined. Between one source and the other, or both, the Metropolis, under the guidance of competent sanitary science, may look forward to the finest and most salubrious potable water of any metropolis in the world.

New method of water collection.

It is implied that he proposes to give the hard water supplies for distribution to the separate trading companies, which is to continue the pernicious waste which, as trading companies, they fail to prevent. Except under unity on a public footing, the wasteful expense of pumping in the enormous and mischievous superfluity of water to be afterwards pumped out, must be further continued.

I have set forth at length elsewhere experiences and observations on the evils and heavy burthens to which the inhabitants of the Metropolis are subjected by vestralisation, of which this "big blunder," as Mr. Monson has called it, and the disgrace to civilisation, as Lord Bramwell and his colleagues have pronounced it to be, is really an outcome. I have addressed myself to the main features of their report, the evidence on which it is founded not yet being issued ; and in respect to the report, I submit the following as my main conclusions.

That it may be taken that on due examination, these conclusions will be established :

Conclusions on the report and steps to be taken.

That the condition of the river Thames, pronounced by the Royal Commissioners to be in a condition to be retrieved at any cost, is due to the measure of proceeding on the combined system with the river first—that is to say, of carrying off rain and storm water in the same channels as the sewage proper, has been at an expense of upwards of six millions of money, that would, on the separate system, have sufficed for the purification of the houses and the streets of the greater part of the Metropolis from the products of stagnant decomposition, and would have largely reduced the enormous expenses of excessive sickness, loss of work, and premature mortality.

That further proceeding with the combined system is to continue injurious waste, and to impose aggravated money burthens on the population threefold greater than the burthen of the poors rates.

That the separate system has been carried out in a number of towns, with variations in the executive details, and that it would be of advantage if these variations were closely examined, with a view to the application of the experience of the best results to the relief of the Metropolis.

That whether the sewage be destined to feed vegetation or to feed fish, it must be delivered, not in a condition of putridity, but fresh ; that it must be delivered fresh on the land to augment its power of

agricultural production, and also to avoid the necessity of carrying it to excessive distances, and to avoid the creation of nuisance, and the resistance to the occupation of land as sewage farms on account of the noxious conditions of putridity.

That chemical disinfectants, deodorisers, or intermittent filtrations, are not needed when sewage is discharged fresh, or before the commencement of putrefactive decomposition.

That the sewage can only be obtained fresh by the separate system ; by the self-cleansing house-drains and self-cleansing sewers, as has been done in a number of towns on that system, attended with the reduction of death-rates, and at outlays which reduce largely the expense, of preventible sickness and premature mortality.

That the water pumped into the Metropolis by the trading companies is greatly in excess of the actual domestic consumption, an excess estimated at more than three-fifths pumped into injurious waste, at an extra expense for pumping it out, as well as at the extra expense for pumping it in.

That the effect of this waste is to reduce proportionately the value of the sewage as manure, and to increase the cost of its distribution, and to reduce the possible returns from sewage farming with it.

That the effective reduction of this waste would reduce nearly wholly the intakes of the supplies from sewage tainted river sources ; and to reduce the demands of pure spring sources available in the vicinity to the Metropolis.

But that the trading companies have failed to reduce this waste, and that it can only be effectually reduced, as at Manchester and at Liverpool, when the supplies for the Metropolis are put, as there, under unity of management on a public footing, as recommended by Royal Commissions and Select Committees of Parliament.

That to arrest the course of continued expense, waste, and grievous evil, and to promote efficient means of the improvement of the condition of the population—especially of the wage classes—it is to be urged that the local administration of the Metropolis should be placed with the least delay under complete unity with securities for the application of special science for their protection.

APPENDIX.

EXTRACT from a Charge to a Jury of the Consolidated Commission of Metropolitan Sewers, by LORD MORPETH, Chairman of the Commission, April 6th, 1848 :—

"Since a jury of the men of the country was last convened, the district for part of which you are acting, though still continuing separate in form, is practically consolidated under one set of Commissioners for the whole of the Metropolis, with the exception of one part of the drainage area. The most important point in which the Westminster District now before you must be interested, is that which might be elicited by the question—

"What has this consolidation, carried out by the Government done for us?

"To take as an illustration the last subject under the consideration of the Court of Sewers—namely, the establishment of paid officers"—

"*It has given you a large increase of valuable service, without any increase, probably with much diminution, of expense.*

"For the Westminster District there was formerly one Chief Clerk, Mr. Hertslet, and one Chief Surveyor, Mr. Phillips—able and efficient public officers, who are both retained for your service, whilst they are advanced to a higher sphere of duty, and to more satisfactory because more efficient service. But the improvement of drainage-works demands scientific appliances and various abilities. We have added to the engineering force Mr. Austin as a Consulting Engineer, who has long studied the subject of town improvement; and Mr. Roe, who, as Surveyor to the Holborn and Finsbury Divisions, took the earliest lead in the improvement of this branch of the public works. Adopting the recommendations of the Sanitary Commissioners, we have deemed the improvement of these works so important to the public health, and the proper performance of the service so needful, as to require undivided attention. We have considered that these services could not be properly attended to as incidents to private practice. We have therefore resolved that all the salaried officers throughout the several Commissions shall, in this department at least, give their whole time to the public service, and shall be freed from private practice. We have, moreover, abolished percentages on works executed. We have, moreover, abolished all fees.

"By the consolidation, you have gained the additional services of one Chief Clerk, of a Consulting Engineer, and one Chief Surveyor and two Assistant Surveyors, without any increase of expense to the Westminster District. The establishments and the payments are not yet fixed; but to the whole of the districts in the Metropolis the consolidation has been attended with this undoubted gain of service, with a reduced expense. The reduction in the Surveying staff has already been from upwards of £6,000 per annum for frag-

mentary and imperfect service, to £4,700 for a consolidated and improved establishment. The gain to each of the other districts consolidated will be similar, and each has now available the services of the entire staff, and with a considerable reduction of expense.

"*Secondly you gain by the consolidation in all that efficiency of works which is dependent on systematic operations on a wide basis*; or, in other words, you have had averted the worse than waste which is incurred by operations on a narrow basis, by feeble establishments acting on limited information.

"When we entered upon our duties, the Sewers of the district were, and unfortunately yet are, and with our best efforts are likely too long to continue to be, what your officers have described them to be—extended cesspools. We have had Sewers in the same district running different ways; Sewers made at great expense which accumulate pestilential deposit (90,000 tons or 62,000 cubic yards of which we have had flushed away): all these works incurring waste of money for sewering the district ill, which would more than have sufficed not only to sewer it but to drain the houses well and abolish the pestilential cesspools over which they are built. Much of this waste has arisen from the want of a proper system of survey. The remedy for future works is to obtain a proper survey. This more perfect work, which will govern not only main drainage, but house drainage, the better construction of streets, the better distribution of water, the identification of properties, better valuations, and the more equal collection of rates, increased efficiency or reduced expense of future works, you gain by consolidation.

"One gain by the systematic works is the better adaptation of sewers to the run of water which they are to discharge. That class of works has not yet been completely systematised. Until the Survey which we propose to make is more advanced, we may not expect any new system of works to be completed. We have, however, in particular instances, and in cases of emergency, directed new sewers to be made. We may present as examples the new portions of sewers brought under the consideration of the Court at the last General Court day, viz.:

In Winchester Row, New Road.—An estimate for a 4-inch pipe even from each house, instead of a brick drain, as required under previous practice	£171	8	4
Ditto for drain at back, instead of the new mode just mentioned - - - - -	52	6	3

The second estimate was approved.

In Dean Street, Soho.—1,300 feet to cost £470, including junctions for house-drains, was ordered, for which the estimate in 1843 was £1,412, without such junctions for house-drains.

In Bedfordbury, St. Martin's.—130 feet of sewer is to cost £33; in 1841, 190 feet at the lower end cost £278 5s. 5d.

"You may be aware how much of the suburban drainage consists of open ditches at the bottom of gardens. The following is one instance of this kind where an uncovered ditch of ten or twelve feet wide was complained of as offensive:

Gloucester Street, Shoreditch.—Estimate for 860 feet of pipe-drain in lieu of open ditch, £215; former estimate, £600. Nearly a quarter of an acre of land will be recovered by

filling up the ditch. A space of garden-ground, ten or twelve feet wide, will be gained to each house as a flower-bed, in the place of a stagnant ditch.

"The foregoing cases may be briefly stated as follows:

	Old Plan.	New Plan.
Winchester Row, New Road ...	£171 0 0 ...	£52 0 0
Dean Street, Soho	1,463 0 0 ...	470 0 0
Bedfordbury, St. Martin's ...	200 0 0 ...	33 0 0
Gloucester Street, Shoreditch ...	600 0 0 ...	215 0 0

"We have before us two reports for the future drainage of Westminster, comprehending varied applications of the similar principle. We may present an estimate from one, not because it is determined upon yet, but because it furnishes an exemplification on a larger scale of the economies to which we hope to approach.

"The comparative cost of drainage-works formerly constructed, and of those now proposed on spaces equally covered, would stand thus:—

PER LINEAL MILE.

		Annual Cost of Flushing, Cleansing, and Repairs.	Average rate of Principal and Interest per house, reckoning 320 houses per mile.
Expense of Works as formerly constructed	£5,000	£70	£1 2 2½
		Annual Cost of Pumping and Maintenance.	
Expense of the system at present proposed	£1,000	£25	£0 5 4

the proposed works costing less than one-fourth of the former system.

"In respect to the more temporary operations of cleansing, we may mention that at the contract price for cleansing under the old system, by the offensive mode of hand-labour and cartage, the expense would have been at per load (taking the sum paid by the City of London, and taking an average of the other districts), 7s., or for 62,000 cubic yards £21,700; while the actual cost under the new system, including every expense, has been £4,650.

"In respect to the management of the rates, besides reducing the collections we have not thought it of advantage to give to one great company (the Bank of England) the undivided profits on the balances of the rate-payers' money in our hands; but, having obtained freehold security from another banking company, and they having given, with greatly increased facilities for transacting business, interest at the rate of two per cent. per annum on the current balance, we have thought it right to open an account with them; and with this saving of interest we expect to pay the salary of two additional Assistant Surveyors at the least.

"The gains from consolidation, then, are the increase of the force of the establishment, the increase of the efficiency of the works, and a reduction of the expense.

"Our future progress, we expect, will be in the increase of efficiency. The Surveyors have at present under consideration improvements in house-drainage which we expect will be accompanied by similar reductions in expense concurrent with the improvements.

"Further advances to the completion and perfection of the works and the administrative service must be dependent on the completion of the drainage district, and on the consolidation of other connected works within our present district, under one and the same competent management.

"Had Westminster remained under a management separate from the other districts, effluvia arising from any deposit created by defective cleansing in this district would not only have been diffused in greater quantities than it yet is amidst your habitations, but if the sewers and drains within your own districts were perfectly well cleansed, you would still, on the prevalence of certain winds, be exposed to the miasma carried from the ill-cleansed sewers in other parts of the drainage area.

"Your own position may be shown by contrast; but representations having been made that increased expenses would be consequent upon the consolidation, or what is termed the centralisation, of our local institutions, at this time of real pressure it is important that the truth should be known, and what has been the fact, and that the course of real improvement is one of economy and of reduction of burthens. The sewers' rates have been, and might continue to be as they would be under separate management, worse than wasted. But sickness and disease, and premature disablement, not to speak of premature death, entail heavy pecuniary burthens, and all well-devised works, and carefully-applied expenditure, must be in diminution of some of the most serious burthens, and tend to give health and strength to meet others which may be less preventible. The rates now required will be confidently applied in reduction of those burthens. But an increase of efficiency in their application depends on the completeness of the powers given for the purpose. In respect to works, an estimate has been cited to show that a complete system of main sewerage may be expected for all Westminster at a charge not exceeding five shillings per house per annum, or little more than a penny per week, for works more complete and certain than any which now exist.

"'On analysing the business of District Courts meeting weekly, fortnightly, monthly, or quarterly,' say the Sanitary Commissioners in their first Report, 'it appears that a large proportion of it arises from the very defects of their own plans and works, which under an amended system will disappear. Those who have paid attention to the dispatch of large amounts of varied business are aware that, up to certain limits, the larger the amounts, the more complete are the means of classifying and systematising it, the better the real dispatch of it. We would cite, as an example, the consolidation, under the Metropolitan Roads Commission, of the administration of the roads formerly administered by a number of local trusts, comprehending the suburban parishes in the Metropolis. Under that Commission the roads have been improved,

the tolls and the debts reduced, and the business of 100 miles of road transacted satisfactorily, with less attendance and consumption of time on the part of the honorary members of the Board than was previously required by the defective dispatch of business by any one of the numerous separate Boards under which important improvements were found to be impracticable. It may be averred that the business of a Commission of Sewers for the whole of the Metropolis may eventually be dispatched better and more expeditiously than the business of one of the single Commissions.'"