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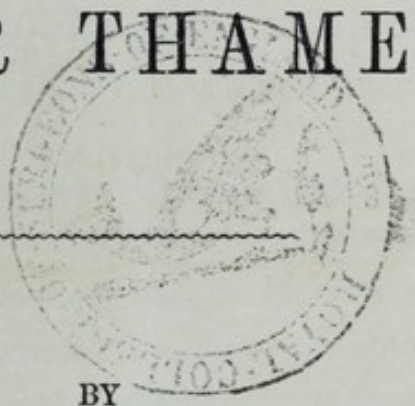
REPORT

ON THE

EFFECTS OF SEWAGE CONTAMINATION

UPON THE

RIVER THAMES.



BY

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Lambeth:

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1858.

REPORT.

*Function of rivers—Nature of putrefaction—River agencies for preventing putrefaction—Vital development—Oxidation—Dilution—Removal by the down-scour—Alleged evidence of river impurity—Foul appearance—Offensive smell—Effect of river emanations upon health—Real evils from present mode of draining the Metropolis—Opinions of chemists and engineers—Conclusion.**

Function of Rivers.—From a consideration of the mode in which our rivers are originally constituted, and their supplies of water unceasingly maintained, it is evident that every great river must form the natural drain of some extensive area. Evaporation is constantly taking place from every surface of water which this earth presents. This evaporated water remains partly dissolved in the atmosphere, partly deposited in the form of clouds, from which clouds and atmospheric moisture our rain-fall and dew-fall are derived. The rain-fall of the hilly districts ever seeking a lower level, ever receiving accessions from the rainfall of lower regions, washes over and through the soil, delving for itself minute channels which unite with one another to form larger channels. Then springs, brooks, streams, and tributary rivers succeed one another, until in the valley of the district, there is formed a huge river, which returns

* This Report is intended only as a popular statement of the question.

the rain water to its original source the sea. Thus, from the sea, into the air, over the earth, and back again to the sea, do we find water ever journeying in its prescribed circle. Now the rain-fall is the great public scavenger. First it cleanses the atmosphere, washing from it many impurities, particularly certain nitrogen compounds, such as ammonia and nitric acid, which result from the decomposition of organic matter. Then it purifies the earth, scouring from its surface, and dissolving from its substance, refuse of every description. Hence we find that the purest river water differs from rain water by the substances it has derived from the soil, while rain water differs from evaporated water by the substances it has derived from the air. Moreover, we find the water of every river has its own specific character, dependent upon the nature of the district from which it has drained.

In common with most large rivers, the Thames is well supplied with variously sized tributaries which empty themselves at different points of its course, from its origin as a distinct river, down to its efflux in the sea. Such, for instance are the Wandle, the Effra, the Fleet, the Ravensbourne, &c. Most of our existing main sewers were originally the natural tributaries of the Thames, each carrying into the main river, the drainage from its own locality. At one time the minor streams and the main river, *though constituted almost entirely of drainage*, did not become offensive. All were fulfilling their natural functions, all were exercising efficiently their natural self-purifying powers. But in course of time, through an increasing density of population, and a consequent disuse of cesspools, the smaller tributaries were no longer capable of maintaining themselves in a wholesome state. The purifying powers which enabled them to withstand the influx of a certain amount of impurity, were insufficient to destroy the daily

increasing mass of human excreta which mingled with their streams. Hence it became necessary successively to cover in many of these tributaries, to convert them into actual sewers, and to prevent as much as possible the escape of any emanations from them. In these tributaries the quantity of substance to be purified was certainly disproportionate to their purifying powers. Now, we have to inquire whether or not the same relation prevails in the main river, whether its self-purifying powers are sufficient for the purification it is called upon to perform.

Nature of Putrefaction.—We know that the excreta of animals, the bodies of animals, the tissues of vegetables, and all forms of organic matter that are not in a living state undergo decomposition. This decomposition may proceed slowly and inoffensively, as is the case with woody fibre; or rapidly and offensively, as is the case with most animal tissues; but the decomposition of both animal and vegetable matters is effected by the same means. The changes are in each instance due to the presence of air or oxygen which breaks up the organic matter, unites with certain of its constituents, and ultimately converts them into various simple forms of mineral matter. Now in this process of the conversion of organic into mineral matter, there is one stage, usually known as the putrefactive stage, in which, and in which alone, does the organic matter become obnoxious. The fresh organic matter, living or dead, and the fully oxidised organic matter are alike unobjectionable. Putrefaction occurs only at the intermediate stage of partial oxidation. We know that without air or oxygen, decomposition cannot take place at all. Hermetically sealed canisters of provisions are transported from one part of the world to another, and, after the lapse of many years, remain perfectly sweet and

wholesome, provided the absence of air has been absolutely maintained. With an inadequate supply of air we have the phenomena of putrefaction. The tissues break up into imperfectly oxidised substances which are more or less offensive according to the nature of the tissue from which they were derived. But in the presence of a large excess of air, more particularly of the air contained in earth and water, these imperfectly oxidised and offensive products become completely oxidised and inoffensive. When animal matter decomposes in contact with a sufficient amount of fully oxidised earth or water, the formation and destruction of the offensive products are almost simultaneous.

The organic matter, both of sewer water and of Thames water, may be classified under the following heads. First we have living animal and vegetable organisms of various kinds; then we have dead organic matter in a sufficiently undecomposed state to serve as food for animalculæ; then we have organic matter which is in a semi-oxidised and putrefactive condition, and which cannot furnish food for animalculæ, but must undergo a further oxidation; and lastly we have organic matter that has been so thoroughly oxidised as to be innoxious. Hitherto it has been nearly always assumed that the organic matter of the river, and of water generally, was all of it objectionable, and that the quantity of organic matter in the water was a criterion of its offensiveness. My own experiments have tended largely to show the incorrectness of this assumption. We know that animal life cannot be supported without organic matter; and sea-water, which is so fertile in animal life, I have found to contain habitually a greater amount of organic matter than ever exists in river water. Moreover, the water of the Thames at high tide almost invariably contains a larger proportion of organic

matter than it does at low tide, which excess is doubtless in part due to contamination with sea water. Again, in the middle of July last, the waters of the London and St. Katherine's Docks, though in a most offensive condition, contained respectively but 6 and 9 grains of dissolved organic matter in a gallon; while several of our Lambeth shallow well waters, that were unexceptionable as to taste, smell, and appearance, yielded me 12, 19, and 25 grains of dissolved organic matter per gallon. Organic matter of itself is not injurious, but under certain conditions it is liable to acquire noxious properties. Under these conditions sea water, river water, and indeed most kinds of natural water alike become offensive.*

The principal agencies by which the putrefaction of sewage in the Thames is prevented, are four in number. First, the development of animal life. Second, oxidation. Third, dilution. Fourth, removal by the down-scour.

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* Referring to the reasons why the sea does not putrify, Dr. Barnes writes: "Whilst it is subject to tidal motion, to agitation by the wind, to the free absorbtion of oxygen favoured by motion, the organic matter it contains does not putrify, whatever the temperature, but is converted into multitudinous living animal and vegetable forms. Precisely the same conditions affect the body of the waters in the Thames, both flood and ebb. Thames water, high or low, never fails to exhibit abundant evidence of the rapid conversion of dissolved organic matter into living forms. So long as the water is subject like the sea to rapid motion by tides, winds, and other influences, I assert from repeated and positive observation that it does not putrify. The constant presence of certain living and growing animals and plants in Thames water is conclusive proof against putrefaction. The process of putrefaction is attended by the evolution of gases that are instantly fatal to the living organisms found in it. The fact, however, is that Thames water, high or low, may, and does, become putrid and pernicious under certain conditions. Under these conditions, namely, stagnation, exposure to air, and increased temperature, sea water itself is not exempt from the change. There are salt marshes, perfectly uncontaminated by sewage, more deadly by far than the Thames is assumed to be. In these, putrefaction and other pernicious changes take place, precisely as they do on the mud banks of the Thames, where acres of deposit largely mixed with organic matter are exposed at low water to the air. This is one source of the foulness of the river. It is not the flowing waters, but the exposed stagnant mud."

VITAL DEVELOPMENT.—The generation of countless forms of animal life, the preying of animals upon animals, is perhaps the greatest and most efficient check upon the process of putrefaction. In nearly every class of animals, from the mammalia downwards, do we find beings whose special work it is to act as scavengers, to thrive upon the semi-putrid carcases and exuviæ which are rejected by more cleanly feeders. But in the lower ranks of animals this function is carried on to its greatest extent. Revelling in the midst of putrefaction, thriving in the sewers, and fattening in the charnel houses, do we find animal life in endless profusion and variety. These animalculæ, however, do not develope themselves from out those portions of organic matter that are already semi-oxidised or decomposed, bnt in the midst of decomposition, they build up their organisms out of the non-decomposed portions, which they as it were rescue from putrefaction. Then, in other conditions or localities, they form the prey of animals of a different grade, which could not have resisted the foul atmosphere in which the original stercorine and carrion forms were generated. We are unable to form any conception of the amount of putrefaction prevented by this wonderful provision of nature in its almost unheeded supply of scavenger animals. It must be remembered that animals of every grade, no matter how-much-soever they grow or multiply, do not add one iota to the existing quantity of organic matter. It is the peculiar function of the vegetable to convert mineral into organic matter. Animals live entirely upon the organic matter directly or indirectly built up by vegetables. Throughout their lives they are constantly consuming more organic matter than they yield, which excess of organic matter they convert into mineral matter by oxidation; and, at their deaths, they must either furnish food for other animals, or else undergo a more violent

continuance of the oxidation to which they were subjected during their lives, and become entirely converted into innocuous mineral matter.

Oxidation.—We have just observed that organic matter when it has undergone a certain amount of decomposition, can no longer act as a pabulum for animal existences, but to become innoxious, must undergo a further oxidation, and be resolved into simpler products. Now water has the property of absorbing air or oxygen, and this oxygen has the property of destroying putrid compounds. If water, from which air has been removed, be charged with that foul vapour called hydro-sulphate of ammonia, perhaps the most offensive of all putrefactive products, that water will remain stinking for months, if the access of air be prevented. But if this same stinking water be exposed to the air, it will dissolve the oxygen of the air, and this oxygen will immediately act upon the putrid matter. Then, more oxygen will be absorbed, more putrid matter destroyed, and in twenty-four hours the smell be entirely removed.* It is true that water can take up but a very small quantity of this purifying gas. One hundred gallons of water can only dissolve about three and a half gallons of oxygen, but as fast as the oxygen is consumed, more is absorbed from the inexhaustible reservoir of atmosphere, so that the river may be continuously maintained in an efficient state of oxidation. Moreover, its agitation by winds, tides, and traffic, tends materially to keep it in a fully oxidised condition. As a proof of the oxidising powers of the river, I may state that it always contains nitrates, the most highly oxidised and least

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* I do not find this experiment recorded anywhere, but it is one that I have frequently performed.

objectionable products of the decomposition of animal matter. Moreover, I have never been able to detect sulphuretted hydrogen in Thames water, though, were it not for the fully oxidised state of the river, this offensive compound would doubtless be given off in considerable quantity.

Dilution.—This is a very important means for neutralizing toxic agencies of every description. We know that the purest atmosphere of the downs, or of the ocean, always contains that deadly poison carbonic acid. But the effects of this poison depend upon its state of concentration. When diluted to a certain extent, its deleterious qualities are not simply diluted in the same proportion, but are absolutely destroyed. An atmosphere containing five per cent of carbonic acid cannot be breathed with impunity. But such an atmosphere diluted with a hundred times its volume of chemically purified air would constitute the purest air that exists in nature. In the same way with poisonous emanations of all kinds. Dilution of substance implies more than dilution of effect—it implies annihilation of effect. It is somewhat difficult to ascertain the amount of dilution which the excreta of London undergo in the sewers and river. We can, however, easily approximate to the average minimum of dilution in the sewers. By a return made to the House of Commons, in July, 1854, it appeared that the London Water Companies, taken as a whole, supplied daily 25 gallons of water per individual. Now, from a very extensive series of data, elaborated with great care by Messrs. Lawes & Gilbert, it appears that the solid and liquid excrements voided daily by every individual contain on the average only two ounces of dried substance, of which one half-ounce is constituted of mineral matter. Whence it follows that if sewer water were of uniform composition, and were derived

solely from the water supply and human excreta, it would contain only 26 grains of organic matter in a gallon.* From analyses made by different chemists we learn that the composition of sewage varies greatly. Sewage from the Earl sewer yielded Messrs. HOFMANN & WITT only 2·7 grains of organic matter per gallon. Mr. WAY found in the sewage of Barrett's Court, 301·8 grains per gallon. I have found in the sewage from Savoy-street, 45·7 grains; in that from the York Road, Lambeth, 48·9 grains, and in that from Broad Street, Lambeth, 77·4 grains of organic matter per gallon. Messrs. HOFMANN & WITT, in their report to the Government referees on the main drainage question, adopted 30 grains per gallon as the average quantity of organic matter contained in London sewage, and their estimate is probably very close to the truth. Now Mr. BAZALGETTE calculates "that the proportion of the sewage at the present time discharged into the river at our very doors, is, as compared with the water of the Thames, at the period of its discharge, as one to fifty." So that at present, when the river contains almost its minimum of water, and receives its maximum of sewage, that sewage increases the amount of organic matter in the river only to the extent of one half grain in a gallon, a quantity that is absolutely ridiculous. This statement, however, applies only to the average result. At some periods the effect of sewage contamination is much less, at some periods much greater, than that above indicated. My experiments,

* The problem for those who advocate, on commercial grounds, the production of solid manure from sewage, is to extract the two ounces of excrement from the twenty-five gallons of water at a profit. I will not say the feat is impossible, though at present we have scarcely any foreshadowings of its realization. But the deodorization of sewage at a certain moderate outlay, is a sanitary problem that has already received a practical solution; and in many parts of the kingdom, this operation will probably be resorted to with advantage.

extending over a period of nearly ten months, shew that Thames water at Greenwich at low tide, when the amount of sewage poured into it is greatest, and the total volume of water least, contains on the average 4·63 grains of organic matter per gallon. The greatest quantity occurred on June 29th when it amounted to 11·2 grains, and the smallest on November 23rd, when it amounted to only 2·1 grains per gallon. However, a large proportion of the organic matter contained in the river, even at low water, is derived, not directly from the sewage at that time discharging into it, but from impurities introduced by the previous upcast flow.

Removal by the down scour. — In reference to the removal of insoluble sewage from the river by means of the ebb tide and freshet, it seems that at high tide the water is nearly stationary, and that during this period a considerable deposition of organic and mineral mud takes place. Very soon, however, the force of the downcast in the middle of the stream becomes sufficient to wash away all deposit, and prevent any further deposition; but in the slack, eddies, and retrogrades the deposition is continued so long as the banks are covered by water. I have found the average quantity of suspended organic matter contained in low water at Greenwich to be 1·3 grains, and in high water to be about two-thirds of that quantity, or 0·89 grains in a gallon. If, however, we take into consideration the greatly increased quantity of water in the river at high tide, it is evident that the total amount of suspended matter in the river, even at Greenwich, is greater at high than at low water; and doubtless the excess is more marked further up in the stream. I am inclined to think, with Mr. Goldsworthy Gurney, that suspended "sewage, if thrown into the Thames, no matter how far down, will be brought up again by the upcast; and, if the retrogrades be not destroyed, it will be

retained in the river." But the causes which prevent the suspended sewage being carried away by the freshet, do not interfere with the efficient disposal of the soluble sewage. The greater part of this sewage, flowing into the river at ebb tide, is even now by the force of the freshet and ebb eventually carried away into the German ocean. The quantity of dissolved organic matter in the river does not undergo a continuous increase. Its amount seems to be regulated chiefly by the season, which of course has a direct influence upon the quantity of freshet, and the force of the down scour. In the summer, the amount of dissolved organic matter increases very considerably, while the force of the scour greatly decreases; but in winter the quantity of organic matter becomes so reduced by the increased scour that its amount per gallon at Greenwich very slightly exceeds its amount per gallon at Ditton. Hence it seems that in the summer season, it would prove advisable to increase the down scour artificially by flushing, as first suggested, I believe, by Mr. FREEBODY. The following analyses illustrate, among other points, the extent to which the river can discharge its dissolved organic matter:—

LOW WATER AT GREENWICH.

Date, 1857.	Hour.	Dissolved organic matter, in grains per gallon.	Dissolved mineral matter, in grains, per gallon.	Rain-fall of previous week, in inches.
October 22nd.	11 A.M.	2·96	32·91	0·19
„ 27th.	1·30 P.M.	5·01	14·01	2·85
November 4th.	10·30 A.M.	2·77	23·28	0·06

The total rainfall between October 7th and October 22nd amounted to less than half an inch. On October 22nd there occurred an enormous rainfall, amounting to 2·57 inches, or one tenth part of the average annual rainfall. Mr. GLASHIER calculated that on that day 20 million tons, or 84 million hogsheads of water fell on the London districts. On October

27th, after the lapse of four and a half days, I found that the amount of saline or mineral matter per gallon, in the low water of the river at Greenwich, had been decreased to one-half the previous quantity, in consequence of the great dilution effected by the rainfall; but that, despite this enormous dilution, the amount of organic matter per gallon had been nearly doubled, probably from the complete scouring of the sewers, inasmuch as this increase of organic matter was not evidenced in water taken high up in the river. But, on the morning of November 4th, I found that this excess of organic matter had been got rid of, and that the water had resumed its usual character.

Having thus considered the means now in existence for maintaining the purity of the Thames, we come to the question, Are they, or are they not sufficient for the purpose? We have, I believe, no other alleged evidence of the putridity of the river than its constant foul appearance, and its occasional objectionable smell, to which points we will now direct our attention.

Foul appearance.—The muddy look of the Thames has usually been considered dependent upon the sewage poured into it, and this error was largely propagated by the loose interpretation of certain paragraphs in a letter which Mr. Faraday published in the *Times* newspaper some two years ago. All chemists and engineers, however, who have examined the matter thoughtfully, are now satisfied that the discharge of sewage has very little direct influence upon the muddy aspect of the river. My own experiments shew that this appearance most certainly does not depend upon the organic matter of sewage, but upon clay and other suspended mineral matter. The excess of suspended mineral matter over the suspended organic matter is greatest at low water, when the river receives its maximum of sewage. The mineral mud suspended in the

river at low water forms seven-eighths of the whole, and the one eighth of organic matter is constituted for the most part of living organisms. Suspended matter, or mud, exists to an equal extent in rivers where the contamination with sewage is infinitessimal as compared with the Thames. Moreover, I have reason to believe that the presence of mineral mud promotes considerably the perfect oxidation of the water.

Offensive Smell.—As regards the smell of the river, I believe, from personal examination, and from inquiries of watermen and others, that an offensively-smelling condition of the water of the Thames is an exceptional occurrence. Sometimes there is perceptible on the river, a smell arising solely from a local cause, as when undiluted sewage from some proximate sewer mouth runs for a considerable distance over the exposed river bank. An offensive smell not unfrequently proceeds from the mud banks, and particularly from that bank which receives the direct rays of the sun. But the most potent cause of smell arises from the upcast flow disturbing the foul organic mud, which the sun had previously acted upon. At those periods in the summer, when the river water itself has an objectionable smell, the smell at high water, or rather at the flow of the tide, is much worse than at low water when we have the dilution of the freshet stream. I believe, moreover, that all water when existing in large quantity and in a heated state has a certain characteristic smell. Even the beautifully pure water supplied by the Lambeth Company from Thames Ditton smells perceptibly at a blood heat; and the water of the Crystal Palace fountains was said to be actually offensive during the hot weather. In reference to the smell of the river during the summer drought, Messrs. Simpson, Galton, and Blackwell write:—"Our attention, during the last few weeks, has been

particularly called to the state of the river Thames, the noxious smell from which has assumed a great degree of intensity; but this arises not so much from any unusual accession of foul sewage, as from the diminished volume of the stream at the present season, and from the more rapid decomposition of the organic matter, which has been favoured by the very high temperature of the water of the Thames." During this period, every upcast tide dissolved semi-decomposed organic matter from the mud-banks, and the downcast tide was insufficient to carry it away. The proportion per gallon of organic matter in the river water, both ebb and flow, underwent a great increase, owing to the inefficient down-scour. Moreover, the river was largely contaminated with sea-water, and there is reason to believe that the presence of putrefying or putrefiable organic matter in sea water is more objectionable even than in river water. The desirability of artificially increasing the scour of the Thames during the summer drought has been before alluded to.

Effect of river emanations upon health. — The alleged unsanitary influences of emanations from the Thames are, I conceive, of a very questionable nature, and at any rate are not proved by evidence. The high mortality of certain metropolitan districts is not directly proportionate to their proximity to the river, but rather inversely proportionate to their facilities for drainage. Thus, Westminster, with a mean elevation of 3 feet, and the Strand, with a mean elevation of 50 feet, are both river-side districts. In the year 1856, the mean death rate of Westminster was 1 in 42·8, that of the Metropolis 1 in 45·8, and that of the Strand 1 in 51·2. In the lowness of its death rate, the Strand ranked sixth among the metropolitan districts, despite its dense population.

During the last three or four years, the amount of sewage

poured into the Thames has increased in an enormous proportion. Therefore, if the fouling of the river does exert any effect upon the public health, this increase of its foulness ought to produce an appreciable effect. On the contrary, we find the death rate and prevalence of epidemic disease in the metropolis to have undergone a marked diminution. Dr. McWilliam the accomplished physician to the Custom House, who has the charge of about 800 men, whose general health is found to be excellent despite their regular employment on the river, their night duty on the river, and their great hardships, writes me word, "I have no evidence that the health of tide-waiters is interfered with by emanations from Thames water; I have certainly heard tide-waiters and watermen complain of the bad smell of the docks and river during hot weather, but I am not prepared to say that I have traced disease of any kind to the odour from the water in either place." We have the opinions of Mr. Busk and Dr. Barnes, the senior surgeon and physician respectively, to the Dreadnought hospital ship. They say that the health of the resident staff is excellent, and that the operation and fever cases, two great tests of salubrity, do remarkably well. Dr. Barnes writes me word: "Medical observation of the health of those who live upon the Thames shows the absence of those diseases which usually denote malaria. Fever is a rare event to originate on the river. Of more than 60 cases admitted on board the Dreadnought during last year, not one could be traced as due to river emanations. They all come from the docks, or from unhealthy ships coming up the river. I have in vain made inquiries to ascertain what disease or form of disease it is that the Thames produces."

Defects of the present metropolitan drainage.—It seems to me that the following two questions ought to be fully

and fairly considered, before determining upon any main-drainage scheme. First, what are the evils resulting from the discharge of London sewage into the Thames? Secondly, how can these evils be best obviated? I believe the answer to the first question would be as follows. One evil consists in the deposition of organic mud upon the exposed banks of the river, and the disturbance of this mud by the upcast. Another evil consists in the flowing of undiluted sewage, for a considerable distance over the river bank, extending from the sewer mouth to the water's edge at low tide. Lastly, a great evil consists in the tide-locking of many sewers for a greater or less number of hours during the day, whereby the low neighbourhoods repose upon a bed of "elongated cesspools," and are always saturated with the drainings from those cesspools. I know of no other real evils, and I am unable to find any other alleged evils in the writings of those who have paid most attention to the subject, and who from their positions and attainments are best able to judge of it. At the same time a more searching inquiry might not improbably expose additional sources of mischief. As to the question, how are these evils best to be remedied? I am unable to predicate the answer, but I think it would not be, by adopting the main drainage scheme. To divert the sewage from the Thames is undoubtedly a most difficult engineering work, and we can scarcely enough appreciate the labour and intelligence that have been brought to bear upon it. But to prevent the evils which at present arise from the discharge of sewage into the river is altogether a different problem, and one that might be solved by a tithe of that labour and intelligence. To effect this object would, I conceive, require no such ponderous mechanism, no such preposterous expenditure. We should not need a magnificent aqueduct of 20 or 30 miles in length, to cause the rain-fall which nature intended

should swell the river at Fulham, to enter the river at Erith. Independently also of the main-drainage scheme being unnecessarily huge, complex, and expensive, I fear it would not perfectly effect its object. No matter at what point of the river the sewage is discharged, you may rest satisfied that organic mud will still be deposited upon the exposed flat banks of the Thames. The efficient embankment of the river would be needed to render the main-drainage scheme successful, and such efficient embankment would most probably render that scheme unnecessary.

Opinions of Chemists and Engineers.—Let me adduce some testimony in favour of the opinions I have ventured to express as to the real evils resulting from the discharge of sewage into the river. Mr. Bazalgette, in a paper read before the Metropolitan Association of Civil Engineers, writes: "In the public prints the question of the purification of the river Thames has been the one that has absorbed the whole of the discussion. *Now, in reality the pollution of the Thames is a minor evil.** There are vastly more important considerations with respect to the London sewage than the purification of the Thames." And a little further on, in illustration of these evils as manifested in the low lying district of South London: "We can hardly conceive any worse case of drainage than exists in this district; the surface of which is from four to six feet below high water, the sewers of which during storms, are overcharged and saturate the ground, and the mouths of which sewers are closed for eighteen hours out of the twenty-four: The great object of a scheme of interception should be, first to remedy these evils, and then purify the Thames."

Query. * Does not the minor evil entail the major expense?

Dr. BARNES, in a paper read before the British Association, writes: "Many of the sewers discharge into the river in a most objectionable manner. Their contents are disengulphed in large floods; not under the stream water, so as to mingle rapidly, but often high above the level of the river, and spreading over the exposed banks. Passengers on the river, smelling the unmixed outpourings of sewers, and exhalations from mud-banks, conclude they have olfactory evidence of the putrid state of the Thames." Messrs. HOFMANN and WITT report to the Government referees as follows: "We cannot but emphatically insist upon it, that *the formation of the mud deposit in the river* appears to us by far the most serious evil which results from the discharge of the London sewage into the river. We cannot too strongly urge this point upon public attention." Mr. GOLDSWORTHY GURNEY, in a Report to Sir BENJAMIN HALL, writes: "In the Thames and all tidal rivers where there is no room at the sides for slacks and retrogrades to form there is no deposit [of mud.] If the retrogrades be destroyed, the mouths of the sewers trapped, and the sewage gases* burnt, all cause of complaint of the atmosphere about the Houses of Parliament would cease. Then a question would probably arise as to *whether any drainage of London beyond the natural outcast power of the river would ever be required.*" Dr. LETHEBY writes me word: "The real mischief in the river is from the mud banks where insoluble sewage settles and is left by the tide to decompose and blacken." Messrs. GALTON, SIMPSON, and BLACKWELL the Government referees write: "The serious injury which the existing system of drainage has caused to the general health of the inhabitants has been due to the fact of the sewage being ponded back during a portion of every tide."

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* If the discharge of sewage into the river were continuous instead of intermittent, it is doubtful whether there would be any objectionable amount of sewage gases to destroy.

Conclusion.—It seems that the sewage diversion scheme is intended to effect two distinct objects: the ostensible one being the purification of the Thames; the important one being the improved drainage of London. With regard to the first object, I am decidedly of opinion that the proposed scheme is unnecessary, and would of itself prove inefficient. Unnecessary, inasmuch as the evils arising from river pollution have been much exaggerated in degree, and, until lately, misunderstood in character. Inefficient, inasmuch as it would not remedy the evils known to arise from the exposed mud banks and defective down-scour. It must be fully admitted that the condition of the Thames during hot weather is often most objectionable, and that some means for remedying this condition are imperatively called for. The ensuing summer will probably convince the most sceptical of the necessity for doing something. At present, indeed, we have no evidence of any ill effects having arisen from Thames emanations, though we can scarcely doubt that sanitary evils would arise if the offensive state of the river were persistent, instead of being, as it really is, exceptional. In my opinion the great cause of smell consists in the disturbance of the sun-acted-upon organic mud by the upcast flow. If all sewers were enabled to empty themselves at high-water, if the flow of undiluted sewage over the banks of the river were prevented, and if the bed and banks of the river were improved so as to prevent the deposition of mud and increase the scour, which if necessary might be still further aided by occasional flushing, I believe that all real evils resulting, or likely to result from the discharge of sewage into the river would be obviated. With regard to the second object—I forbear to express quite so strong an opinion upon the necessity and efficacy of the sewage diversion scheme as a means for improving the drainage of the low lying districts of the metropolis.

I cannot help thinking, however, that if engineers had directed their attention independently to this question, and had not hampered themselves with considerations of Thames dispollution, they would have arrived at an equally efficient and much less expensive plan. But my sole wish in reference to the whole subject is, that a free and open investigation should take place, in order to ascertain what the evils really are, and what is the best mode of preventing them. Hitherto, the ostensible problem involved in main-drainage discussions has been the diversion of sewage from the Thames. I want the real and ostensible problem to be an exact adaptation of means to an end; and that end, the cure of all evils which shall be demonstrated to have a real existence. If, after the investigation of the evils, the sewage interception scheme should be considered the best remedy, which, however, I certainly do not anticipate, let us adopt it by all means, and let it be carried out by the body of gentlemen now charged with its execution, who, despite the sneers of small wits, are known to have conducted the business entrusted to them in a most efficient and upright manner. I should like to see this Board of Works able to exert more independent action. Instead of being called upon to execute a special sewage diversion scheme, I would have them empowered to carry out, after due enquiry, whatever scheme they considered best adapted to remedy the proved evils resulting from the present mode of draining the metropolis into the river.

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