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# **On the drainage and sewage of London and of large towns**

**James Copland**

LONDON:  
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New-street-Square.

DEAR MR. WELLINGTON VALLANCE,

When I had the pleasure of conversing with you a short time ago, you urged me to publish my views respecting the Drainage and Sewage of London, and the remedies for the evils resulting from those sources. I then stated as an excuse for my not entertaining your recommendation, the urgency of my engagements, and the want of time requisite to the due consideration of so extensive a subject. Afterwards, however, reflecting upon the cogency of the various reasons suggested by you, not the least of them being the fervent hope you expressed that I may have the gratification of rendering important service to the community upon this, the most engrossing subject of the age, I was induced to think that your advice might be

adopted by me with the loss of a few only of the usually limited number of hours devoted to sleep. You have now before you the result. I leave it to your own excellent judgment to send it to the printer or to burn it. I shall, I promise you, be quite satisfied with your decision.

I remain, yours faithfully,

JAMES COPLAND.

*5, Old Burlington Street,  
22nd Dec., 1856.*

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ON THE  
DRAINAGE AND SEWAGE OF LONDON  
AND LARGE TOWNS,  
THEIR EVILS AND THEIR CURE.

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INTRODUCTORY REMARKS.

IT is obvious, that a correct knowledge of evils which result from the imperfect drainage of large towns, and from the sewage of these towns, as now generally disposed of, is the chief inducement to the abatement or entire removal of these evils, whilst it indicates the means by which these ends may be attained. The injurious influences proceeding from these sources have been long known to, and their effects exposed by, many members of the medical profession; but, until a comparatively recent period, the warnings and expositions of medical writers failed to excite the attention of the public, and it was not until the introduction of pestilential cholera into this country in 1832 that any alarm was produced by these evils, and that due attention was paid to the effects which result from them to the community: these effects are, the production of many diseases by them, and the predisposition occasioned by them to other maladies of a most dangerous and epidemic nature. Indeed, there have been, and now are, very few medical writers, who have fully entered



upon the consideration of the causes of disease and of the means of preventing these causes, who have not urged the importance which should be attached to those which arise from drains and sewers of every description, when imperfectly constructed, as well as from the absence of them, and from similar causes of endemic and epidemic disease, and who have not advised the adoption of means for their counteraction, amelioration, or removal. It is now above thirty years since these subjects were discussed by the writer, and twenty-five years since they were again, and more fully, treated of by him under the heads, "*Endemic Causes of Disease*," and "*Epidemic Influences*," in his large work on "*Practical Medicine*." The manifestly injurious effects produced on the inhabitants of, and visitors to, London and large manufacturing towns, by the absence, in many places, and the imperfect construction, in others, of drains and sewers, and by the interments within the heart and precincts of the metropolis and other towns, were subsequently fully set forth by him in the third volume of that work (see pp. 232—247.).

Contemporary with these latter expositions, other medical writers insisted on the same topics, and also brought the subject before the profession and the public. Soon after this enlightenment a Parliamentary Committee investigated the subject; the writer and several other medical men were examined by this Committee, and a Health of Towns Commission was constituted, and reported upon the sanitary defects of the principal towns throughout the country. Since then, and recently more especially, the Boards of Health and popular writers have imputed to drains and sewers, or to the want of them, the visitations of Pestilential Cholera to London and other places, and

have assigned to the exhalations from these sources more than they are capable of causing ; for, instead of being the exciting or efficient causes of this pestilence, they only predisposed the constitutions of the inhabitants to receive the infection of this malady, and reinforced the noxious operation of the emanations from the infected on those exposed to them.

Since the recurrence of Pestilential Cholera, the influence of emanations from drains and sewers, as well as of the effluvia in houses and localities where drains are required but are wanting, has been discussed not only by medical, but also by popular writers ; and the subject has been still more recently entertained by the daily and weekly press of the metropolis. The pioneers, however, in this work were the writers on medical science, who imputed to these sources of disease no more nor less than they actually produced in the sum of human calamity. The several Boards of Health, which have been formed during the last twenty-five years, have erred, as might have been expected, from the deficiency of practical medical experience in their members, — and most egregiously and injuriously, as respects human life, by imputing to the causes under consideration effects to which they only predisposed, and by denying the existence, and by neglecting to guard against the influence, of other causes which were undoubtedly in active operation ; and by their inability to estimate, with any accuracy and precision, the causes of disease which are developed in all crowded places and towns, and their effects where the drainage is imperfect or neglected, or the water supply deficient, and where means of disinfection are not employed — in short, by their incapability to discharge the duties which had been imposed upon them, and which they had undertaken to discharge.

## CHAPTER I.

*The Sources of Disease furnished by the Want of Drainage, by imperfect Drainage, and by an insufficient Supply of Water, and their injurious Influences on the Human Frame.*

IT has been shown by the writer, in his work on "Practical Medicine" already referred to, that, even in the largest houses and widest streets, the emanations from privies within the houses, owing to insufficient drainage and water supply, and to the remora of the exuviæ or excrementitial discharges of the inhabitants in the drains, before they pass beyond the precincts of their residences, often give rise to unpleasant smells and injurious effects, especially in the offices and lower apartments; the decomposition of the exuviæ, and the gases thereby furnished, depressing the vital powers and infecting the constitutions of those very persons from whom these exuviæ proceed. These effects are much more manifestly produced on the inhabitants of narrow streets, of close courts, yards, and cellars, or other places beneath the level of the streets. In most of these places insufficient water-supply, crowded apartments, confined and contaminated air, exhalations from drains, cesspools, and sewers, and imperfect ventilation, combine to develop diseases, often to an epidemic and an alarming extent.

The materials which constitute a portion of the contents of drains and sewers, and these the most important in a sanitary point of view, are the exuviæ or

excrementitial discharges from the inhabitants, and from horses and cows. These consist chiefly of organic matters, which undergo, as soon as they are discharged, and which continue for some time to undergo, various changes, certain of which have eluded the analytical researches of the chemist, or which have not been hitherto satisfactorily investigated. Others again have been shown to be gaseous, and to consist chiefly of sulphuretted and carburetted hydrogen gases, of nitrogen and carbonic acid gas, free ammonia and other vapours, whilst the more solid matters are the phosphates, urea, uric acid, ammoniacal salts, and salts of potash, soda, lime, magnesia, alumina, &c.—all these being intended by nature to nourish the plants of the earth, and thereby to furnish aliment for man. Of these materials, either contained in, or produced from, animal discharges, the most injurious to human life, when respired, are the gaseous, at the same time that they are most unpleasant to the sense of smell. This sense, wisely placed at the very entry of, and forming the portal to, the organs of respiration, and over the entrance to the digestive canal, indicates, by the reports it furnishes, both of what is inspired and what is taken into the mouth, that which is injurious to the economy, when presented to either of these avenues, through which the life of the individual is sustained. And whenever this sense is offended, in any degree, it may be taken for granted, that a prolonged, and, in some cases, even a temporary, respiration of the air which is contaminated so as thus to affect it, will be more or less injurious. Fortunately the ammonia, set free by the decomposition of the organic materials, often serves in some measure to stimulate the olfactory nerves and respiratory passages, and thereby to counteract the



depressing effects of other gases, and of their combinations. It is unnecessary to follow the physiological procession of phenomena resulting from the operation of these causes—from the respiration of the gases emitted by the sources now indicated, either in a more or less diluted, or in a concentrated, state.

The writer has here, as well as elsewhere, insisted upon the injurious influence of the emanations from the exuviae or excrementitial discharges, as long especially as they continue in the drains within the dwellings, because they are, in these situations, the most injurious to the health of the inhabitants; their bad effects arising chiefly from their remora in the drains constructed for their removal. This remora is caused either by an insufficient fall for their discharge, a deficient supply of water, or by both. When thus retained in the drains for any time, the exhalations and volatile gases proceeding from the excrementitial discharges escape from them into the lower parts of the houses, and rise through the pipes of the water-closets to the highest apartments. As these discharges percolate the soil, either within or without the dwellings, or flow into larger drains and sewers, they undergo changes. In the soil they are at first partially deodorised; but, with the saturation of the soil by them, noxious emanations arise from it; and infection or contamination of the human frame thus may proceed slowly and imperceptibly from them. When the excrementitial discharges reach the larger drains and sewers they are generally diluted still further than they had been by the water furnished by the cisterns with which water-closets are provided; by the falls of rain, the detritus of the streets washed into the drains, and by the fluids from factories, slaughter-houses, gasworks,

&c. ; the resulting compounds undergoing various and successive changes from decomposition and fermentation, and producing the lighter and more volatile gases and emanations, according to the admixtures thus formed, to the degrees of temperature to which they are exposed, and to the rapidity or slowness of their flow in the channels artificially provided for their discharge. There is no doubt that the changes produced by the admixture of materials in the large sewers differ, and the gaseous products and exhalations from them also differ, in different sewers and in different quarters of the metropolis; and that the products of all of them also differ, more or less, from the exhalations which arise at first from the decomposition of human excremental discharges. Such differences may be inferred from the more concentrated state, and the different nature, of the impurities which flow from the house-drains into the larger drains, and from the decomposition, or putrefaction, or chemical combinations they are disposed to assume. Chemistry, as yet, has not furnished us with the facts required to fully elucidate this subject; but, as far as the observation of the writer has enabled him to form an opinion, he believes that the gaseous formations, and effluvia disengaged in the earliest stages of decomposition of animal excrement and exuviae, and from dead animal matter, are more fraught with injurious and infecting elements, than the more advanced stages of fermentation and decomposition, or other chemical combinations, in the large sewers; that the emanations from small drains within houses densely inhabited, and, from the want of drains in others, are consequently the most productive of disease, especially to their inhabitants; and that the sources of these emanations require more particularly a recourse to such

means as will most rapidly carry them into the large or common sewers, and prevent their accumulation — more particularly an abundant supply of water.

Having thus taken a cursory view of the sources from which the human frame, in London, and in most large manufacturing or other towns, is weakened in some cases, is diseased in others, is contaminated or infected in many, and is predisposed in all to contagious and epidemic maladies, according to the constitutional powers of the individuals exposed to these sources, and to the concentration of the emanations proceeding from them, I shall briefly notice more particularly certain of the special effects resulting from them.

The effluvia or emanations from the sources pointed out are not always perceptible to persons who have become, by residence, accustomed to them, and their effects are hence often imperceptibly and slowly produced. In all members of a family, and more especially among the youngest members, debility, in its numerous forms and consequences, is the soonest and the most injuriously induced by these causes ; occasioning numerous forms of visceral disease in some, and scrofula, consumption, and glandular obstructions in others, and predisposing all to be seized by infectious, contagious and epidemic maladies, whenever they are exposed to the poisonous emanations by which these maladies are propagated. Each person infected by either of these maladies — whether continued fevers, scarlet fever, measles, small-pox, pestilential cholera, &c.—becomes a focus of infection to those surrounding him, if they are predisposed by the emanations proceeding from the sources now pointed out ; or if he reside within the sphere of their influence. Even the clothes of persons embued by the infecting poison of either of these infectious maladies, will communicate it to those

which have become predisposed by the causes now insisted upon — by the effluvia proceeding from drains, sewers, or foul reservoirs, from stagnant foetid pools, or from other sources of injurious exhalations.

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## CHAP. II.

### *Of the several Sources from which the Thames and other navigable Rivers are contaminated.*

It may be conducive to a clear exposition of the evils of metropolitan and town sewage, and of the means which may be devised for their cure, to have a distinct idea of the several sources from which the contamination of the Thames and other navigable rivers proceeds, and of the probable comparative share which each of these may contribute to the general result. 1st. There are more or less injurious elements flowing into the Thames and other rivers, arising from the exuviae of the inhabitants and of many of the lower animals, from dead animals and animal matter in states of decomposition, from the highest to the lowest parts of the course of these rivers. 2nd. There are, more especially, the same injurious materials — injurious when neglected, and exposed so as to contaminate the atmosphere, but beneficial when utilised and employed in agriculture — in superabundant quantity, and in various grades of concentration, furnished by the sewers of the metropolis and its immediate vicinity. 3rd. There are the refuse animal matters and excrementitial discharges, and the foul water from the numerous ships in the Thames and



other tidal rivers and in the docks communicating with these rivers, and the cupreous salts dissolved in the water, furnished by the sheathings of ships. 4th. There are the contaminations produced by dead animals; by the garbage and decomposing animal matters thrown into the rivers; and by the blood and animal fluids flowing into it from slaughter-houses; and, 5th, The foul waters, contaminated by various mineral and saline products, proceeding from gasworks, factories, &c., &c.

Now, it may be asked, what may be presumed to be the share which each of these sources contributes to the total amount of contamination? This question cannot be answered, although some indefinite idea may be formed respecting it; but it may be presumed that the metropolitan sewage furnishes a much greater amount of the contamination of the Thames than all the others combined. It cannot, however, be inferred that the removal of this sewage to such a locality and distance as not to reach the Thames would leave the river pure and uncontaminated; for, as long as the sources of contamination in the whole of the course of the river remain with the only exception of those furnished by the metropolis, and as long as the river and its shores are the seats of commerce and of manufactures, so long more or less of the causes which render the Thames impure will remain, or even be much increased.

As the sewage of London produces the greatest amount of contamination, as it most injuriously affects the population when it is not rapidly carried away, as its discharge into the Thames abstracts from agriculture and horticulture the elements of fertility which ought to be furnished to both from this most productive source of these elements, as the more solid or consistent

matters carried into the Thames by the sewers, render its banks much more unhealthy than they would otherwise be, and as the accumulation of these matters at its embouchure endangers its navigation, the remedies for these evils more especially and immediately demand the attention of the legislature, and in a way commensurate with their importance and with the scientific acquirements of the country and of the age. The remedy, or remedies, for one is insufficient, have been, it is true, considered by the Board of Works, through their Engineer. But restricted as this board is said to have been by the Legislature, and manifestly incompetent as all are, who do not possess scientific acquirements, to deal with this very difficult and complex subject, the remedial measures recommended are not such as will satisfy the public. For effective sanitary measures can be devised only by men of science, and with due reference to the prevailing diseases of the inhabitants. The causes which impair health on the one hand, and those which promote health on the other, being best known to practical physicians, the propriety of having recourse to their opinions as to these and other sanitary measures is obvious.

The remarks now made apply to all large towns, rivers, and other places similarly circumstanced, equally with London and the Thames.

Engineering ability and ingenuity may devise specious plans for sewers, and may extend them anywhere — to the German Ocean or even to the North Sea; but the cost is no small objection. Even if carried out as now proposed for London, these plans may cost more than double the amount now calculated; for the numerous difficulties to be overcome, and various contingencies which may occur, may even run the amount still

higher; and, when all is completed, the results may be far from satisfactory; and, instead of the evils above exposed being in any measure remedied, they may be greatly increased, — as will appear more fully in the sequel.

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### CHAP. III.

*Considerations arising out of the Plans of Intercepting Sewers, furnished by the Engineer to the Board of Works, for the Drainage of London.*

ACCORDING to the plans of Mr. Bazalgette it is proposed to construct sewers, into which the subordinate drains will run, of great magnitude. These "*intercepting sewers*" are to consist of two principal trunks on the south side of the river, with subordinate branches, — these trunks extending from Putney to below Woolwich; and of three principal trunks, with subordinate branches, on the north side of the river, extending from Brentford to about the River Lea, where they are to unite and to form one open sewer through Essex to some unknown destination. Now throughout these very prolonged courses, the celerity or retardation of the current through them, notwithstanding the construction of, and recourse to, pumping stations, &c., and the continued operation of steam power, must depend upon the descent through them or the amount of fall in each, for the steam power can only raise what flows from the sewers into the pumping stations.

But let the state of the metropolis be contemplated

for a moment, if the construction of these sewers be carried out. Let it be remembered that two of the five trunks (throwing the subordinate sewers out of view) run through the principal streets of the metropolis:—the middle intercepting trunk sewer from Kensal Green, through Bayswater to Oxford Street, Holborn to Hackney; the lower intercepting trunk sewer from Brentford, through Chelsea, Pimlico, along the Strand, Fleet-street, through the City, to Blackwall and Bow, terminating in the commencement of the extension trunk, to the eastward of the river Lea. The construction alone of these sewers and of their numerous contributory branches must prove a most serious matter to the inhabitants of the streets through which they are carried. The trunks especially must be both deep and large; and consequently the quantity of earth, saturated with, and rich in the products of, animal decay through the lapse of centuries, that will be thrown up during these constructions and exposed to the action of the atmosphere and to the influence of the sun, must be productive of terrestrial emanations calculated to generate a fatal typhoid epidemic of long continuance. London will be as deeply, more generally, and not less fatally, cut up into trenches as the grounds surrounding Sebastopol. But this may only be the commencement of calamity; for the intercepting or main sewers, of which I have referred only to two out of many, being constructed continuously for many miles, must necessarily have a very slight descent or fall; and the sewage flowing through them will consequently have a slow current, and be liable in parts to more or less remora or interruption. The further consequences of this condition will be a delayed, imperfect, or interrupted discharge from the house



drains ; irruptions into the streets of foetid and noxious gases arising from the decomposition of the excrementitious and other materials contained and delayed in the sewers, through the shafts, or the gullies and gratings, required to allow the passage of the superficial drainage and rain water ; and an accumulation of the solid materials in the drains and sewers, owing to the slowness of the currents passing through them, thereby remarkably impairing the efficiency of these constructions, or even altogether choking them, so as to require frequent openings and cleansings, which also will prove most injurious to health, and productive of fevers, &c.

The temperature in the larger of those drains and sewers may be inferred to be, in the deepest and largest, very nearly if not the same as the mean annual temperature of the metropolis ; but in certain circumstances and places it may rise much above this, especially where fermentation and decomposition are going on, as may be expected, in the materials contained in them, especially if the currents through them be slow, or any obstruction take place in them. In these circumstances the foetid and noxious gases will rise in increased quantity from them through the openings, gullies, or gratings provided for the passage of the surface drainage, and for the escape of the hydrogenous and other explosive gases that may be generated within them. These emissions of foul air will, in most states of temperature and weather, be either continuous or intermittent ; but the great frequency of their recurrence, and the direction of the current of air, will readily be ascertained by holding a small piece of down or light feather attached to a thread over the gratings. In very cold weather the foul air will rise in consequence of its higher temperature ; and in very warm weather the

heat will descend through the gratings of the gullies and increase the decomposition and fermentation of the excrementitious and animal matters contained in these sewers, and the quantity of gaseous products thereby formed. These products must escape one way or another. If these vents or grated gullies be trapped or otherwise prevented from allowing the escape of the noxious emanations, evils will result of a still more serious nature than those previously experienced ; for the noxious gases being specifically lighter than atmospheric air, will find their way either upwards or downwards in the course of the sewers, but most frequently upwards, and will invade the houses whose drains run into the sewers which generate the gases — a not infrequent occurrence, however, in some states of season and of weather, especially when the current through the drains is very slow or obstructed, owing to increased consistence of the sewage, and insufficient supply of water.

It may be said, in reply to this objection to the system of drainage now proposed, that this evil will exist, to some extent, in all drains which run from houses into the large sewers, in all large towns. This may be admitted, but it is the great amount of the resulting evil which renders it noxious ; for, if the drains have a much shorter course, a more rapid fall, and are discharged into disinfecting reservoirs ; and if their contents be rendered more fluid, and less liable to interruption in their flow, by a more abundant supply of water to the houses, the evils now argued against will hardly exist.

The difficulties of constructing the sewers, as now proposed, through the metropolis and its vicinity, will be found so great as not to be overcome without a much greater outlay than has been calculated upon by the en-

gineer. These difficulties will be found to increase as he advances towards the eastward parts of his constructions; and if he attempt to carry the sewage, by an open sewer, through Essex, or farther, without employing disinfecting agents, he will augment the injurious effects of the Essex Marshes to an incalculable extent; and, with easterly winds, the emanations from the accumulated contents in such a sewer will be carried over London, and, being reinforced and condensed by the smoke, and by the sulphurous acid and carburetted hydrogenous gases and other gases arising from combustion, and from the impurities, the leakage, and imperfect combustion of the coal gas, will rest upon the metropolis as a cloud, when the wind is low, not merely obscuring the atmosphere, but also infecting the inhabitants.

Such being the evils, as respects the health of the inhabitants, that may be expected from the plans of drainage and sewage about to be adopted, what are those which the Thames is likely to experience? A very large proportion of the water of the Thames is carried off by the water-companies for the use of the inhabitants, and is again restored to the river in a foul and injurious state, through the sewers. Now, if this quantity of water, instead of being thus restored, should be carried into the German Ocean, or even to some situation near the mouth of the Thames, by means of a prolonged sewer, the river would be so far diminished in the power of its current as to be ultimately insufficient to sweep away the accumulations of mud or alluvial deposits formed at its mouth. Whilst the muddy and unhealthy banks of the Thames will thus, from the diminution of the stream or current, be more exposed, during the ebb-tides, to the action of the at-

mosphere and of the sun, and will emit more abundant and more noxious exhalations, the sewer proposed to be made through Essex will become a foul river, and will ultimately rival its parent,—if the water for the supply of London be abstracted from the Thames as at present,—and will waft the seeds of disease more extensively than is now accomplished both by the river and by the sewers which run into it.

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#### CHAP. IV.

*Means advised for deodorising and disinfecting the excrementitial and decomposing Substances flowing into, through, and from Drains and Sewers.*

THE object to be desired in dealing with the sewage of London, and of all large towns, is not only to deodorise, but also to disinfect it, and to employ those means which are most calculated to utilise it, or to render the sewage most serviceable for agricultural and horticultural purposes. It has been generally inferred, that the removal of the unpleasant smells, or the deodorisation of the sewage, is the chief object to be entertained; but an infecting or poisonous influence may exist without any smell by which its presence may be betrayed. Therefore, the means employed to deodorise should also be calculated to disinfect the materials with which they are mixed. Certain of the means which suggest themselves for disinfection, especially the cream or hydrate of lime, have been viewed as having the effect of setting free ammonia, upon the existence of which the virtues of



sewage as a manure partly depends. This objection has been pushed much too far ; and it may be obviated by combining with the lime one or other of the several kinds of carbon or charcoal, which will retain the ammonia, and at the same time both deodorise and disinfect putrescent animal substances. It has also been objected to the employment of lime that the quantity of it which will exist in the solid sewage will render the manure, which it assists in forming, too cheap for any attempts to utilise the sewage becoming remunerative ; and that the manure, thus formed, will not be suitable to all soils ; but when duly managed, it will be appropriate to many soils ; and when used as a compost, or combined with other manures, and immediately tilled into the earth, it will be suitable to most. These objections are urged chiefly for the sake of argument, for a parade of scepticism is viewed by many as a sign of superior knowledge. But the admixture of a due proportion of wood charcoal, or of peat charcoal, or of soot, or even of coarsely powdered coke, will obviate most of these objections, which have been too captiously urged ; and will be found most serviceable for agricultural purposes, as furnishing, in the very slow manner required, the carbon which is so essential to the growth of plants. In certain circumstances of season or states of concentration, or when the sewage is more than usually rich in animal putrescent substances, and most productive of noxious exhalations, and especially when infectious maladies are prevalent, then either of these may be used in larger quantity ; or a small proportion of the chloride of lime may be added to them, the quantity of this latter substance capable of sufficiently disinfecting the soil of drains and sewers being very small.

The difficulties in the way of deodorising and disinfecting the excrementitial and putrescent matters flowing from sewers are by no means so great as many believe, and are so very few, as shown by the works at Leicester, as to be readily overcome by engineering talent.

The agents now advised are calculated — 1st, To admit of the removal of the more consistent parts of the sewage in carts, waggons, barges, &c., whether covered or uncovered, without generating or diffusing any smell, or infectious or injurious exhalation; and consequently without endangering the health of those employed in the removal, or of those in the vicinity of the receptacles or reservoirs into which the sewage directly passes from the mouths of the main sewers, and commingles with these disinfecting and deodorising substances: 2nd, To admit of the solidification, and of the retention, of the organic, animal, and volatile parts of the sewage, in the same or in similar modes to those employed at Leicester, whilst the additional agents now recommended accomplish the retention of the fertilising elements for agricultural purposes; the solidification of the sewage, allowing the removal of it to great distances, and the preservation of it, so as that it may be used appropriately to the nature of the soil, and, where it may appear unsuitable to the soil, it may be used as a compost, or united to other manures. These are important facts, and their practical bearings have been fully shown by the justly celebrated inventor of the Electric Telegraph, Mr. W. Fothergill Cooke, in his pamphlets on this subject, and by his discourse very recently delivered at the Society of Arts.

## CHAP. V.

*The General Principles and System of Drainage and Sewage recommended for London, and all large Towns when duly adapted to their Situations.*

THERE are certain principles which recommend themselves to common sense in constructing drains and sewers for large and densely populated towns and localities; namely, — 1st, To adopt, consistently with the nature, states, and circumstances, of the locality, the shortest course, the greatest fall, and consequently the quickest discharge, from the commencement of the drain to the outlet or mouth of a main sewer, where the contents are subjected to disinfecting agents; 2nd, To aid this rapidity of discharge by copious dilution and abundant water supply in the houses from which the drains proceed, as the best means of preventing exhalations from them, through shafts, gullies, and gratings, and the contamination of the air in streets, houses, &c.; 3rd, The construction of reservoirs in such a manner as that sewers may pass or open into them, and that the usual sewage may be received in one, and undergo disinfection by the agents above recommended, and in another adjoining, into which the more fluid or watery sewage, from great falls of rain, may pass either directly or flow over from the former, the contents of both being retained to undergo purification, and the disinfected and consistent materials being treated as recommended, and removed for agricultural purposes. The water thus purified may be used either for purposes of irrigation, or be allowed to flow into

rivers or canals, according to the state and circumstances of the locality.

The immediate disinfection of the sewage, as it flows from the sewer, and the shortest course of the sewer, from the last of the contributory drains to the opening of it in the reservoir, are objects particularly deserving attention. Where the circumstances of the locality admit, the reservoirs should be as near as possible to the main trunk or trunks, which should pass directly into the reservoirs, the sewage being instantly commingled with the disinfecting agents. Whether the reservoirs be covered or uncovered, is not material, if their contents have been disinfected, inasmuch as in neither case will any injurious emanation be produced or retained, if the materials advised for disinfecting have been used, even in smaller proportions than are generally supposed to be requisite. For, as the writer has already stated, the most injurious effects produced by imperfect drainage are experienced in houses which have an insufficient supply of water, whose drains are defective or run into others equally defective, and in a less remarkable manner and degree at or near the outlets of the drains or sewers.

Instead, therefore, of the drains and intercepting and prolonged sewers now recommended by the Engineer to the Board of Works, the writer of this will, he hopes, be pardoned if he advises the construction of drains conformably with the principles he has above stated, viz., that the sewage should have the shortest and most rapid descent from the houses to the reservoirs formed for its disinfection and deodorising; and, for the more complete attainment of this end, that the houses should have an abundant supply of water to dilute and promote the discharge of the excrementitious contents of their drains.



These objects can be attained only by commencing the drains in the higher parts of the vicinity of London, on both sides of the Thames, and by terminating them in trunk sewers opening into disinfecting and deodorising reservoirs, constructed in several places on the banks of the river, between high and low water mark, where no higher situations on its banks can be obtained. In some places where the locality is limited, the reservoirs may be extended, more or less, along the banks or shores of the river; and the more consistent parts of the sewage may there be disinfected, be rendered useful for agricultural purposes, and in this state be conveyed to a distance for these purposes, whilst the sewage water will be allowed to flow into the Thames, being deprived of the conditions which rendered it injurious to health. The river, in consequence of this mode of dealing with the sewage, will not be liable to any contingent obstruction of its navigation from further deposits along its banks or near its mouth, and it will, moreover, retain the full amount of its stream and the rapidity of its current, without any diminution of the one or interruption of the other.

The number of reservoirs on each side of the Thames or other rivers may depend upon the engineering facilities with reference to already existing drains, to the fall or descent in the principal drains and sewers, and to the construction of the main sewers terminating in the reservoirs. The number on the north side of the Thames may be six or seven, or even as many as ten or twelve, and on the south side of the river from five to seven; but the number on both sides should chiefly depend upon these and other circumstances connected with the nature of the locality and with former constructions — matters entirely belonging to the province

of the engineer. The wish of the writer is to further *three* grand objects, which are of the greatest importance to the metropolis and to the country,—namely, 1st, The promotion of the health of the inhabitants of the former, and the healthiness and prosperity of the latter; 2nd, The preservation of the fertilising materials contained in the sewage for very important purposes, and in a state which may render these purposes attainable without the least risk to the health either of those employed in preserving them, or of those in any way exposed to them; and 3d, The preservation of the navigation of the Thames, and other tidal or navigable rivers, without any future risk, and of their flow without deposits on their banks or embouchures; and with a purity very much increased, at least as far as the removal of contaminating sources can be accomplished in the present state of our knowledge.

If the principles which the writer has endeavoured to set forth were applied, with such variations or modifications as locality, population, &c. might require, to the drainage and sewage, not of London only but also of all the large towns through this country, and if all the more consistent sewage were employed as manure, and the watery parts for irrigation, the greatest benefits would result to the population. It has been most eloquently, as well as most truly, stated by the Father of Agricultural Chemistry in this country, the justly celebrated Sir H. Davy, that “the doctrine of the proper application of manures from organised substances offers an illustration of an important part of the economy of nature, and of the happy order in which it is arranged. The death and decay of animal substances tend to resolve organised forms into chemical constituents; and the pernicious effluvia discouraged in

the process seem to point out the propriety of burying them in the soil, where they are fitted to become the food of vegetables. The fermentation and putrefaction of organised substances in the free atmosphere are noxious processes: beneath the surface of the ground they are salutary operations. In this case the food of plants is prepared where it can be used; and that which would offend the senses and injure the health, if exposed, is converted by gradual processes into forms of beauty and of usefulness: the foetid gas is rendered a constituent of the aroma of the flower, and, what might be poison, becomes nourishment to animals and to man."

THE END.

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