
The Sewage Question in California

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OFFICE OF THE STATE ENGINEER, CALIFORNIA, }
SACRAMENTO, August 30, 1883. }

The Honorable Board of Directors of the Stockton Insane Asylum:

GENTLEMEN: The question of sewerage for your institution naturally divides itself into two parts:

The *First*—What shall be done with the sewage matter?

The *Second*—By means of what works and appliances shall it be disposed of?

The ultimate determination of each of these questions involves a consideration of the other, but the study must commence with the first mentioned.

This report is divided into five parts; the first four being devoted to the *first* question above mentioned, and the last one to the *second* question, as follows:

Part 1—The Pollution of Rivers and Estuaries.

Part 2—The Application of Sewage to Land.

Part 3—The Artificial Treatment of Sewage.

Part 4—The Disposal of the Asylum Sewage.

Part 5—The Sewage Works Proposed at the Asylum.

In submitting this paper I do not apologise for requiring so much of your time as it will take to read a long report, because I am impressed with the magnitude of the subject, and with a sense of the fact that we are about to take a step which will be looked to as having been a precedent, when in the future this sewage disposal question shall have attracted as much attention here as it has in older countries; and I feel that it is our duty as officers of the State to leave behind a record of the fact that we have looked deeper than the surface of the matter, and tried, at least, to start aright.

Very respectfully,

Your obedient servant,

WM. HAM. HALL,
State Engineer.

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WHAT IS TO BE DONE WITH SEWAGE?

PART 1—THE POLLUTION OF RIVERS AND ESTUARIES.

THE EFFICIENCY OF SEWERAGE WORK.

Every sewerage proposition must be considered from the standpoint of efficiency as well as from that of cost.

To be *efficient* such a system must effect the final disposition of the sewage matter in a way unobjectionable alike to the locality sewered, to other localities, and the public generally.

The question of efficiency in sewerage systems has received very much attention within the past few years.

European centers of population, and outlying districts as well, have been thoroughly shaken in their social structures by this sewage question, and are yet earnestly considering it.

And even in the comparatively young communities of our Eastern States such sanitary matters occupy a prominent place in the minds of the thinking people of all leading cities and suburban neighborhoods, and have received fitting recognition at the hands of professional and scientific men.

As the result of this activity of practice, observation, and thought, there is a fund of experience for us to contemplate.

The professional man who undertakes to look beyond the surface of this subject finds at his command a library of recorded experiences and facts, which are multiplying so rapidly that there is no branch of applied science at this time more progressive than that known as Sanitary Engineering.

No questions in this connection have received more earnest attention than those of the efficiency of the disposal of sewage;

first, by mingling it with the waters of streams and tidal estuaries; and *second*, by applying it to land; and, as auxiliary to each or both of these, *third*, the question of the artificial treatment of sewage matter to render it more easy of efficient final disposal by the other mentioned methods.

The sewage to be dealt with at your institution is simply fouled water—that is, it is “water carried,” and not “middenstead” matter.

The object of all sewerage work in dealing with this class of sewage must be to return the water to its natural state of purity, and to change to harmless, if not useful, forms, the other constituent parts of the substance treated.

THE POLLUTION OF WATERS.

The practice of the disposal of sewage by mingling it with the waters of rivers, tidal estuaries, etc., has been upheld upon the theory that running waters soon purify themselves: that the organic matters become changed in character, and other objectionable parts so far dispersed or altered as to lose appreciable influence upon the human senses and all harmful effect upon the human system.

It was alleged that the particles of the organic (animal and vegetable) parts of noxious matters, being dispersed by mingling with comparatively large bodies of water when dumped into a river or estuary, were brought in contact with the combined or dissolved oxygen of the air in the water, or of the air over the water, by the rolling or boiling motion of the current, and thus oxidized—a change equivalent in its effect to *burning*.

The theory appeared to be well founded. A number of instances were cited where the waters of streams polluted by sewage, apparently cleared themselves by running a few miles. Others were brought forward where clear water streams polluted by peaty matter, and rendered dark and opaque by the vegetable organic matter held in solution, became clear after running similarly short distances. These changes it was said

were due to oxidation of the animal matter in the one case, and the vegetable matter in the other; and, hence, that the waters were purified.

And it was argued that contact with air under these conditions of mingling with water, having this effect of oxidizing organic matter in these cases, it would have such effect in all cases, and, hence, the mingling of sewage with running or tide agitated waters was not a vicious and objectionable practice.

So well grounded has this theory appeared, and so strong were the interests involved in its favor, that in England, "until recently, sanitary engineers have done their best to remove sewage matter from towns into rivers in obedience to legislative requirements." (Bailey Denton, Lectures, etc., p. 248.)

But for years there has been the most violent opposition to this "pernicious and disgusting practice," throughout Western Europe, but more especially in England, where the subject has been forced to the front in ways that could not be ignored, and where the form of laws and social organization appears to have allowed wider range to the discussion than it attained in the other countries.

But facts soon proved that the theory of self-purification of river waters was at fault. Some streams of no less but greater volume, receiving no more or perhaps less sewage, did not purify their waters as was alleged of others, and inquiry developed the fact that by no means all peaty waters become pure in their onward flow.

And, most perplexing of all, it was observed that streams which for years had received sewage matter without much apparent detriment to their waters, became foul to every sense, within a comparatively short space of time, and without any considerable increase in the amount of sewage led into them.

The subject now assumed a serious form. Great sewerage works had been carried out, immense manufactories located and operated, and all depending for efficiency upon the

privilege of a free outfall for sewage into the tidal or inland waterways of the country.

The battle now became fierce. Sanitarians generally, and towns located low down on the streams, protested against the pollution of the waters by town sewage and manufacturing offal at points above.

The property owners ("rate payers," so called in English literature—really non-resident landlords in many instances) in towns where sewerage works had been constructed leading the sewage into the streams, as well as those in other towns which desired to construct works on this principle, together with the manufacturers generally, who were for getting rid of their offal waters in the easiest way to avoid further expense to themselves, vigorously opposed interference with existing practices.

The fight now became a war very similar to the struggle which has gone on in this State between the hydraulic miners and the farmers and others in the Sacramento Valley, with not so much organization of the contending parties, however; but with legal points on both sides, and denial and assertion of facts in a way almost identical.

The objection urged that the waters were rendered unfit for drinking purposes was answered by saying that they ought to be filtered, and that all waters ought to be filtered before drinking, anyhow. About this stage of the contention other towns and cities resorted to filtering their water supplies, and supplying companies were forced by legislative enactment to maintain filter beds in connection with their works.

In the meantime the attention of scientific men had been secured, and a store of systematically arranged facts was accumulating from observation and experiment. The aid of chemistry had been invoked and waters were subjected to chemical analysis with comparatively satisfactory but sometimes startling results, for waters which had been regarded as pure and which were so to all appearance, taste, and smell, were shown to be laden with organic matter of a character

calculated to develop the most deadly zymotic diseases under conditions favorable for such development.

Some apparent cases of self-purification of streams were shown to be delusive: the waters were *clarified* and *deodorized* but not *purified* either of their organic impurities or inorganic elements not to be desired in potable waters.

The next step towards the truth was the result of systematic studies into the causes of apparent self-purification of river waters in some instances, by which results the old theory of the oxidation of organic matters by contact with the air, and the consequent purification of river waters, as heretofore stated, is shown to have been altogether in error.

It is now known that, *as a general thing*, waters polluted by the organic matter of sewage do not purify themselves within any limited space of time or distance of flow, as has been supposed, and in no material degree by the sole action of the oxygen contained in the water or of the air above it.

It is certain that alleged cases of self-purification are only apparent to the eye and sense of smell, and are not real; and it is contended that if waters are dangerous to health they had better have the noxious appearance and smell, and thus carry with them a warning of their character, than be tempting to the eye or lulling in effect.

It is explained that the action of self-purification of rivers of organic matter, found to take place in some cases, is due to the admixture from tributary streams or springs along their banks, of other waters having certain mineral substances (such as ferric oxide, copper, and alumina) in solution, or to the action of certain clays or the mineral constituents of certain clays which compose their bed or banks; and hence that such instances of self-purification are due to peculiar circumstances, which, being local and not generally distributed, establish the rule as against self-purification at all.

It is understood that the action of the soil of the banks or bed of a stream in purifying its waters of organic matter, after awhile ceases, and that in the mean time the soil itself has

become foul and poisoned to a degree that its effect upon the water, were it really purified above, would be to re-impart a noxious organic matter to it in a considerable degree.

SOME AUTHORITIES ON THE SUBJECT.

The line of authorities in support of these general conclusions is so very extended that any attempt to give a fair idea of them in a hurriedly prepared paper as this one must be, would be futile; and at the same time it should be remarked that opinions are not all one way. A careful tracing of the subject, however, has led me to the conclusions which I have given; and I believe that any one at all competent to judge of scientific argument, acquainted with the standing of the leading men who have appeared in it, and who will laboriously trace the subject through the records of the original authorities, will find them overwhelmingly in support of the propositions I have laid down, both as to bearing of facts and argument.

A few citations will show their general tone on this point of the pollution of river waters:

The Rivers Pollution Commission.

Consequent upon the rapid deterioration in the quality of river waters in England, and upon the growing opposition to the mingling of sewage with them, in 1865, by authority of law, a Royal Commission was appointed to inquire into the subject.

Men of the very highest professional and scientific standing and widest experience were appointed to the Board. Sir Robert Rawlinson, Past President of the Institution of Civil Engineers; John T. Harrison, Esq., Member of the Institution, and of the Local Government Board of the Kingdom, and Professor John T. Way, one of the leading chemists of the country, being the members.

In the first report of this Board (pp. 18 to 22) is to be found a summary of the extended series of experiments upon the subject of "self-purification of river waters," and it is conclu-

sively shown that the idea is a fallacy—that purification in any considerable degree, except in very rare cases, does not take place. This report raised a perfect storm of opposition supposed to be in the interest of capital interested in property and works that would have to be heavily taxed if any change was made in the manner of disposing of sewage.

In 1868 the Queen commissioned a new set of members of the Rivers Pollution Commission. These were Sir W. T. Denison, Colonel in the Corps of Royal Engineers; Edward Frankland, Esq., one of the most eminent chemists of the present age; and John C. Morton, Esq., an eminent sanitarian.

This was a collection of eminent men charged, by the terms of their commission, with the duty of “inquiring how far the present use of rivers or running waters in England for the purpose of carrying off the sewage of towns and populous places, and the refuse arising from industrial processes and manufactures, can be prevented without risk to the public health or serious injury to such processes and manufactures, and how far such sewage and refuse can be utilized and got rid of otherwise than by discharge into rivers or running waters, or rendered harmless before reaching them,” etc.

For the sake of brevity, I quote only from the sixth report of the Commission, issued in 1874, it being the latest to hand at this day.

Under the head of “*Quality of water from different sources*,” the Commission say:

“6. *River water*, usually in England, but less generally in Scotland, “consists chiefly of the drainage from land which is more or less cultivated. When it is further polluted by the drainage of towns and “inhabited places, or by the foul discharges from manufactories, its “use for drinking and cooking becomes fraught with great risk to “health. A very large proportion of the running waters of Great “Britain are either at present thus dangerous or are rapidly becoming “so.” (Sixth Rept. Riv. Poll. Com., p. 425.)

Under the heading, “*As to the possibility of rendering polluted water again wholesome:*”