STAFFORDSHIRE COUNTY COUNCIL.

EXTRACT FROM MONTHLY REPORT

OF THE

COUNTY MEDICAL OFFICER OF HEALTH,

Presented to the Sanitary Committee, Nov. 6, 1897.

Sewage Disposal at Tipton.
Experimental Filters.

As the Committee are aware, for some time past an experimental sewage disposal plant has been in operation at Tipton, with the object of ascertaining whether it would be possible (by additions and improvements at the existing outfall works) to satisfactorily deal with that portion of the sewage of the district which now drains to the works, and which, at present, gives rise to serious pollution, as well as with the sewage of about 6,500 people in the immediate neighbourhood. The experimental plant has now been at work sufficiently long to warrant reliable conclusions being arrived at, and, in this report, these conclusions, together with the facts upon which they are based, are set forth.

In order that the Committee, and others who may have to consider this report, may understand the circumstances which led to the experimental work being undertaken, it is desirable, in the first instance, to give a short summary of the existing means of sewage disposal within the Tipton Urban District.

The District, for an urban one, is widely scattered, having an area of 2,697 acres, and a population, according to the last census, of 29,314. The population is grouped together at centres, chiefly round the boundary, the central part being non-residential and nearly exclusively devoted to mining operations.

At present no attempt is made to deal with the larger portion of the sewage of the district, it simply finds its way into streams and canals, at convenient points, by means of road drains. An exception to this rule exists, however, in the case of the Great Bridge district, where disposal works were constructed at Toll End, in 1888, with the sanction of the Local Government Board, and at a cost of £15,400. At present the sewage of about 5,300 of the population is conveyed to these works, and it is proposed to increase this number by about 6,500, bringing the total up to 11,800. Originally it was intended, ultimately, to sewer the whole district to this point, but, for reasons which will presently appear, the Authority have now abandoned that idea.

As regards the area now draining to the disposal works, some portion of the sewage is conveyed to the outfall sewers by old road drains, and, in order to complete the sewering of this area—a most desirable proceeding for many reasons—the Authority, a few years ago, applied to the Local Government Board for a loan of £1,200. In response to this application, an Inquiry was held in October, 1894, which resulted in the loan being refused, on the ground that the Board would not sanction further expenditure unless a scheme was presented for dealing with the sewage *on land*.

The District Council again communicated with the Local Government Board, pointing out that, under the circumstances, land disposal was out of the question. This led to one of the Board's Inspectors being instructed to visit the district to ascertain whether this was really the case, and, after an inspection of the district, he recommended three sites as being suitable for the purpose. The District Council, having considered the Inspector's proposals, came to the conclusion that all three sites were out of the question by reason of unfitness and prohibitive cost.

Two of the sites proposed are said to be, in parts, about 60 feet below the level of the stream into which the effluent would have to be discharged, and, being old mining areas, are studded all over with disused shafts. The local Surveyor pointed out that to prepare either of these sites for the purpose would not only involve an "enormous" outlay, but, that when the work was carried out, the "inevitable result" would be that the sewage would find its way into the old pit shafts, and thus lead to litigation with the Mines Drainage Commissioners.

As regards the third site which was proposed by the Local Government Board Inspector, it is two miles distant from the outfall works, and within the Borough of Wednesbury. The local Surveyor commenting upon this site points out that, as both the Borough of Wednesbury and the County Borough of West Bromwich had, in their own interests, to carry their sewage a mile further than the site in question, it is not likely that either of these Authorities would allow Tipton to make use of the land without offering strenuous opposition to such a scheme.

Previous to these negotiations with the Local Government Board, the County Council had repeatedly brought pressure to bear upon Tipton on account of pollution, not only from the existing disposal works, but also from the district generally. After many communications between the County and the District Councils, a joint Conference was held at which the whole question was carefully considered. It is unnecessary to go into detail regarding this Conference and the enquiries it led to—suffice it is to say that the conclusions arrived at were as follows:—

1.—That, owing to the serious subsidences from mining operations which are now going on in portions of the district through which the intercepting sewers must necessarily pass (which subsidences may possibly take place even to a greater extent in the immediate future) it would be most unwise, at present, to sewer the whole district to the existing outfall works.

2.—That the unsewered portions of the district—other than that portion which it is proposed shall be drained to the existing works, and a portion containing less than 100 houses, which can be connected with the Wednesbury sewers—may, without fear of injury to the sewers, be sewered to two points, where disposal by means of precipitation, artificial filtration, and land treatment could be successfully adopted, the outfalls being at such a level as would allow of all the sewage being carried, by gravitation, to the existing outfall works, if in the future, when subsidences had ceased, it appeared wise to adopt that course.

3.—That, whatever means of disposal may ultimately be adopted, the completion of the internal sewerage of the district which now drains to the existing outfall works must be carried out, and that this work, for which the loan of £1,200 is required, is urgently called for.

A Map has been prepared by the Surveyor which shows, by distinctive colours, the drainage areas referred to, and the following are the localities, with their approximate populations, embraced in each area :—

Locality	Area	Approximate Population.
Tipton Green	Horseley Proposed Outfall ...	12,340
Bloomfield		
Princes End...		
Dudley Port (south-west side) ...	Burnt Tree ,, ,, ...	5,380
Burnt Tree		
Toll End	Great Bridge Present Outfall	11,800
Great Bridge		
Horseley Heath		
Dudley Port (south-east side) ...		
Ocker Hill		
Gospel Oak		
Lea Brook (part of)		
Lea Brook (rest of)	To Wednesbury Sewers ..	400
		29,920

The construction of the experimental filters at the existing outfall works was the outcome of the Conference above referred to, the object being, as already stated, to arrive, if possible, at some satisfactory scheme of disposal for the sewage of the Great Bridge area, *without land*, in the hope that the Local Government Board might be induced to re-consider their refusal of the loan, it being understood that schemes would then be prepared for dealing with the sewage of the other parts of the district, locally, on the lines already indicated.

Before detailing the results obtained by the experimental filters, it may be well to give a short description of the existing works, as, in all probability, these works will have to be adapted to any scheme which may ultimately be carried out. The area covered by the works is about $5\frac{3}{4}$ acres, and the larger part of the sewage which now drains to the works reaches the outfall by gravitation. A portion, however, has to be pumped, and this is effected by means of a gas engine (8 h.p.), which is also utilized for pumping the sludge and working a lime mixer. The method of disposal is precipitation followed by artificial filtration through filters composed of sand, gravel, and slag. There are two sludge tanks and three precipitation tanks, with a total capacity respectively of 44,000 and 984,000 gallons. The precipitation process is assisted by the addition to the sewage of "alumino-ferric" and lime. The filters, two in number, are 3ft. deep and have a total superficial area of about 1,546 yards.

As regards the capability of the existing plant for disposing of the sewage of the area in question, I have ample evidence, both from periodic inspection, and repeated analyses extending over about five years, that the quality of the effluent has invariably been far from satisfactory, and that the cause of this has been inefficient filtration. So far as the precipitation process is concerned—as one would expect, considering the large tank accommodation in proportion to the population—there is little fault to be found, but as regards the filters, they are structurally incapable of producing a good effluent. Apart, also, from the structure of the filters, they are situated at such a level that water-logging must necessarily take place (except in the driest weather) at a depth of about 2ft.; and as one essential element in successful filtration is the free aeration of the filters, those in question naturally cannot possess any material purifying power.

Owing to the great advance which has taken place in artificial filtration since the construction of the existing filters, the District Council determined to construct the experimental filters which, with the Committee's approval, I am now reporting upon. Three filters were constructed in the first instance, one of coke breeze, another of sand and gravel, and the third of sand and gravel aerated on Lowcock's principle, which consists in artificially pumping air into the filter. The coke breeze and ordinary gravel filters were completed in September, 1896, but it was not until January, 1897, that Lowcock's filter was ready for use. Early in the year, owing to the great success which had been achieved by the new Garfield coal filter at Wolverhampton, I recommended the District Council to substitute one of these filters for the ordinary gravel experimental filter. Accordingly, this was done, under the superintendence of Mr. Garfield himself, the work being completed and the filter in use on February 28th, 1897.

As the ordinary gravel experimental filter was only in use for about three months during the winter, and did not give very satisfactory results, I do not propose to complicate this report by introducing the analytical records of samples collected from it, but will deal simply with the coke breeze, the Garfield, and the Lowcock filters.

The coke breeze and the Garfield filters measure 12 feet square, but Lowcock's measures twice that area, and is divided into two filters measuring 12ft square each. The depth in all cases is only 3ft 9in., as the fall from the tanks to the stream which receives the effluent did not allow of a depth of 4ft. 6in., which would have been preferable. Each filter was worked under similar conditions with the same tank effluent, 200 gallons per superficial yard being passed through the coke breeze and Garfield filters, and 100 gallons through the Lowcock filter during the 24 hours. The coke breeze filter was at first worked on the principle of charging and discharging recommended by Mr. Dibden, late chemist of the London County Council, but after a time it was worked, like the others, on the continuous flow system with intervals of rest, the proportion being 12 hours at work and 12 hours rest.

One advantage claimed for Lowcock's filter is that it can be worked continuously—but soon after the experiments started, this, for various administrative reasons, was not found practicable, so that through the greater part of the time it was worked like the others, as regards periods of rest. Had it been worked without any rest, then the 200 gallons per 24 hours would have passed through it.

The figures of analyses, extending from September 8th, 1896, to the end of the same month this year, are set forth, in detail, in tables attached to this report. From these figures I have worked out the following means and percentages which, being comparative, will assist the Committee in forming an opinion as to the relative merits of the respective filters in dealing with the sewage in question, which, I may state, is an ordinary domestic sewage from a town with comparatively few water-closets.

SAMPLE.	No. of Samples Analyzed.	Parts per 100,000.								Percentage Purification	
		Solids.			Chlorine.	Free Ammonia.	Organic Ammonia.	Oxygen absorbed in 4hrs. at 80° F.	Nitric Nitrogen.	On Organic Ammonia basis.	On Oxygen absorbed basis.
		In Solution.	In Suspension.	Total.							
Tank Effluent	13	82·7	1·6	84·3	10·2	1·25	0·23	0·77	Nil	—	—
Old Large Sand Filter	15	76·6	1·5	78·1	10·8	1·19	0·14	0·53	0·09	38·2	31·2
Experimental: Coke Breeze ,,	10	84·0	0·9	84·9	10·0	0·90	0·16	0·58	0·38	33·2	29·0
Experimental: Lowcock's ,,	8	80·7	1·4	82·1	10·0	0·27	0·05	0·22	0·74	75·7	68·5
Experimental: Garfield's Coal ,,	8	91·4	0·3	91·7	10·6	0·19	0·04	0·20	0·81	80·6	70·8

With reference to the number of samples analysed, it will be seen that it varies, but in estimating the percentage purification figures in the case of the experimental filters, the mean of the corresponding tank effluents in all cases was taken as a basis. As regards the samples of tank effluent upon which the percentages in the case of the old sand and gravel filters were estimated, it was not possible to adopt this course, hence, no doubt, the slight discrepancy between the tank and filter effluents which some of the figures appear to show—for example, those of the solids and the chlorine. For all practical purposes, however, the percentage figures in the case of the old sand filter also may be accepted as being near the mark.

The percentage purification figures have been worked out on the bases, both of the reduction of the organic ammonia and the amount of oxygen absorbed, because the reduction of these in the filter compared with the tank effluents constitutes a very good index of the decrease in the putrescent matter, and, therefore, of the efficiency of the filtration.

Another important figure is the quantity of nitric nitrogen present in the filter effluents. It indicates converted nitrogenous organic matter, and, as a general rule, the higher this figure the more active is the purifying power of the filter.

In this connection, it may be mentioned that the period of the year when the artificial filters were started has an important bearing on their activity. Had the filters been started in the Summer in place of in the Winter, the results, in all probability, would even have been better. Bacterial growth, upon which the activity of filters mainly depends, takes place but slowly in Winter, whereas it starts vigorously in Summer, and, when once established, the Winter does not interfere to any great extent with its continuance.

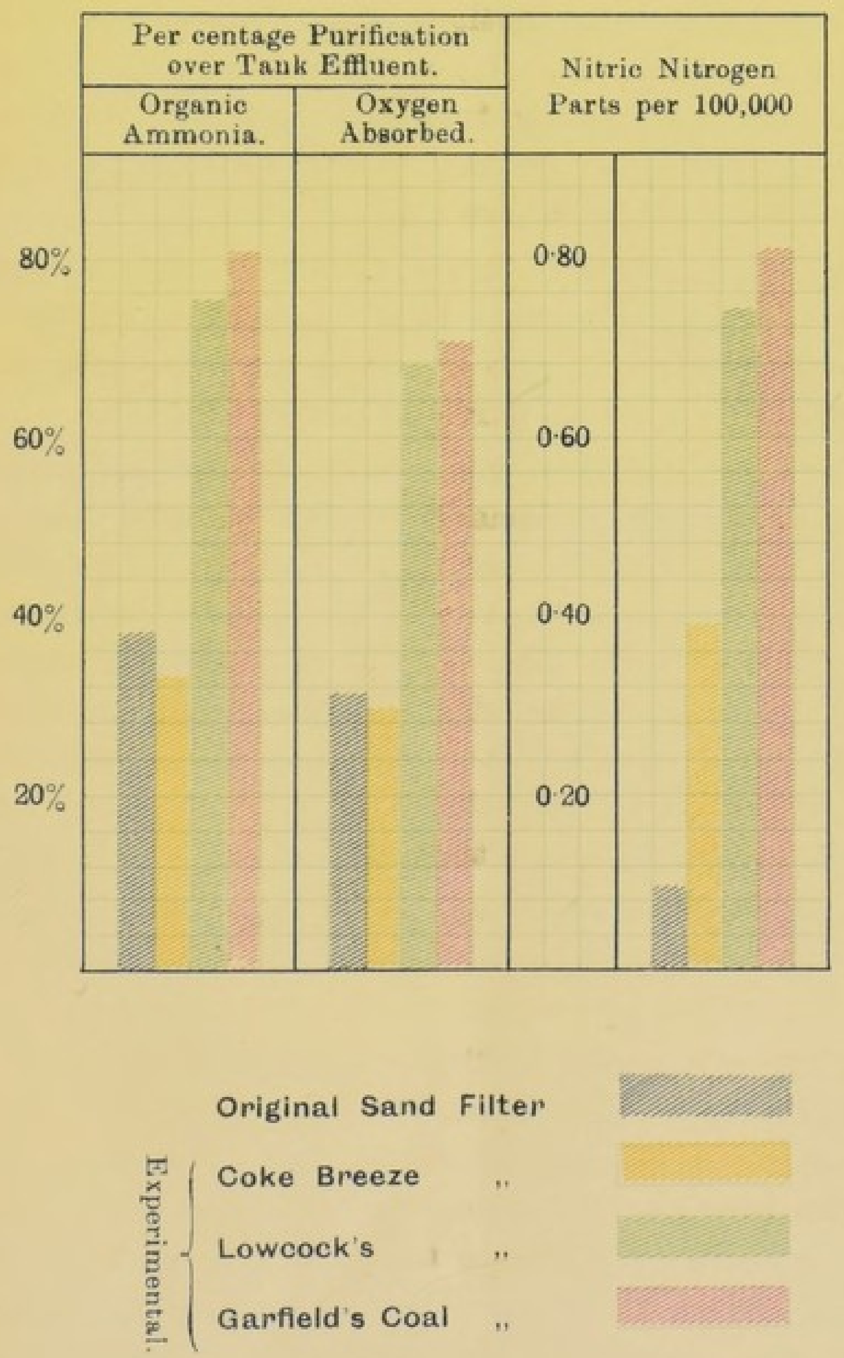
From the above figures I have prepared the accompanying diagram, which indicates, at a glance, by means of coloured columns, the relative results from the different filters.

It will be seen that the effluents from the Lowcock and the Garfield Filters are conspicuously purer than those from the coke breeze or the original sand filters. The latter two effluents are practically the same as regards impurity, except that the nitrification is greater in the case of the coke breeze filter.

As the experiments were undertaken with the view of arriving at an improved system of artificial filtration, the only

Sewage Filtration at Tipton.

Diagram showing mean standard of activity of each filter, estimated on the series of analyses set forth in the tables.



two filters which need be considered are Lowcock's and Garfield's, which are represented by the green and red columns respectively.

The results obtained from these filters are certainly highly satisfactory. The reduction of organic impurity, as indicated by the percentage reduction of organic ammonia and oxygen absorbed, is very large in both cases, and slightly greater in the Garfield than in the Lowcock effluent. Equally satisfactory, in both cases, is the nitrification effected, and here, again, the Garfield effluent is the better.

If, then, corresponding success in dealing with the sewage in question on a large scale, by either process, can reasonably be expected, the difficulty, as regards Tipton, is comparatively easily solved.

On experimental data, the preference must be given to the coal filter, especially considering the fact that it did twice the work of the Lowcock filter, although it does not follow that the latter might not have dealt with an equal volume had circumstances permitted of its being used continuously. The coal filter also has other advantages, for, it involves less initial cost in construction, and a smaller annual expenditure in working.

When the Tipton experiments were first started the only knowledge we had of coal as a filtering medium was that derived from the working of the experimental filter at Wolverhampton. Since then, however, coal filters, on a comparatively large scale, have been constructed in other districts in this County, and in Derbyshire, with uniformly excellent results.

We may then, I think, with confidence conclude, that the Tipton District Council are in a position to efficiently dispose of the sewage of the district by precipitation and artificial filtration, supplemented, in the case of about three-fifths its bulk, by land treatment, and we now have sufficient evidence of this to justify the District Council in again approaching the Local Government Board on the matter.

This time, however, they should be prepared to give an undertaking to at once prepare plans, for the approval of the Board, for the proper disposal of the whole of the sewage of the district. It is true that the urgent matter (from a sewerage point of view) is the construction of the internal sewers in the district which now drains to the works at Toll End, but (from a river pollution point of view) it is equally important that the disposal works themselves should be perfected and efficient provision made for the disposal of the sewage of other parts of the district. It has now been shown that the difficulties which, hitherto, have been supposed to stand in the way can very well be overcome, and the District Council may reasonably anticipate that the Local Government Board will be prepared to re-consider the whole question and grant facilities for carrying out the work which it is so important should no longer be delayed.

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SEWAGE FILTRATION AT TIPTON.

DETAILS OF ANALYSES OF EFFLUENTS.

PARTS PER 100,000.

TANK EFFLUENT.

Sample Collected.	Solids. In Solution.	Solids. In Suspension.	Solids. Total.	Chlorine.	Free Ammonia.	Organic Ammonia.	Oxygen absorbed in 4 hours at 80° F.	Nitric Nitrogen.	Depth at which test lines are obscured.
1896.									
Sept. 8	73·0	6·0	79·0	9·2	1·760	0·299	1·600	Nil.	1·5
Oct. 19	84·0	Nil.	84·0	10·2	1·640	0·196	0·696	Nil.	4·0
Nov. 4	87·0	Nil.	87·0	10·6	1·660	0·304	0·888	Nil.	3·5
1897.									
Jan. 11	94·0	Nil.	94·0	10·0	1·619	0·108	0·520	Sl. Tra.	7·5
Mar. 8	92·0	1·0	93·0	10·2	1·538	0.270	0·752	0·05	4·0
,, 6	102·0	Nil.	102·0	11·0	1.078	0.112	0·500	Trace	14·0
,, 30	93·0	Nil.	93·0	10·8	1·176	0·132	0·584	Nil.	8·0
April 21	87·0	4·0	91·0	10·2	1·153	0·297	0·972	Nil.	4·0
May 17	75·0	3·0	78·0	11·0	0·885	0·234	1·060	Nil.	3·5
June 9	72·0	Nil.	72·0	9·6	1·016	0·256	0·440	Nil.	4·0
,, 14	69·0	Nil.	69·0	10·0	0·936	0·171	0·344	Nil.	15·0
July 19	68·0	7·0	75·0	11·0	0·840	0·506	1·168	Trace	2·5
Sept. 28	79·0	Nil.	79·0	9·4	0·977	0·147	0·580	Nil.	14·0

COKE BREEZE FILTER.

Sample Collected.	Solids. In Solution.	Solids. In Suspension.	Solids. Total.	Chlorine.	Free Ammonia.	Organic Ammonia.	Oxygen absorbed in 4 hours at 80° F.	Nitric Nitrogen.	Depth at which test lines are obscured.
1896.									
Sept. 8	70·0	Nil.	70·0	8·8	1·760	0·219	0·668	Nil.	4 inch.
Oct. 19	87·0	Nil.	87·0	9·8	1·300	0·144	0·468	0·10	5 ,,
Nov. 4	89·0	Nil.	89·0	10·4	1·560	0·254	0·640	Nil.	3·5 ,,
1897.									
Jan. 11	94·0	Nil.	94·0	10·2	1·344	0·092	0·440	0·35	7 ,,
Mar. 30	97·0	Nil.	97·0	10·8	0·666	0·077	0·368	0·42	9·9 ,,
April 21	88·0	Nil.	88·0	10·0	0·791	0·210	0·944	0·41	5 ,,
May 17	76·0	2·0	78·0	10·6	0·733	0·196	0·872	0·41	7·5 ,,
June 9	75·0	2·0	77·0	9·4	0·468	0·156	0·360	0·42	5·5 ,,
,, 14	70·0	Nil.	70·0	9·8	0·368	0·126	0·360	0·61	Over 2ft.
July 19	74·0	5·0	79·0	10·8	0·032	0·200	0·748	1·11	6·0 inch.

LOWCOCK'S FILTER.

Sample Collected.	Solids. In Solution.	Solids. In Suspension.	Solids. Total.	Chlorine.	Free Ammonia.	Organic Ammonia.	Oxygen absorbed in 4 hours at 80° F.	Nitric Nitrogen.	Depth at which test lines are obscured.
1897.									
Jan. 11	91·0	Nil.	91·0	9·2	1·280	0·045	0·195	0·28	11·5
Mar. 30	91·0	Nil.	91·0	10·4	0·384	0·030	0·120	0·5	Over 2ft.
April 21	88·0	1·0	89·0	10·6	0·007	0·024	0·260	0·79	,,
May 17	81·0	Nil.	81·0	10·8	0·169	0·056	0·300	1·33	17·5
June 9	72·0	2·0	74·0	9·6	0·130	0·090	0·216	0·66	8·5
,, 14	74·0	1·0	75·0	9·8	0·088	0·058	0·100	0·79	Over 2ft.
July 19	67·0	7·0	74·0	11·0	0·071	0·108	0·396	0·83	10
Sept. 28	82·0	Nil.	82·0	9·2	0·092	0·037	0·196	0·74	Over 2ft.

"GARFIELD" COAL FILTER.

Sample Collected.	Solids. In Solution.	Solids. In Suspension.	Solids. Total.	Chlorine.	Free Ammonia.	Organic Ammonia.	Oxygen absorbed in 4 hours at 80° F.	Nitric Nitrogen.	Depth at which test lines are obscured.
1897.									
Mar. 6	113·0	Nil.	113·0	12·8	0·740	0·030	0·116	0·10	Over 2ft.
,, 30	96·0	1·0	97·0	11·0	0·475	0·042	0·236	0·55	,,
April 21	103·0	2·0	105·0	11·0	0·012	0·024	0·172	0·95	,,
May 17	101·0	Nil.	101·0	11·0	0·064	0·037	0·200	2·08	,,
June 9	81·0	Nil.	81·0	9·4	0·004	0·043	0·120	0·87	15·5
,, 14	79·0	Nil.	79·0	10·0	0·135	0·058	0·184	0·61	Over 2ft.
July 19	77·0	Nil.	77·0	10·8	0·108	0·088	0·348	0·39	12·5
Sept. 28	81·0	Nil.	81·0	9·2	0·025	0·042	0·272	0·95	Over 2ft.