A SCHEME

OF

SEWERAGE AND SEWAGE UTILIZATION

FOR

HORNSEY.

PREPARED FOR THE HORNSEY LOCAL BOARD OF HEALTH,

BY

BALDWIN LATHAM, C.E.,

MEMBER OF INSTITUTION OF CIVIL ENGINEERS, PAST PRESIDENT OF SOCIETY OF ENGINEERS, &C

Author of

"PAPERS ON THE DRAINAGE OF THE FENS;" "SUPPLY OF WATER TO TOWNS;" "UTILIZATION AND PURIFICATION OF SEWAGE;" "LECTURES ON SANITARY ENGINEERING AT THE ROYAL ENGINEER ESTABLISHMENT, CHATHAM;" "APPLICATION OF STEAM TO THE CULTIVATION OF THE SOIL," &C.

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PREFACE

In October last, the Hornsey Local Board of Health invited a number of Engineers to submit designs for the sewerage and disposal of the sewage of their district, on the understanding that the schemes presented should embrace a mode of disposing of the sewage by its application to land, and that the unsuccessful competitors should each receive 50 guineas. The author, with others, submitted a scheme, which is embodied in the following pages, and which has been adopted by the Hornsey Local Board as the basis of their future operations.

B. L.

7, Westminster Chambers, Westminster, S.W.
April, 1870.

A SCHEME OF SEWERAGE AND SEWAGE UTILIZATION FOR HORNSEY.

To the Hornsey Local Board of Health.

GENTLEMEN,

In conformity with the instructions conveyed to me by your Clerk, Mr. Hammond, I have very carefully considered the whole of the matters appertaining to the construction of a system of sewerage for your district, and on the accompanying Plan I have laid down such a system of sewers and other works as will be sufficient for the present and prospective requirements of the district in question. Instructions. Scheme sufficient for present and prospective requirements of district.

As the instructions conveyed to me pointed out the mode which should be adopted for the disposal of the sewage, it will be needless for me here to enter upon the special advantages of the mode of disposal which you have so wisely resolved should be adopted, therefore I will confine my attention to the special merits of the scheme delineated upon the Plan already referred to. In designing a system of sewerage for any district, it is requisite to take into consideration :— Mode of disposal by irrigation.

1st. The area of that district.
2nd. The rainfall of that district.
3rd. Its geological character. Matters for consideration in designing a scheme of sewerage.

4th. Its physical outline.

5th. The present and prospective number of its population.

6th. The water supply of that district.

Area of the District.

Area of Hornsey parish.

The total area of Hornsey parish, exclusive of the portions detached, is 2973 acres. The district under your care is somewhat less than this, as

Area in Metropolitan Board's jurisdiction.

155 acres are in the jurisdiction of the Metropolitan Board of Works; and in considering the area to be drained, a further deduction for water must be made, which will make the probable area of the

Area to be sewered.

district included and taken into consideration in the proposed scheme of sewerage about 2700 acres.

Rainfall.

Mr. Cuthush's Rainfall Tables.

The rainfall of the district for the last seven years has been kindly furnished to me by Mr. Cutbush, of Highgate Nursery, and is as follows:—

Year.	Annual Rainfall.	Number of Rainy Days.	Greatest Rainfall observed in 24 Hours.	Date of Greatest Rainfall.
1862	28·24	178	1·20	Sept. 29th.
1863	22·75	135	1·43	June 19th.
1864	18·16	106	0·94	Nov. 24th.
1865	30·49	147	1·16	Oct. 23rd.
1866	32·14	191	1·81	June 30th.
1867	27·14	135	1·90	July 25th.
1868	21·91	129	0·70	Jan. 12th.
Average	25·83	145	—	—

From these Tables it will be seen that on the average of the last seven years there have been 145 rainy days in the course of the year, but the number varies from 106 to 191. The greatest rainfall observed in twenty-four hours has been nearly two inches. Having regard to these excessive rainfalls, it will be requisite that due provision should be made in the sewers to take in such an amount of rain as cannot conveniently be excluded. As far as possible I should endeavour to lead the rainfall into its existing channels, which should be kept open for this purpose, the effect of which in future years may be of great importance, as a time may come when it may be requisite to adopt some scheme for pumping the sewage of your district, in order that it may be utilized, and when that day arrives it will be more economical to lift the sewage proper, instead of having to deal with a large quantity of rainfall and sewage combined.

Number of rainy days.

Greatest rainfall in twenty-four hours.

Provision made in sewers for storms.

Rainfall to be directed to existing channels.

Importance of keeping as much rainfall as possible out of sewers.

Economy in pumping secured by keeping rainfall out of sewers.

Geological Character.

The parish of Hornsey includes in its geological character a portion of the Bagshot sand, which overlies the London clay at Highgate. The remaining portion of the district is London clay, covered, in some cases, with brick-earth, in others with red gravel and sand in the higher portions of the district, and in the valley-flats with sandy clay and with washed gravels with flint. The imper-

Bagshot sand. London clay.

Nature of covering of London clay.

On account of impervious character of subsoil provision made for rapid discharge in sewers.

vious geological character of the subsoil of the district renders it requisite that sufficient provision should be made in the sewers in order that all surface water which may find its way into the sewers may be discharged with certainty and rapidity.

Physical Outline.

Outline favourable for construction of sewers.

The physical outline of the district of Hornsey is highly favourable to the construction of sewers, and the falls in many cases are so very rapid that sewers of a comparatively small size can be used for the drainage of a large area. On the other hand, the district is extremely irregular in its configuration, which renders a much greater length of sewer necessary than is required in districts which have one uniform plane of inclination. The careful study of the physical outline of the district is a matter of vital importance when considering its drainage, especially when the question of the ventilation of sewers has to be considered. In a district similar to that of yours, in which many of the sewers will have very rapid falls, unless due provision is made the gases which will be generated in the whole system of sewers in the district will be sure to find their way into the higher localities. In the scheme proposed, therefore, special precautions have been taken in order to secure the perfect ventilation of all sewers, so as to prevent the transference of the sewer gas from

Irregular configuration. Increased length of sewers.

Physical outline of district requires careful study.

Importance of provision for ventilation of sewers.

Gases ascend from low to high localities.

Precautions taken to secure ventilation.

the lower to the higher portions of the district. These provisions will be specially referred to hereafter.

Population.

The population of the parish of Hornsey, as shown by the various returns of the census, has been for many years steadily on the increase: in the year 1801 the population was 2716; in 1831, 4856; in 1851, 7135; in 1861, 11,082; between 1801 and 1831 the parish increased at the rate of 2 per cent. per annum; between 1831 and 1851, at the rate of 3 per cent. per annum; and between 1851 and 1861, at the rate of 4½ per cent. per annum. It will be seen that through a period of sixty years there has been a gradual rate of increase, and the ratio of the rate of increase has year by year advanced. Taking these facts into consideration, it would be well to consider what would be the population fifty years hence, because the execution of the proposed works of sewerage, and the money that will be required for the payment of the land for outfall purposes will probably together exceed one year's assessable value of the district, and therefore it may be requisite to put in force the clauses of the 21 & 22 Vic., c. 104, s. 78; and 24 & 25 Vic., c. 61, s. 19, in order that an extension of borrowing power may be granted; and in this case the repayment of the capital expended will extend over fifty years, and

Population Tables.

Rate of increase.

Ratio of increase advanced.

Cost probably exceed one year's assessable value.

Extension, borrowing powers.

Repayment in fifty years.

in all fairness to succeeding generations the works which it is now proposed to make, and to which succeeding ratepayers will have to contribute, should be of such a nature and character as to be successfully employed by those who may hereafter have to pay for them. Assuming therefore in future the population of Hornsey increases at the rate of .5 per cent. per annum, which rate is only half per cent. per annum greater than the rate of increase from 1851 to 1861, the population in 1879 would be about 18,000; in 1889, 29,000; in 1899, 47,000; in 1909, 77,000; and in 1919, 126,000.

Expense of works paid by present and future ratepayers.

Probable rate of increase in population.

Probable population in future years.

A further point requiring consideration in connection with the population is whether the area of the district is sufficiently extensive, in order to accommodate this greatly increased population. It has been already mentioned that the area of the district included in the scheme of sewerage is 2700 acres; the number of people inhabiting a house in the parish of Hornsey according to the census of 1851 was 6·14; in 1861, 6·2. Having regard to these facts, and taking some existing portions of the parish, such, for example, as Haringey Park,—three houses occupy one acre; and therefore at this rate there would be accommodation for 50,000 people. In Park Terrace, Park Road, twelve houses occupy one acre of land; so that at this rate the district would be capable of accommodating 200,000 people; and in the

Area of district sufficient to accommodate increased population.

Population in some parts of Hornsey.

suburbs of Highgate there are six houses upon one statute acre; and therefore the district at this rate is capable of containing a population of upwards of 100,000 people. It is questionable, having regard to the suburban character of the district, if it will extend beyond a certain population without lessening its special attraction as a residential place. When the district is thoroughly sewered, it will have an increased reputation as a desirable residential locality, and consequently its population is likely to increase at a rate more quickly than suggested by me; therefore I am of opinion that, having regard to all the circumstances of the case, it would be wise to make provision for at least a population of 80,000 people. My experience in connection with the suburbs of London justifies me in coming to this conclusion, and it could be shown that there are districts in the neighbourhood of London that have increased, and are likely to increase, in a far greater ratio than the rate I have already mentioned. As an example, the parish of Croydon may be taken. In 1861 the population was little over 30,000; it has now a population of upwards of 60,000. The works of Croydon were originally intended for a population of 20,000, so that a large sum of money has been expended in increasing the capacity of the sewers to meet the requirements of the increased population. This has been done at a loss, owing to the abandonment of works which were insufficient, and

Suburban character of district.

Loss of attraction by increase in population.

Influence of sewerage works in district.

Population for which provision is made in sewers.

Experience in suburban districts.

Increase of population in Croydon.

Croydon taken as a warning to make provision for future.

Loss at Croydon.

therefore it will be well to guard against such a contingency in your district. Taking into consideration the area of the district drained, the probable population, the amount of rainfall that finds its way into the sewer, I cannot advise you to construct an outfall sewer of less dimensions than would equal in size a 4 ft. × 2 ft. 8 in. sewer, making provision wherever convenient for the discharge of storm-water, and keeping as much of the rainfall out of the sewers as possible, as the great principle to be borne in mind in the construction of sewerage works is that the rainfall should go into the rivers, the sewage only on to the land.

Size of outfall.

Rainfall to rivers.

Sewage to land.

Water-supply of the District.

For all purposes of this Report the water-supply is taken at 5 cubic feet per head per day of the population.

Sewers.

All sewers of smaller diameter than 24 inches which have been laid down upon the accompanying Plan, are intended to be glazed socket-pipes, those of larger dimensions will be constructed in brickwork laid in Portland cement. As the rate of fluctuation in the flow of sewage through the sewers will be great on account of circumstances already referred to, and also on account of the probable increase in the population, the main

Size of earthenware-pipe sewers.

Portland cement used in construction of brick sewers.

sewers are made oval in section, as this form will be found to be the best adapted for conveying away the sewage of the district. The whole system of sewers delineated on the Plan may be divided into six Sections; each Section draining either part or more of the various watersheds in the district under your jurisdiction, and comprise the following localities:—

Oval brick sewers.

Division of system of sewerage into six Sections.

1st. The area north of Muswell Hill and Fortis Green. By reference to the levels of the district, it will be seen that the area has its fall in a northerly direction, or to the valley below the Colney Hatch Lunatic Asylum. In the scheme proposed, it will be observed that this portion of the district is drained to the same general outfall as other portions of the district; the branch outfall for effecting this object is made to contour round the valley east of Coppett's Farm, afterward proceeding northward of Alexandra Park, and then by Wood Green Railway Station and past the New River reservoirs, joining the sewers at Hornsey. As, however, this line does not include the extreme limits of your district in this direction, and in the event of its being desirable to include the whole of this portion of your district in the drainage scheme, an outfall sewer can be constructed as shown by the red dotted line on the Plan, by which all the sewage of the district may be brought through the tunnel on the Great Northern Railway, and to the same

1st Section.

Valley below Colney Hatch Lunatic Asylum.

Wood Green Railway Station.

New River reservoirs.

Drainage of extreme limit of district.

common outfall provided for all other portions of the district. It may here be mentioned that all outfalls out of your district will be constructed under the powers by the 24 & 25 Vic., c. 61, s. 4; and the owners of property may make use of the sewers by virtue of the powers conferred by the 29 & 30 Vic., c. 90, s. 9, on such terms as may be agreed upon between you and them; and in case of dispute the matter may be settled by two justices or by arbitration.

Power to construct outfall out of district.

Sewers out of district may be used by adjoining owners.

2nd Section.

Fortis Green.

Muswell Hill.

2nd. That portion of the district north-west and north of Highgate, including North Hill, Fortis Green, and part of Muswell Hill. In collecting the sewage of this district a sub-main will be requisite, which shall contour the valley below Fortis Green, as this valley falls to the west and out of your district. Another sub-main will pass under the embankment of the Edgeware and Highgate Railway, and contour the east side of the valley, and collect the sewage of the district about North Hill and the west of Highgate. These two sub-mains will be joined in Southwood Lane, at Upton Farm, and from this point the branch outfall will cross over some fields, and proceed in nearly a direct line down the highway to Hornsey, collecting in its way the sewage of the district in which it is placed.

North Hill.

Upton Farm.

3rd Section.

Southwood Lane.

3rd. All the district east of Southwood Lane and Churchyard Bottom Wood. The branch outfall from this district will pass through the fields

north-east of Churchyard Bottom Wood, taking in a branch main from Park Road and joining the outfall of the second section of sewers in the Muswell Hill Road. Park Road branch.

4th. All the district north-east of Highgate, including High Street and Archway Road. The branch outfall sewer for the upper part of this district will pass under the bridge of the Edgeware and Highgate Railway east of the Archway Road, and will then pass down the valley to Crouch End, taking a portion of the drainage of Crouch End, and joining the branch outfall of the second Section in High Street, Hornsey. With regard to the upper part of this district, it will be seen that the sewers are placed at the back of the houses in High Street, Highgate, as it will be found that the work could be constructed at less cost in this position, and will be better on sanitary grounds, for it will be observed that the whole of the houses in this particular locality are closely built, and that the land falls rapidly from the front to the rear of the several premises. Therefore, in order to drain the back premises to the street, the sewer must be placed at great depth, and every house-drain would have to pass under the house, which is a condition of things that should be avoided if possible. 4th Section. Archway Road. Crouch End. Advantage of back drainage in some localities. Avoid constructing sewers under houses.

5th. The remaining portion of your district at Crouch End and the branch outfall from this district will run westward to the Great Northern Railway, will pass under the bridge near Haringey 5th Section. Crouch End.

House, and join the branch outfall from the district north of Seven Sisters' Road, and from this part the combined sewers will run in a straight line to Tottenham Lane, passing under the New River and joining the main outfall in Tottenham Lane.

Crossing New River.

6th Section.

6th. The district north of Seven Sisters' Road, including Finsbury Park. By reference to the levels on the Plan, it will be seen that this portion of the district falls partly to the south-west and partly north-east. In order therefore to sewer that portion of the district naturally falling to the south-west, it will be requisite to construct a branch sewer at some depth in the Seven Sisters' Road, and which would have its fall from south-west to south-east, so that all this portion of the district, including Stroud Green Lane, will pass by the branch sewer in Seven Sisters' Road, thence down Green Lanes through one of the roads of Finsbury Park, and crossing under the Tottenham and Hampstead Junction Railway at the point it is crossed by the New River, and so on to join the branch sewer of Section No. 5, which has already been described.

Deep cutting in Seven Sisters' Road.

Stroud Green.

Finsbury Park.

Crossing Tottenham and Hampstead Railway.

All sewers converge in Tottenham Lane.

The whole of the branch sewers of the district will converge at a point in Tottenham Lane, north-east of Hornsey Railway Station, and from this point the main outfall will convey all the sewage of the district by gravitation to the proposed irrigation area coloured pink upon the large Plan, and shaded on the small Plan. The importance of

Importance of works.

works of sewerage, when considered in reference to the health of the place, makes it desirable that the most perfect works, including the latest improvements in construction, should be adopted; and in the scheme proposed, the system which at the present day is now universally recognized as being the best, and as recommended in the instructions issued to engineers and surveyors by the Local Government Act Office is laid down on the Plan, and is now recommended to you for your adoption. The chief features consist in constructing the sewers as far as possible in perfectly straight lines, having man-holes at every lateral point of deviation, and ventilators, lamp-holes or man-holes at every vertical deviation. In this system the whole of the sewers are under perfect control, and can be examined at any time without breaking open the ground, and any ordinary stoppage may be removed without recourse to breaking-up the streets, thus saving the great expense and annoyance that occurs when a stoppage has to be removed.

Desirability of adopting latest improvements.

System proposed recommended by authorities at Local Government Act Office.

Sewers constructed in straight lines.

Position of man-holes, lamp-holes, and ventilators.

Sewers under control, and can be inspected.

No breaking-up streets to remove stoppages required.

The system delineated on the Plan has been laid out with a special view to secure the perfect ventilation of the sewers. It has been already pointed out in the early part of this Report, that in your district the subject of ventilation is one of vital importance if the system of sewerage is to be perfect. In the early sewer-works of this country it was found that, before a system of sewerage was carried out, the low-lying districts were

Ventilation of sewers.

Ventilation of vital importance.

Experience in early sewer-works.

the most unhealthy, whereas, when a system of sewerage was executed, the fevers and other zymotic diseases which usually frequented the low-lying districts were transferred from the lower to the upper portions of the district. This was due to the transference of the sewer-gas (generated in all portions of a system of sewerage) to the higher points, and this gas escaping into the dwelling-houses of the inhabitants became the source of disease, because due provision had not been made for the ventilation of the drains and sewers. The evil results arising from the want of ventilation have shown it to be necessary that every system of sewers to be perfectly successful should be thoroughly ventilated, and proper ventilation cannot be secured unless the sewers are constructed with special reference to it. The mode in which the ventilation is proposed to be accomplished in the proposed scheme, is by taking a small portion of the fall at every man-hole and ventilator in order to break the sewers in short lengths, so that the gas found in one length of sewer is allowed to escape without traversing the whole length of the sewer from the lower to the higher districts. The accompanying sketches will demonstrate the principle involved in the system, which we will assume represents a sewer in Hornsey.

Transfer of disease from low to high districts.

Escape of sewer-gas into dwelling-houses in high localities.

Every system of sewers should be ventilated.

Sewers should be constructed with special reference to ventilation.

Mode in which thorough ventilation is proposed to be accomplished.

Fig. 1 represents a branch sewer discharging into the main outfall sewer at A. This branch

sewer, A B, may be of indefinite length, and is drawn with one uninterrupted fall; therefore the gas generated at A, or in the lower portions of the sewer, or between A and B, will ascend towards B as the rate of flow of sewage in the sewer increases, and thus the sewer-gas that will be displaced as the sewer begins to fill with sewage will ascend towards B, and probably enter the houses in the higher district. As an example, we will suppose that a sewer is running half full, and that it suddenly begins to run three-quarters full; the effect on the imprisoned air of the sewer, if there are no openings for ventilation, will be found, according to the law of the diffusion of gases (that the pressure is inversely as the space occupied), that the imprisoned gas would have a pressure of one atmosphere, or over 30 feet head of water. Although this is an exaggerated case, it is easy to comprehend how the pressure of gas in a sewer may be increased to such an extent as to force the ordinary water-traps that are provided, and which at the most are only equal to two or three inches pressure of a column of water.

Example of the compression of sewer-gases.

Law of diffusion of gases.

Ordinary house-traps inefficient to prevent sewer-gas entering premises.

Assuming that under ordinary circumstances a ventilator is placed at A, Fig. 1, and another at B, the air will enter the sewer at A, and rush up it to B with a velocity determinable by the altitude of B above that of A; and even supposing that there is an opening midway between the two points, or at C, the gases moving from A in the direction of B,

Flow of air in sewers.

Effect of uninterrupted falls in sewers.

having a given velocity, are moving in the same plane as the line of sewer, and therefore will leap over the ordinary space of the man-hole at C, so

Tendency of gas to accumulate in the higher portions of the district.

that the gas has a tendency to accumulate in the neighbourhood of B. To remedy this defect, and prevent the undue accumulation or transfer of gas

Mode of expelling gas from all parts of a system of sewers.

from the lower to the higher district, the sewers will be constructed in a series of steps, as shown in Fig. 2.

By this arrangement the gases produced at A, or between A and C, are discharged at C, because the sewer above C is not in the same plane as the sewer below C shown in Fig. 3, and the gases are consequently directed out of the line of plane in which

Man-hole shafts for drawing off foul air.

they were travelling, and so escape at C; and as every man-hole becomes a shaft for drawing off the foul gas, the comparatively short distance the man-holes are asunder tends to make the whole system

Escaping vapours oxidized.

work very efficiently. The gases escaping at the ventilator are intended to be oxidized by being

Materials used in oxidizing vapours.

passed over trays containing charcoal or magnetic oxide of iron (carbide of iron). The arrangement

Arrangement of materials used in oxidizing vapours.

for effecting this is shown in Fig. 4. The materials used in oxidizing the escaping gases are arranged in a manner patented by me. The advantages of

Impossibility of sewer-gas to escape without being oxidized.

this sewer ventilator are:—It is impossible for the sewer-gas to escape without coming into contact with the material used for destroying the escaping gases; the materials used in the destruction of the gas are preserved from the action of the overflow

water from the dirt-box, and therefore they will last considerably longer than the material used in any existing form of ventilator; and should the oxidizing material become concreted so as to interfere with the escape of the gases, no injurious consequences will accrue, as there will always be an uninterrupted passage for the escape of the gases into the external air. There are other advantages gained by the falls taken at the man-holes for the purpose of ventilation in the modern system of sewers as laid out in straight lines, which can only thus be secured. For example, take a very common case, as shown in Fig. 5.

Preservation of materials used in oxidizing vapours.

Free escape for vapours in case of concretion of oxidizing materials.

Other advantages of mode of construction proposed.

The sewers B, D, E, meet at C, on the same level, and their contents are discharged by the sewer A. The general effect of a sudden enlargement in a sewer is to check the velocity. When the sewer B discharges into the sewer A (assuming that both sewers A and B are of equal size and inclination), a loss of velocity will take place in passing the man-hole; and therefore if B at the time was running full, the sewage must head up in the man-hole to such a degree as shall make up for the loss of head by reason of the enlargement at the man-hole. Although no evil will result in this case if the sewers A and B are in the same line of flow, yet when the sewers from D to E enter the same man-hole, the matter is very different. I have seen a case very recently in which two sewers met, as the sewers C and D—one sewer

Effect of sudden enlargement in sewers.

Effect of sewers meeting in opposite directions.

being larger than the other; the smaller could not discharge its contents in time of storm, and therefore flooded all the cellars in the neighbourhood.

Beneficial effect of the outfall sewer being lower than other sewers.

If the level of the outfall sewer A is lower than the other sewers, as proposed in this scheme, each sewer will have a perfectly free and unobstructed outfall.

Man-holes intended to be used for flushing.

All the man-holes are also intended to be used for the purpose of flushing the various sewers with the sewage which may be flowing down the sewers of the district, so that, with the exception of one or two lengths of sewer at the higher points of the district, the whole of the sewers can be flushed by the ordinary flow of the sewage, the sewers at the man-holes being so arranged that the sewage can be dammed back, in order to permit it to accumulate, and then by suddenly allowing it to be discharged from the man-holes, and to flow down the sewers, great flushing power is secured. With regard to the man-holes at the extreme high points of the district, these also will be used for flushing purposes; but in order to flush the sewers leading out of them, it would be requisite—probably once a month—to provide a quantity of water, which should be admitted into the man-hole, and then suddenly discharged down the sewers. The whole of the man-holes throughout the district are constructed in reference to the flushing; and with regard to the brick sewers, special flushing-gates will be provided, so that the sewage of the district

Sewers flushed by ordinary volume of sewage.

Mode in which flushing is accomplished.

Man-holes at head of sewers used for flushing.

Brick sewers to have flushing-gates.

will be made to keep the sewer free from any accidental deposit. It is only necessary to add, the whole system of sewers has been so adjusted to the work they will have to perform, that the ordinary flow of sewage through them will render them self-cleansing; and the flushing arrangements provided are so much in excess of what is absolutely requisite, but are introduced as an additional source of safety, and for the purpose of removing accidental deposits.

Sewers designed with view to be self-cleaning.

Flushing arrangements introduced as additional means of maintaining efficient working of sewers.

Preparation of the Sewage for Irrigation.

The sewage of the town may be divided into two descriptions: namely, solid and liquid. The solid sewage, consisting of the fæces, paper, sand, &c., owing to the rapid rate of fall of the district, will for the most part find its way to the outfall in a nearly perfect state. It will be requisite that this solid matter should be removed, as it is for the most part insoluble, and if permitted to flow with the liquid sewage on to the land, it will produce a nuisance, as it must there lie to be exposed to the atmospheric influence before it will become fit food for plants, and be taken up by the soil; and during this process of preparation or decomposition on the irrigation area it would create a nuisance. Moreover, during the period it is undergoing decomposition, experience has shown it will kill, instead of promote the growth of plants.

Description of ordinary town sewage.

Solid matter should be removed from liquid sewage.

Solid matter cause of nuisance on land.

Mode that has been hitherto adopted for the removal of solid matter.

Hitherto this solid matter has been removed by tanks; but this tank-system has been the only blot upon the system of sewage irrigation as at present practised throughout the whole country; and it is my intention, therefore, *not* to recommend you to construct tanks for the removal of this solid matter, but to erect a very simple apparatus which will remove the whole of the fæces, solid matter, and sand, &c., from time to time, as fast as it is brought down by the sewers. A similar apparatus is now being erected at Croydon for the Croydon Local Board of Health, in lieu of their present tanks, which have always been a great nuisance. The apparatus will occupy a comparatively small space. In your case, the apparatus in duplicate will not cover 500 superficial feet of land. The motive-power for driving the apparatus is the sewage itself. The whole of the solid matter is removed in a fresh state or before decomposition has taken place; therefore this solid matter is much more valuable as an article of manure than the solid matter taken from tanks, which can only be removed after decomposition has set in. The liquid sewage, not having to flow through a mass of decomposing fæces (as in the tank system), is much sweeter, and there is, therefore, no likelihood of the sewage producing a nuisance in the neighbourhood of the irrigation area. The apparatus is extremely simple and inexpensive in its cost: and, moreover, as the

Mode proposed for removal of solid matter.

Apparatus at Croydon.

Small space occupied by apparatus.

Sewage itself the motive-power of the apparatus.

Removal of solid matter in fresh state.

Solid matter removed by apparatus more valuable than when removed in tanks.

Liquid sewage is sweet, and will not create a nuisance in the neighbourhood of the irrigation fields.

Apparatus simple and inexpensive.

sewage itself performs the work that has hitherto been performed by manual labour, the great expense of this labour will be saved. The sewage will be conveyed to the solid-sewage extractors in an iron sewer, and after leaving the extractor, will flow into another iron sewer. These iron sewers are requisite in order that the sewage may be conveyed by gravitation to the whole of the land selected for irrigation. Iron sewers might be dispensed with if land only on the south of Lordship Lane is taken.

Apparatus saves the expense of manual labour.

Iron sewers.

Iron sewers only requisite in order to command the whole of the land by gravitation.

Irrigation Area.

The irrigation area has been selected in such a position that the whole of the sewage of Hornsey may be conveyed upon it by direct gravitation. The area coloured pink is over 200 acres in extent, and nearly the whole of it is capable of being irrigated by direct gravitation. With two exceptions only, there are no houses within a quarter of a mile of the proposed irrigation area; the nearest house is Broadwater Farm, and probably hereafter it may be desirable to take this farm and the land adjoining, as buildings will be requisite in connection with the sewage farm. The next nearest house is at Tottenham Park, which is about 200 yards from the lower irrigation fields.

The nearest field to the Park is No. 205 on the

Irrigation area.

Area of land.

Irrigated by direct gravitation.

No houses near proposed irrigation area.

Broadwater Farm.

Tottenham Park.

Ordnance map, and this need not be irrigated, as it is only required in order to secure an outfall into the river Moselle, and in this case the irrigation area would be 400 yards distant from that house. The quantity of land selected is more than sufficient for the present requirements of Hornsey, and there is other land immediately contiguous to it, to which the sewage could be applied. For the present requirements of the district, not more than half the area selected would be necessary in order to effect the perfect purification of the sewage, but it would be advantageous to get possession of the whole area, as hereafter it may be difficult to procure land, and the whole area may be treated directly and indirectly with sewage, so as to get the best possible results. The irrigation area will be laid out upon the most approved principles, using for the purpose of distributing the sewage covered carriers, so that no crude sewage will be seen on any portion of the irrigated area. These carriers were introduced and patented by me in 1867, and are now coming into general use in localities near inhabited districts. They consist of glazed pipes, either laid on the ground or partly or wholly sunk into the ground, with slits or openings on the upper surface, through which the sewage flows on to the land as shown in Fig. 6 (being a plan of one of the pipes) and Fig. 7 (a section of the same).

Outfall in river Moselle.

Quantity of land selected more than sufficient for present requirements.

Half present land, or 100 acres, sufficient for present.

Desirable to take all the land.

Land laid out on most approved principles.

Crude sewage will not be seen on irrigated land.

Patent carrier.

Description of patent carriers.

The flow of sewage from these pipes is regulated

in a manner similar to that practised in ordinary carriers, or by thin metal plates being placed in the joint of the pipes. The great advantages of this system consist in the small area of sewage that is exposed to atmospheric influence, and a further advantage lies in the facility with which it can be carried out. It may be advantageous to secure even a larger area of land than is shown, as I am of opinion that the most profitable mode of applying sewage will be found in conjunction with the ordinary agricultural pursuits. For example, a farmer having a farm of 100 acres: if 20 acres are put directly under sewage, and a sufficient head of stock is kept to eat up the produce grown on the 20 acres of sewaged land, he would have sufficient manure from his stock to manure with the heaviest dressing the remaining 80 acres of his farm; in short, the cattle would be made use of as the means of converting liquid sewage into solid manure, with this great advantage, that the cattle not only give back the manure, but also the value for the sewage produce they have consumed. If arrangements can be made to secure any additional land on lease by the mode shadowed forth, it may be kept in the highest state of fertility, and the whole of the crops may year by year be removed from the land without any baneful effect or exhaustion of the land so treated. The small portion of the land included in the irrigation area that is too high to be commanded by the liquid sewage

Mode in which flow of sewage from carrier is regulated.

Use of metal plates.

Advantages of system.

Facility with which the system can be carried out.

Most profitable mode of using sewage.

Example of sewage farming and ordinary farming combined.

Land manured with heavy dressing of farmyard manure.

Cattle give manure and value of sewage produce.

Land on lease may be kept in the highest state of fertility.

All crops may be removed from land.

Small portion of land treated with solid sewage.

can be treated with the solid matter extracted by the sewage extractors, and so every portion of the sewage will be utilized on the area recommended to be taken for the purpose. The land selected for the purpose of irrigation is of a quality highly favourable for the application of the sewage, and is in character similar to the land used by the Croydon Local Board at South Norwood.

Every portion of sewage utilized.

Quality of land selected favourable for irrigation.

Estimates.

The whole of the items composing the estimates for the sewerage works and sewage irrigation works have received my most careful attention, and I will guarantee that the works when executed will not exceed the estimated cost more than the margin allowed by you. My estimate for the cost of every sewer shown by the strong red and blue lines in the Ordnance map, inclusive of the cost of man-holes, ventilators, flushing arrangements, street gulleys, and sewage extractors in duplicate, but exclusive of compensation, is 25,000*l*. The works included in the estimate comprise—

Estimates guaranteed.

Sewer shown on Ordnance map.

Amount of estimate, 25,000*l*.

Amount of work included in estimate.

8276 yds. of brick sewers.
34,200 yds. of earthenware pipe sewers.
1533 yds. of iron sewers.
129 man-holes and ventilators combined.
172 ventilators single.
200 street gulleys.

Street gulleys.

The street gulleys, except in crowded thoroughfares, the drainage from which is likely to be very impure, and in some unavoidable cases, are intended to be connected with existing drains or other channels, which shall be preserved and maintained for this purpose. If man-holes are dispensed with, then the estimate may be reduced to 24,000*l.*

Estimate reduced if man-holes are not used.

Cost of laying down land.

The cost of laying down 100 acres of the land coloured pink, for irrigation purposes, inclusive of levelling, sowing, and providing patent pipes for a portion, will be 1000*l.* Probably many of the roads that are shown to be sewered are highways not repairable by the parish, and the sewers in these roads would, if thought desirable, be made by the owners under the powers of the 11 & 12 Vic., c. 63, s. 69 ; and therefore the cost of constructing sewers in these roads should be deducted from the estimates. The total cost of the works of sewerage with man-holes and irrigation will be 26,000*l.*, or without man-holes, 25,000*l.* Assuming that 26,000*l.* were borrowed at 4½ per cent. for repayment in thirty years, the annual sum of 1596*l.* 3*s.* 10½*d.* would be required to repay the interest and the sum borrowed. If for repayment in fifty years, the annual sum of 1315*l.* 13*s.* 0½*d.* would be required. I estimate the value of the produce on the irrigation area, when it comes into full bearing, at 25*l.* per acre per annum ; so that the irrigation works will contribute more than will pay the cost of the land and working ex-

Many sewers will probably be constructed by owners.

Power to compel owners to make sewers and parish roads.

Total amount of estimate.

Annual sum required for repayment of borrowed capital.

Value of produce of irrigation will pay cost of irrigation works.

penses. This estimate of the value of the produce of the irrigation area is quite within the mark, and is less than the sum realized by the Croydon Local Board at South Norwood. At South Norwood this land is 30 acres in extent, and was let for the first three years to a tenant at a rent of 200*l.* per annum, which expired on the 25th March, 1868. After the expiration of the term, the Croydon Local Board received in the remaining portion of the year upwards of 600*l.*, and this year up to the present time they have received for the produce of the 30 acres 707*l.*, and are very likely to receive an additional 50*l.*, making a sum equal to 27*l.* per acre as the value of the produce. I do not think it desirable to state publicly what I consider to be the value of the land selected for irrigation, as by so doing it certainly would prejudice your position when you have recourse to arbitration, but some of the land in question is totally unfit for building, as at present it is liable to be flooded, and therefore it is about the least valuable land in the neighbourhood. With regard to the purchase of the land, it may be looked upon rather as an investment than otherwise, as year by year its intrinsic value will increase. Supposing that you succeed in getting powers from the Secretary of State, and confirmed by Parliament, to take the land, it will be possible for you to make such an agreement that you may have a portion of the money required for the pur-

Sum realized at South Norwood for produce of irrigated land.

Not desirable to state price of land publicly.

Land selected for irrigation unfit for building.

Purchase of land an investment.

Recommendation to borrow on mortgage on land.

chase of the land secured on mortgage upon the land itself, instead of upon the rates, so that with an extension of borrowing powers you would have a considerable margin for borrowing for other purposes. The whole of the works of sewerage may be executed within a period of twelve months. The time that will be occupied in the preparation of the land for irrigation will depend upon the time of the year the work is undertaken. It is impossible with any degree of certainty to level and form land for irrigation purposes in time of frost, or when the ground is hard in summer.

Time it will take to execute the works of sewerage.

Time it will take to prepare land for irrigation.

The advantages claimed for the scheme are :—

Summary of the advantages of the scheme.

1st. The entire sewerage of the whole district and the collection of the sewage at one outfall only.

2nd. The latest improvements in the construction and ventilation of sewers.

3rd. The preparation of the sewage for irrigation in an inoffensive and inexpensive manner.

4th. The conveyance of the sewage of the entire district by gravitation to a suitable area of land.

5th. The selection of an area of land for irrigation which is removed from any populous neighbourhood, such area being convenient and accessible by good roads.

6th. Economy of construction.

Thanks to local Surveyor.

Before concluding this Report, I beg to express my thanks to Mr. Rogers, your Surveyor, for the information I have received from him in the preparation of this scheme.

Districts surveyed, levelled, and Plans corrected.

The large Map accompanying this scheme has been corrected, and the levels of the district and irrigation area have been taken, in order to render the scheme complete and perfect in every particular.

I have the honour to remain,

Gentlemen,

Your obedient servant,

BALDWIN LATHAM,

Mem. Inst. Civil Engineers,
Past President Soc. of Engineers, &c., &c.

6, WESTMINSTER CHAMBERS, WESTMINSTER, S.W.,
10*th November*, 1869.

LONDON:
PRINTED BY WILLIAM CLOWES AND SONS, STAMFORD STREET
AND CHARING CROSS.

FIG. 1.

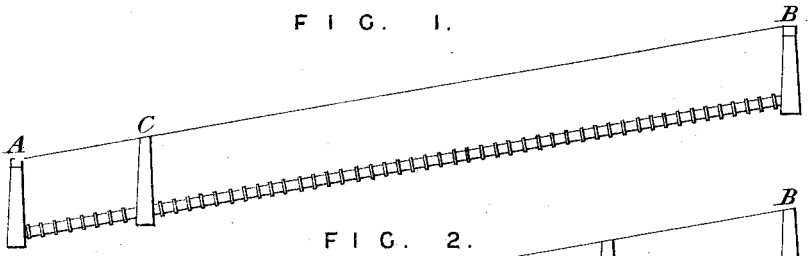


FIG. 2.

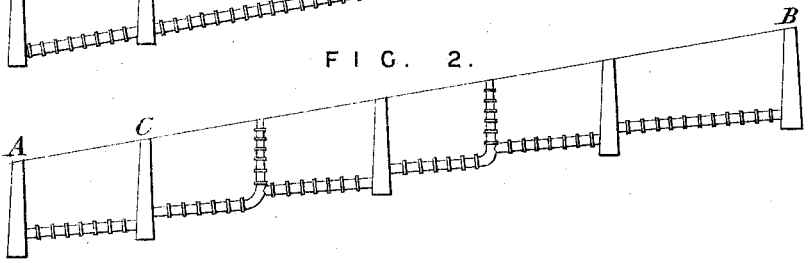


FIG. 3.

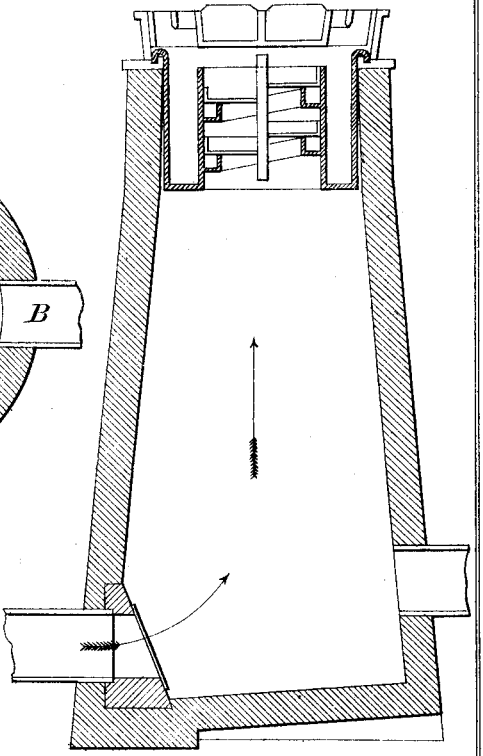


FIG. 5.

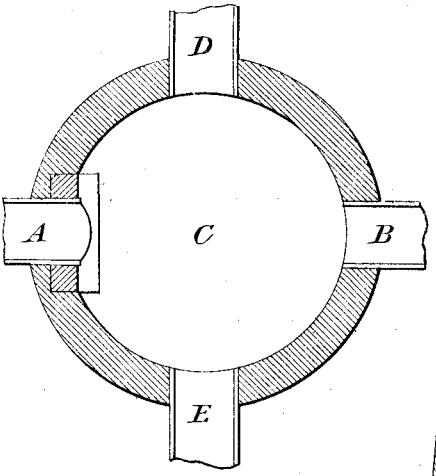


FIG. 7.

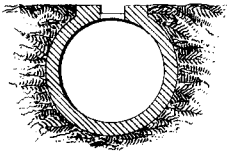


FIG. 4.

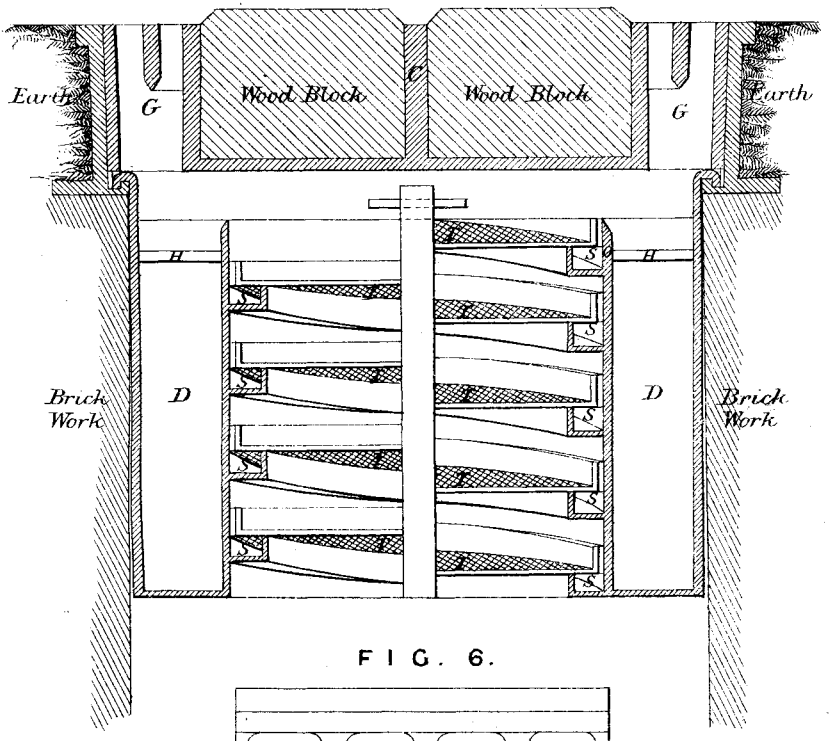
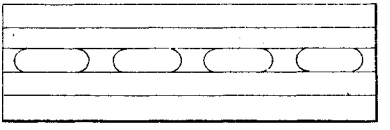


FIG. 6.



Reference.

C. Manhole cover.

D. Dirt box for intercepting dirt and stones which may pass through the street grating.

G. Grating for the escape of oxidized vapours.

S. Spiral trough conveying overflow water to sewer.

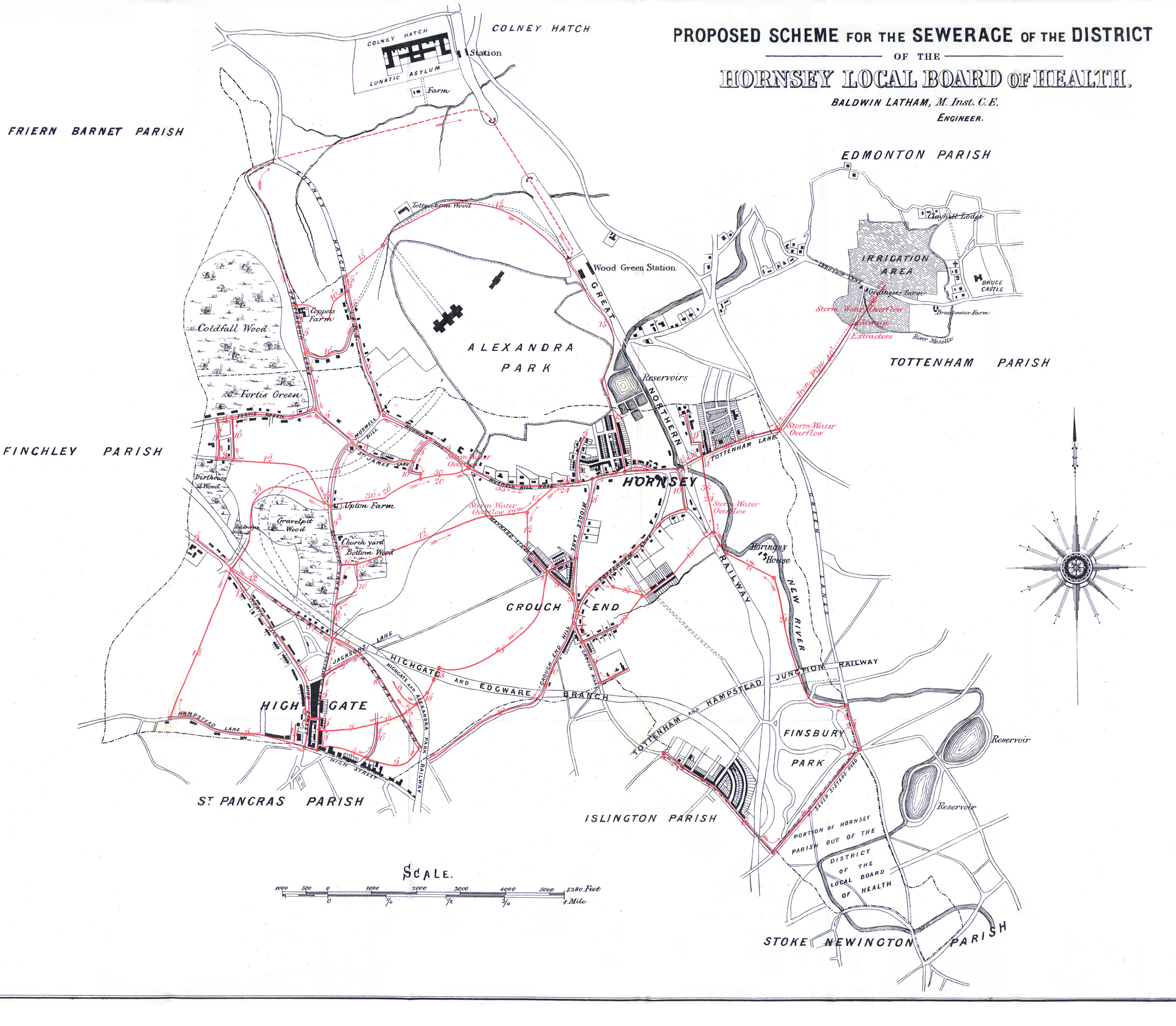
T. Spiral tray containing materials for oxidizing gases.

O. Overflow from dirt box into spiral trough.

HH. Handles to lift out dirt box.

PROPOSED SCHEME FOR THE SEWERAGE OF THE DISTRICT
OF THE
HORNSEY LOCAL BOARD OF HEALTH.

BALDWIN LATHAM, M. Inst. C.E.
ENGINEER.



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