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# Sydney Sewerage.

BY Mr. J. M. SMAIL, M. Inst., C.E., Chief Engineer to the Metropolitan Board of Water Supply and Sewerage.

*(A Paper read before the Sydney University Engineering Society on October 13th, 1897).*

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### I.—HISTORICAL.

THE first English settlement in Australia was made by Governor Phillip, who fixed his camp on the banks of a stream flowing into Sydney Cove, afterwards known as the Tank Stream, from the fact that several tanks were excavated out of the stream, and supplied the early settlers with water. For many years this stream supplied the daily wants of the settlers, but as the population increased, and the settlement developed

into a town, this source of water supply gradually became polluted, and was finally utilized as a vehicle for carrying off the refuse and filth of the community. The Tank Stream might, therefore, be said to be the first constructed sewer in Australia.

As the town extended, other sewers were constructed of various forms and sizes, discharging into Cockle Bay, now Darling Harbour, on the west side, and into Woolloomooloo Bay on the east side. The lines of many of these are forgotten, but were occasionally met with in carrying out the old and new systems of sewerage.

Prior to 1850 no system of underground sewerage worth the name existed, though a few detached drains for conveying the storm water from streets, or slop water from houses, had been constructed. The sanitary arrangements were of the most primitive kind. The common cesspit, with its attendant abominations, was the rule; the slop water passed into the street channels, or over the rocks fringing the harbour, as was found most convenient.

Sanitary legislation in the colonies has been piecemeal and perfunctory in its application. The principal acts passed in the early days of the colony were chiefly connected with the prevention of sale of diseased meat, and adulteration of food, and it was not until the passing of the Sydney Sewerage Act (17 Vic., No. 34), in 1853, that any practical steps were taken towards improving the sanitary condition of the city with regard to its system of sewerage.

This act repealed a former enactment passed in 1850, and provided for the appointment of three Commissioners, who were to carry out the provisions of the Act, in lieu of the old City Council, which was dissolved by Act of Parliament. The Commission was not allowed to exist without inquiry into its administration. A Select Committee of the old Legislative Council, of which Mr. Martin (the late Sir James Martin, Chief Justice), was chairman, was appointed to inquire into the then new system as proposed by the Commissioners. The evidence given before the Committee is interesting, as showing the different opinions as to the size, construction, and the materials to be used in the proposed sewers. One witness, who held a high professional office at the time, gave it as his opinion that the main sewer should be made large enough to admit of a horse and cart passing in and out. This method of fixing the size of a main sewer has the stamp of originality, but is not likely to find much favor at the present day. It was also considered whether it would not be advisable to import the necessary stone ready dressed from China for use in constructing the sewers.

Another interesting item of inquiry was whether the trigonometrical survey of the city, which was then in progress, could not be dispensed with. The results of the investigation may be summed up in a few words: The engineers were allowed to do the work they understood,

with advice to the Commissioners to keep an eye on their responsible officers. The Appropriation Bill was passed, and the work of providing Sydney with a system of sewers was inaugurated. After about four years' control of civic affairs the Commission was dissolved, and the present City Council was instituted, in 1857, by Act of Parliament (20 Vic., No. 37).

The old system consisted of three main sewers, viz., one discharging at Benelong Point, Fort Macquarie; the second into the head of Darling Harbour; and the third into Woolloomooloo Bay.

Owing to the foreshores being elevated but little above the H.W.M., the discharge was fixed to take place at low water, and the limited depth of covering necessitated the adoption of a form of section which, while giving a large carrying capacity, reduced the scouring power, so that after a time they became sewers of deposit, and required considerable expense to keep them clear of silt.

From these main sewers branches were constructed along the principal streets, the section being the old form of oviform sewer, with occasional lengths of circular section.

The material used in construction was Sydney sandstone, brick and stoneware for the pipe sewers.

After a lapse of nearly 40 years, some of these old sewers are in a good state of preservation, the only defects being found in the wearing away of the invert by the erosive action of street metal. It should be stated that the sewers were designed on the combined system, *i.e.*, for carrying off the storm water from the streets as well as the house sewage.

The original plans of the trigonometrical survey are to be seen at the office of Water Supply and Sewerage Board, and an inspection of same with those of a later survey will show the development of the City and adjoining suburbs during the past 40 years.

The citizens, as a rule, were not slow to take advantage of the new system, and properties were connected to the sewers, the supervision generally being left to the plumber or drainer carrying out the work. The Act which empowered the Commissioners, and afterwards the Council, to carry out the sewerage works, did not confer any compulsory powers, consequently the supervision over an important part of the work was carried out in a very perfunctory manner.

The discharging of the sewage from the City into the Harbour and bays could not but lead in time to a dangerous state of pollution, and the condition of the harbour at the various outlets became so objectionable, that in the interests of the public health a Commission was appointed to enquire into the best means of intercepting the sewage, and disposing of it outside the city. The results of the labours of this Commission was the inception of what is termed the New System, which

has now been in a large degree completed. — A description of this system constitutes the second portion of this paper.

In 1889 the administration of the water supply and sewerage for the city and suburbs was transferred to a Board, composed of seven members, three nominated by the Government, one of the number being President, and four elected by the Sydney and suburban municipalities—two by the former, and two by the latter.

By this arrangement the ratepayers are represented in the expenditure and control of the Department, and also the Government, who advance the necessary funds to carry out works.

## II.—NEW SYSTEM—CONSTRUCTION.

*Description of System.*—The new intercepting system comprises two main outfalls—one, the northern, discharging at a point near “Ben Buckler,” at Bondi; and the other, the southern, discharging into a sewage farm on what was known as Webb’s Point, on the south shore of Cook’s River.

The main lines were recommended by the Commission, and afterwards reported on and amended in some particulars by the late Mr. W. Clarke, M. Inst., C.E.

The northern system starts from a large chamber in the Meriverie Cliff, near Ben Buckler, on the seaboard. From this chamber two tunnels have been driven and lined, forming two separate outlets, so that a free discharge is available in either northerly, easterly, or southerly gales. From the roof of the chamber a shaft has been carried to the surface for ventilation purposes and the escape of air, when the sea breaks into the outlet channels and chamber.

The dimensions of the main outfall at the lower end are 8 feet x 7 feet 6 inches, decreasing to 6 feet 10 inches x 5 feet 10 inches at the junction of Oxford and Liverpool Streets. At this point is a large chamber, into which the three main branches discharge.

The northern branch passes under Hyde Park to Castlereagh Street, where it bifurcates, one sub-main intercepting the old outfall sewer in Macquarie Street, and the other intercepting the sewers discharging into the Cove at the Queen’s Wharf.

The western branch extends along Liverpool Street and Kent Street, intercepting the sewers which formerly discharged into Darling Harbour.

The south-western branch passes under Belmore Gardens, the Benevolent Asylum, and along George Street West to Carlton Street, where it bifurcates, one branch passing on through Darlington, under Victoria Park to Prince Alfred Hospital; the other extends along George Street West, including a long cast-iron syphon, to Bay Street, where the

branches serving the Glebe and Balmain join. This section intercepts the sewage formerly discharging into Blackwattle Bay above the 40 ft. contour.

A fourth branch sewer passes along Bourke Street to Potts Point, and intercepts the sewage which discharged into Woolloomooloo Bay.

The fifth branch extends along the western bank of Lacrozia Creek to Elizabeth Bay, intercepting the sewage which formerly flowed into Rushcutter and Elizabeth Bays.

The sixth branch extends along the Double Bay Valley, passes under Edgecliff Road, and terminates at Denison Street.

*Northern Outfall.*—The northern system so far as completed intercepts the sewage at the 40-foot contour.

In carrying out this work various strata were met with. In some cases the formation was indurated sandstone, with occasional ironstone bands, which tried not only the temper of the tools, but likewise that of the contractors; in other cases shale, clay, and water charged sand were met with. Wherever the line of sewer crossed a creek, provision was made for offset and scour valves.

The materials used in the construction were principally concrete, bluestone, or sandstone, as was deemed necessary; the former was employed for the lining and upper part of the sewer, and the latter for foundations in bulk.

The proportions of bluestone concrete were 1 of cement, 2 of sand, and 4 parts of bluestone metal, broken to  $1\frac{1}{2}$ " in gauge.

The cement was all tested by the Departmental machine before being used. The first machine used was of the Baily type, which consisted of a graduated lever with a bucket on the end; to this was attached a water gauge, graduated to pounds. A small reservoir was fixed on top of the pedestal, and a  $\frac{3}{8}$  pipe led the water from the reservoir to the bucket. The briquette moulds were of the large size, being of  $1\frac{1}{2}$ " section. This machine, proving very unsatisfactory in many respects, was replaced by one of Adie's latest type, which gave satisfaction, not only to the engineers, but to the importers, who had a considerable interest in the cement passing the official test. It is worthy of note that many of the well-known brands of cement, which, before the inception of the progressive policy of public works, were considered to be of first-class quality, failed to pass the comparatively moderate test required.

The bricks used in the works were of the class termed double-pressed plastic, and it devolved upon the author to make enquiries as to the best material obtainable. The result of the enquiry led to a superior class of brick being fixed as the standard sample, and all the bricks used in connection with the sewerage works of Sydney are of this character, and will last for all time. The Sydney University Laboratory was used

to a considerable extent in testing the crushing resistance, not only of the bricks, but also of concrete and stoneware pipes, the various tests being carried out by Professor Warren. The results of the brick tests show in some cases a higher resistance to crushing than the best English bricks, the average crushing resistance of some of the samples submitted being 2,782 lbs. and 2,228 lbs. respectively.

In carrying out the Northern Outfall it was necessary to guard against the surcharging of the same, and this was provided for by an overflow sewer, which joins the main duct at Deep Dene, and traverses the low-lying ground in Lacrozia Valley, discharging into Rushcutter Bay.

Owing to the bad foundations—the line passing through an old swamp—this sewer, which is oviform in section, is carried on arches with circular piers. The piers were built in concrete blocks, resting on a wrought-iron curb, with a cutting edge, and excavated within. The process was the same as sinking an ordinary well in soft ground. After the well piers had reached a stable bottom and had been tested, the interior was filled with clean sand, and a foundation block of concrete was made to receive the piers and skewbacks. The arches were then constructed on proper centring, and a method of striking them was devised by means of sand boxes. This, however, did not prove a success, as the sand would not run out uniformly, and erratic movements were the result. It was accordingly abandoned, and the usual method of wedges adopted. The sinking of the wells was not accomplished without much trouble, as very often the curb would find the remains of some of the old monarchs of the forest, and cause a cant in the work. This timber had to be cut through, or removed, as the case might be. The piers and arches have since their construction shown no signs of movement.

On one length of the outfall a rock-boring machine was tried, but, after many attempts, the Sydney sandstone, with its occasional ironstone bands, proved too much for it. The slow progress made, and cost of renewing the cutters, led the contractor to abandon it, and resort to the usual methods of drills and explosives.

An examination of the outfall since its coming into use shows that, with even the ordinary flow of sewage, it would be dangerous for a man to pass through without some provision for holding on. This has been provided for by fixing life chains to stanchions let into the soffit of the arch.

An automatic flow register has been fixed in this outfall to register the daily flow of sewage, the Glenfield pattern, usually employed in connection with reservoirs, being adopted, with very satisfactory results.

Where so much tunnelling had to be done, it was necessary that the axis of the sewer should be very carefully fixed on the surface, and the

line transferred down the shaft with equal accuracy. It was an important point that the shaft marks should be so fixed that they could not be tampered with, since miners, especially those on task work, have a knack of altering a line to suit their particular method of working. It is a matter of surprise how close some miners will work to line and levels given, while with others the reason for protecting the permanent marks become apparent.

*Southern Outfall.*—The Southern Outfall sewer commences from the inlet chamber on the north bank of Cook's River, and passes over low-lying ground, and through sand-hills, across Gardiner's Road to the Botany Road. The sewer for a large proportion of its length is in embankment. It is circular in form, 5' 6" in diameter, built in blue-stone concrete, with a lining of 4½ inches of brick, and 9-inch brick arch. The internal face is rendered in cement mortar throughout. The foundations are in sandstone concrete, and, where in any bulk, the pressure on the foundation soil is relieved by circular openings.

Where creeks are crossed, the sewer is carried on concrete arches with wing-walls, and offset chambers with penstocks are constructed. There were no difficulties of any importance in the way of bad foundations in this section. Near the Botany Road the section changes to the Hawksley, 4' 6" x 3' 6", built in concrete and brick, with cement rendering. Here it was found necessary to construct a sub-duct under the invert on account of the heavy subsoil drainage. The quality of bricks and concrete are the same as before described.

From Botany Road along Bourke Street the sewer, on account of the quick grades, changes to 3 ft. 3 in. x 2 ft. 2 in. and 3 ft. x 2 ft., oviform with sharp invert. This section of the work caused considerable trouble, on account of the water met with, and, the formation being running sand or bog for the most part, the work was not carried out without difficulty. On one length the cutting was over 30 feet deep, and water was tapped a few feet below the surface. One contractor got disheartened, and gave up the work; but the next one carried it right through.

On one occasion the presence of water was so great that it blew the bottom of a manhole right out, and flooded the lower part with sand and water. This difficulty was overcome by placing vertical pipes at the side, so as to allow the water to pass up clear of the bottom, which was filled in with sand-bags, and afterwards filled over with concrete, made with neat cement. These side pipes were allowed to flow until the completion of the contract, when it was found that the subsoil water had been lowered to such an extent that the pipes could be plugged up and rendered over. This effectually cured the evil, as no further trouble was experienced with this manhole.