CHAPTER 3

SEWAGE TREATMENT - FROM SEWAGE FARMS TO SEPTIC TANKS

During the second half of the nineteenth century sewage treatment methods developed rapidly with most of the research going on in Britain, Europe and the United States. A large number of proposals were made and the debate over which methods were best was often heated. It was a time when articles on sewage treatment appeared not only in engineering journals but also in scientific journals. Many books were written, often by lawyers and medical men as well as by engineers. Sewage treatment was a subject that the general public had an interest in at this time.

Most developments were based on empirical research and the theoretical understanding of how they worked often came later. This is not to say that the investigators were oblivious to scientific discoveries. In fact they often used such discoveries to justify particular treatment technologies and to improve upon them.

The impetus for this research came mainly from Britain where there was a perceived need to clean up the rivers and streams. Many local authorities were forced to experiment with different methods and variations to those methods so as to conform with legal and government requirements. Several companies saw this as an opportunity to make a profit and various processes and materials were patented and marketed.

At first it was thought possible that an ideal treatment solution could be found that effected a high purity of effluent, left no awkward by-products and had no smell. During the second half of the nineteenth century this was what researchers aspired to.

In Sydney, in places where ocean disposal was too expensive in the short term, some of the more popular treatment methods developed overseas were experimented with. Sydney authorities could afford to experiment because ocean disposal was always an option in the long term but the very fact that such schemes were experimental often prejudiced their viability from the start.

In its final report in 1877 the Sydney Sewage and Health Board decided that the city sewage should be intercepted before it was discharged into the Harbour. Most of it would be diverted to Bondi where it could be discharged, without treatment into the sea. This decision will be discussed more fully in chapter four when the preference on the part of engineers for ocean disposal will be considered. In this chapter the various treatments that were implemented where ocean disposal was not available will be explored, in particular the sewage farming option.

SEWAGE FARMS AND THE CONSERVATION LOBBY

In 1877 the Sewage and Health Board also decided that the southward draining city sewage and that of the southern suburbs of Surry Hills, Redfern and Newtown should be taken to a sewage farm on the edge of Botany Bay. (see figure 3.1) This decision followed the investigations of its Engineering Committee

which was chaired by E.O.Moriarty, Engineer-in-Chief for Harbours and Rivers. The composition of the committee was not recorded but was likely to have included the City Engineer, the Engineer-in-Chief for Railways and the Commissioner for Roads and Bridges.[1]

Figure 3.1 Diversion of Sewage from Harbour

Source: F.J.J. Henry, The Water Supply and Sewerage of Sydney, Halstead Press, Sydney, 1939.

The Engineering Committee recommended that the southward draining sewage not be used for broad irrigation but that it be treated by a method known as "intermittent downward filtration".[2] This method used the land as a filter through which the sewage drained. Crops could be grown on the land which would be richer after the sewage had filtered through but this was a secondary consideration since the primary purpose of using the land was to purify the sewage effluent before it went into Botany Bay rather than to utilise the sewage as a fertiliser. Much less land was required to treat the sewage in this way than would be necessary if the sewage was used for broad irrigation, a process in which the sewage was used to irrigate the soil and so was directly taken up through the roots of the vegetation.

1 Sydney City and Suburban Sewage and Health Board, Twelfth and Final Report, 1877, p3.

2 Sydney City and Suburban Sewage and Health Board, No.10 Committee, Second Report, 21st October, 1875.

The Engineering Committee, in the course of their deliberations, requested from the Board a definite indication of their views on sewage farming before they spent too much time and money estimating the costs of such an option. The Sewage and Health Board therefore formally debated the idea in January 1877 and recommended that the sewage farm be established.

The Board's recommendations (especially the ocean outfall at Bondi) were controversial enough for the government to find it necessary to engage an eminent English Engineer, W.Clark, who had been brought out to Australia partly to solve water supply problems, to investigate and report on the drainage and sewerage of Sydney. Clark presented his report, which supported the Board's recommendations for both the Bondi ocean outfall and the Botany sewage farm, to the Colonial Secretary in July 1877.[3]

In 1882 309 acres were resumed by the Government at Webbs Grant for disposal of sewage. The area was bounded on one side by the Cooks River and on the other side by Botany Bay. The land was to be divided into three parts and rotated; one third being under filtration, one third being prepared for crops, and one third with crops growing on it.[4]

Before the sewage farm was fully operational another report was presented to parliament by George Stayton, an engineer with the sewerage branch of the Roads and Bridges Department and a man "of considerable English experience".[5] In a proposed drainage scheme for the Western Suburbs Stayton recommended that the sewage of the Western Suburbs also be channelled onto the sewage farm at Webb's Grant.[6] On Stayton's recommendation an additional 311 acres was resumed at Webb's Grant in 1890. (figure 3.2 shows Stayton's Western Suburbs sewerage scheme.) The land was swampy and even when the Western Suburbs scheme was completed in 1900 only a small part was used for filtering sewage. This extra land was mainly used for the agistment of stock and another small part was leased to Chinese market gardeners.[7]

The idea of a sewage farm was more popular than dry conservancy methods because it seemed to combine the best elements of both worlds; the speedy and automatic removal of wastes from residences, the utilisation of sewage as fertiliser and the avoidance of pollution of waterways.[8]

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3 W. Clark, Report to the Government of NSW on the Drainage of the City of Sydney and Suburbs, 1877.

4 W.V.Aird, The Water Supply, Sewerage and Drainage of Sydney, M.W.S.&D.B., Sydney, 1961, p137.

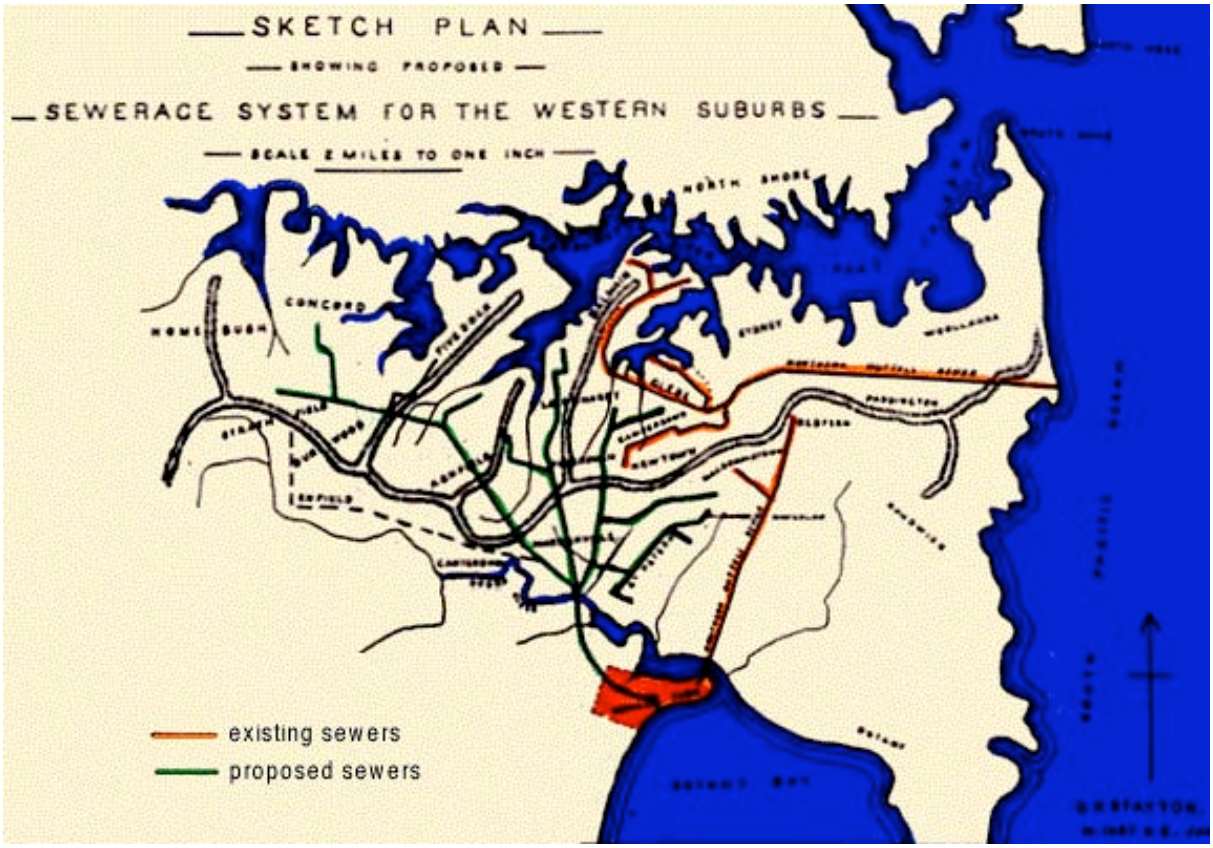
5 Parliamentary Standing Committee on Public Works, Drainage Works, North Shore, 1888, p6.

6 George Stayton, Report on a System of Sewerage for the Western Suburbs of the City of Sydney, 1887.

7 Aird, The Water Supply, Sewerage and Drainage of Sydney, p137.

8 NSW Legislative Assembly, Votes and Proceedings 1876-7, p685.

Figure 3.2 Western Suburbs Sewerage System



An anonymous poet in the Evening News extolled the benefits of sewage farms.

> Dear people! thus to fill my maw,
> By outrage of just Nature's law!-
> If you but us'd your city's filth
> To fatten crops, and feed their tilth,
> Till Nature turning "vile" to "good",
> Returned your waste in fruit or food!
> Your farms and fields would gain in wealth,
> Whate'er your city wins in health,
> And lustier crops and lengthening lives
> Would prove how sense, with science thrives.[9]

Many Sydney-siders had been impressed by the "immense" vegetables produced by Chinese market gardeners who made use of sewage as a fertiliser without any ill-effects. [10] However, the faith that many laypeople had in the value of sewage farming as a sensible and commonsense practice was not reflected in circles where the certainty of economic values were what counted. Mr Watt, the Government Analyst, argued that waterborne sewage had very little manurial value and should be disposed of into the sea where possible.[11] Clark claimed that no process of turning sewage into manure had been a financial success and in

9 Evening News, 23rd March 1880.

10 Sewage and Health Board, Tweflth and Final Report, pp 134-5.

11 ibid., pp134-5.

Sydney, where labour was expensive, it was even less likely to be profitable.[12] A Tasmanian engineer argued that "every pound gained in a year by a sewage farm is gained by a yearly expenditure of more than a pound either in labour or in interest upon capital expended."[13]

By the time Stayton reported in 1887 the Adelaide sewage farm had been established and was just beginning to make a profit. It had 470 acres which were irrigated with the city's sewage and in the Winter intermittent-downward filtration was also used because of the extra rainfall. Stayton said the Adelaide farm

> shows that liquid sewage is an especially valuable fertilizer in a hot climate, and that under good management, a substantial income can eventually be derived from grazing and fattening stock and from the growth and sale of root crops, fodder, plants, fruit and vegetables.[14]

Several British non-engineering experts tried to estimate the value of sewage as fertiliser. For example, Professor Corfield valued it at 1 million pounds per year per 3 million people.[15] Burke, another British expert, pointed out that in England at the time an enormous amount of manure was imported and artificially manufactured. Guano was imported from Peru and other islands and the Peruvian government was already concerned that the deposits would soon be exhausted. The market for artificial fertilisers was also immense.

> Indeed, the number of artificial manure companies paying large dividends, as well as the immense fortunes realized by so many private manufacturers, has almost passed into a proverb, and is perhaps the best index to the enormous demand for artificial manure in this country. [16]

Burke judged any system of sewage disposal by its ability to extract as much of the valuable constituents as possible from the sewage. To him this was equally important as obtaining a pure effluent.[17] This was, however, not a universal view.

The debate within the Sewage and Health Board reflected to some extent the debate going on in the wider community over sewage farms. Members of the Board were unsure about a sewage farm because of the reported experiences of sewage farms overseas and one member argued that it would become a "permanent nuisance, very offensive and dangerous to the health" and that there was a real risk of disease being caused by eating produce grown on a sewage farm.[18]

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12 Clarke, Drainage of the City of Sydney and Suburbs, p13.

13 A. Mault, `The Sewerage of a Seaside Town', Australasian Association for the Advancement of Science 4, 1892, pp772- 3.

14 George Stayton, Sewerage and Drainage of the Western Suburbs, Department of Public Works, 1887, p22.

15 W.H.Corfield, Sewerage and Sewage Utilization, D.Van Nostrand, New York, 1875, pp76-79; 127.

16 Ulick Ralph Burke, A Handbook of Sewage Utilization, 2nd edition, E & F.N.Spon, 1873, pxv.

17 ibid., pxiii.

18 Sewage and Health Board, Twelfth and Final Report, pp131-2.

Moriarty, the Engineering Committee's representative on the Board quoted extensively from various British reports which supported the idea of "downward intermittent filtration." He gave examples of successful farms in Britain and pointed out that the soil was enriched in the process, that there was no evidence of ill-health in neighbouring residences and that there was no evidence that entozoic diseases were propagated by the produce.[19] Mr Dansey, the City Health Officer, and Dr Alleyne, Health Officer, also members of the Board did not feel sewage farms were a health problem either.[20]

The main community opposition to the idea came from those living near the proposed location of the farm. In March, 1880 a meeting of mayors of suburban municipalities was held to consider Clark's scheme of sewerage. Several Mayors expressed their opposition. The Mayor of Alexandria, Mr Henderson, called the scheme for draining the southern suburbs of the city "one of the most monstrous proposals that was ever suggested by any Government." He pointed out that the location intended for a sewage farm was "a perfect swamp" and that 100 acres would be totally insufficient. The Mayor of St Peters, Mr Judd, agreed that the idea was "a most monstrous one".[21] Shortly afterwards, a deputation, claiming to represent 40,000 people went to see the Minister for Works to protest against the plan for the southern draining sewage.[22]

Also the perception that sewage grown vegetables might be harmful had some currency in the community. This found expression in letters to newspapers. For example one letter writer claimed that in Paris many people had asserted that "an injurious flavour of sewage matter" could be detected in vegetables grown in this way.[23] Most people agreed that a poorly managed sewage farm could be a real nuisance but advocates of sewage farming claimed that a properly run farm was safe and healthy and not smelly:[24]

> ... careful investigations in France, Germany, and England have failed to bring to light a single case of injury to health, or of offence arising from sewage irrigation properly conducted.[25]

The debate amongst the experts on the best means of disposing of or treating sewage was every bit as fierce as that over the best way of carrying it away from residences. Burke, an English barrister, wrote in 1873 that

> a well-known sanitary reformer once said to us that he knew only one topic besides polemics upon which men's party spirit got the better of their good sense, and even of their regard for truth and justice, and that was the treatment of sewage.[26]

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19 ibid.

20 ibid.

21 Sydney Morning Herald, 17th March 1880.

22 Evening News, 27th March 1880.

23 Evening News, 20th March 1880.

24 Corfield, Sewerage and Sewage Utilization, p121; W.H.Corfield, A Digest of Facts Relating to the Treatment and Utilisation of Sewage, MacMillan & Co, 1871, pp271-283.

25 Sydney Morning Herald, 24th March 1880.

26 Ulick Ralph Burke, A Handbook of Sewage Utilization, pix.

This led to the most confusing discrepancies in the statistics, Burke observed, so that manure was valued at over £5 per ton by one writer and at less than the cost of carriage by the next. A high authority claimed that a sewage farm was unhealthy to neighbouring residents whilst the statistics showed the death-rate in the area had decreased markedly since the establishment of the farm.[27]

As for the chemical analysis of the effluent, Burke complained,

> One would think that when we had reached the region of pure science a calm voice would speak from the laboratory in the unprejudiced tones of perfect accuracy; [28]

But no, each scientist found differing amounts of nitrogen and reached different conclusions. [29]

The inability to resolve these controversies over scientific points, which had also marked the debate over dry conservancy technologies and would later be typical of controversies over chemical precipitation, artificial filters and septic tanks, were all symptoms of an immature field of study which had not been fully colonised by a professional group with its own paradigm.

A HALF-HEARTED EXPERIMENT IN SEWAGE FARMING

Although Sydney engineers would have preferred ocean disposal, they were not averse to experimenting with intermittent downward filtration which was receiving some good reports overseas as a new and modern way of sewage farming. Its real advantage in many towns and cities in Britain and the United States was that it took up far less land than traditional sewage farming and land was often scarce and the ocean distant in these places. The situation was somewhat different in the newly established city of Sydney but the perception of the value of intermittent downward filtration overseas was transferred to engineers here.

The Sydney Sewage and Health Board decided that the sewage farm would be an experiment which, if it failed, would not be wasted since the sewers could be "extended to Botany or elsewhere". The land could be sold and the outlay to take the sewage to the farm would fit into "any scheme adopted hereafter". The advantage of the scheme, was that it did not "bind the country to any large expenditure".[30]

Moreover, it was readily realised that the lobby for utilisation of the sewage as fertiliser was fairly strong at that time in Sydney and the sewage farm experimentation had the added bonus of placating that lobby. One member of the Sewage and Health Board said,

> I feel sure the inhabitants of this city would be more satisfied to go to the expense of a second great sewer when they know that sewage

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27 ibid., px.

28 ibid., pxi.

29 ibid., pxi.

30 Sewage and Health Board, Twelfth and Final Report, pp143-6.

> farms will not answer. I do not think they will be satisfied until the experiment has been made.[31]

In other coastal towns and cities where ocean disposal was more economic, less effort was made to placate the utilisation lobby. A typical argument which was put forward in the United States in answer to the alleged wastefulness of waterway disposal was put forward by Colonel Waring, an American engineer,

> When our sewage flows off with the drainage, its constituents are, perhaps, quite as likely to come back to us in the form of fish, shell-fish, or seaweed, as they are to come back in the form of crops when it is spread over an irrigation field.[32]

The underlying preference for ocean disposal and the experimental nature of the sewage farm determined the location of Sydney's farm. It was placed at Webb's grant, on the way to the sea on the north-west corner of Botany Bay, bounded on one side by the bay and on the other by the Cooks River. The site was composed of low-lying, raw drift sand and covered in scrub. The land had already been purchased by the government for the purpose of dumping nightsoil and it was a location from which a sewer main could easily be extended to the coast should the experiment fail.

Although one member of the Sewage and Health Board and many locals argued that the land at Webb's grant was far too small an area and totally unsuitable for the purpose, the engineers were considered to be the experts in this area. The choice of location was, however, made on grounds other than maximising the effectiveness of the farming operations.[33] Clark declared the land at Webb's grant to be suitable and that there was sufficient land less than ten feet above sea level available.[34] Stayton also claimed the remote site with its "free sandy soil" 8 or 9 feet above sea level was "admirably fitted" for sewage disposal.[35]

Sewage was first turned on to the farm in August 1887. In the first years of operation of the Botany Sewage Farm about 1.5 million gallons of sewage would arrive at the farm each day. Lime was added to the screened sewage for precipitation and cleansing and the effluent was then transported to the irrigation beds which took up 34 acres at one end of the farm. The irrigation beds were at different levels separated by earthen banks and with filtration drains which channelled the effluent to the Cooks River. These beds were each flooded with effluent in rotation and, while not in use, they were cultivated with the sewage sludge which was ploughed into them.[36]

At first the sewage farm was a great success. (see figure 3.3) On the cultivated land the Board's employees produced cabbages, turnips, lucerne and sorghum and this produce was readily sold. The produce not sold was consumed by pigs

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31 ibid., pp146.

32 Geo.Waring, Jr, Modern Methods of Sewage Disposal, D.Van Nostrand, New York, 1894, p42.

33 Sewage and Health Board, Twelfth and Final Report, p131.

34 Clark, Drainage of the City of Sydney and Suburbs, p13.

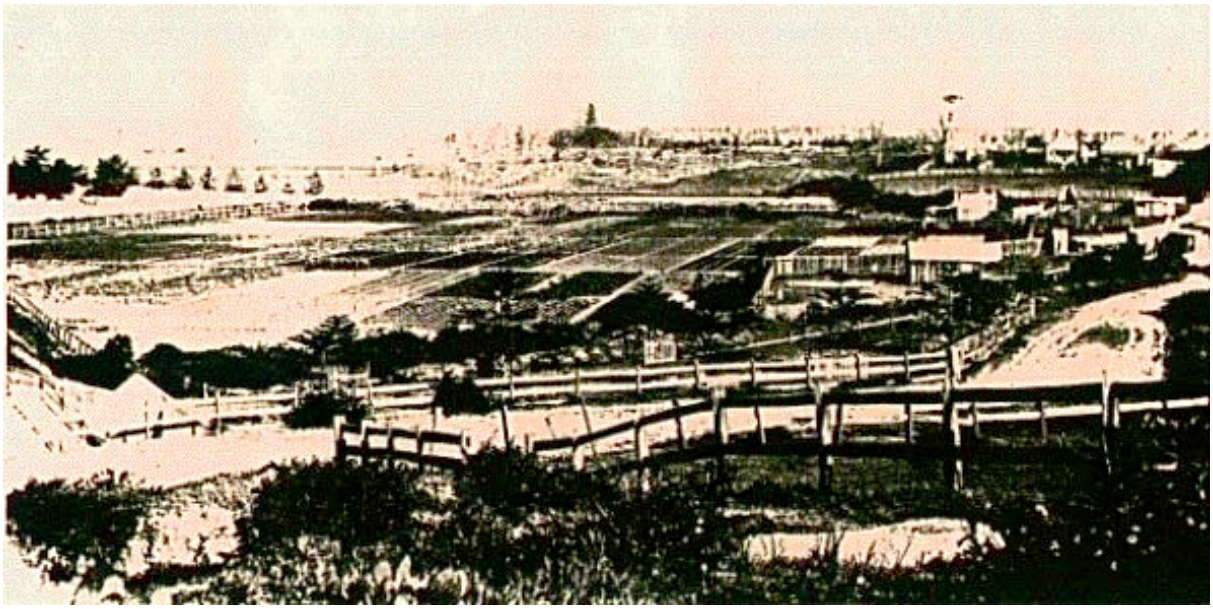
35 Stayton, Sewerage and Drainage of the Western Suburbs, p8.

36 F.J.J. Henry, The Water Supply and Sewerage of Sydney, Halstead Press, Sydney, 1939, pp171-2

and cows purchased for this purpose. Areas not suitable for crop raising were laid out in grass paddocks for agistment of cattle.[37] It was reported in 1890 that lucerne had grown "beyond expectation" and the effluent water, which was analysed by the Government Analyst every quarter, was purified satisfactorily.[38]

> the question of disposal had been solved favourably from a sanitary point of view, and it accords with the opinion of sanitary engineers who have had any experience in the matter, that notwithstanding any prior treatment the sewage should, as a final measure, be disposed over and filtered through land.[39]

Figure 3.3 Sydney's Sewage Farm



In 1893 the Board decided to lease the farm out since it had shown what could be done commercially and in 1894 it was leased for ten years subject to the Board being able to continue to use the land for sewage disposal. It was hoped that in this way the rental for the land would cover the Board's running costs for the farm. It had been costing between £500 and £600 per year to operate the farm. However, the farm was not properly maintained by the lessee. The resultant state of the farm was such that the sewage disposal operations would soon be compromised. After 12 months the Board was forced to cancel the contract.[40]

The flow to the farm increased rapidly each year to 3.25 million gallons per day by 1900. Figure 3.4 shows the increasing flow to the farm and the filtration area set prepared for the sewage. One can see that after 1898 the flow to the farm rapidly increased without a corresponding increase in filtration area. Figure 3.5

37 ibid.

38 J.M.Smail and W.L.de L.Roberts, `Purification of Sewage', Australasian Association for the Advancement of Science 2, 1890, p684.

39 Henry, The Water Supply and Sewerage of Sydney, p685.

40 ibid.; Aird, The Water Supply, Sewerage and Drainage of Sydney, p138.

shows the increasing number of houses being served by the city's sewerage system. Most of the additional sewage would have gone to the farm.

Figure 3.4 Sewage Farm Area and Flow of Sewage

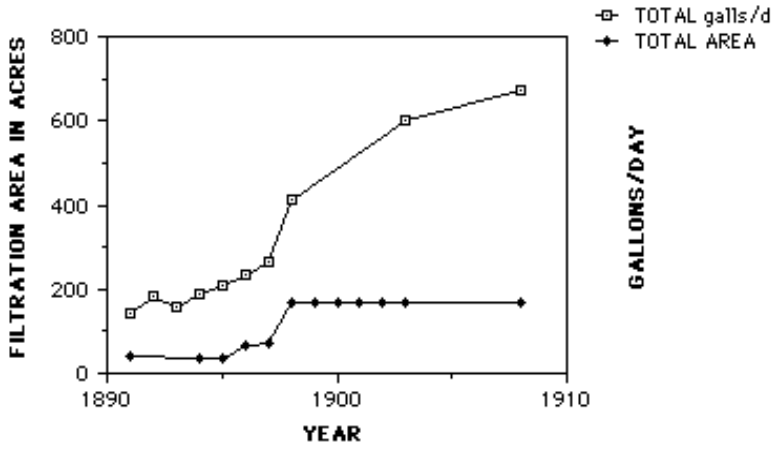
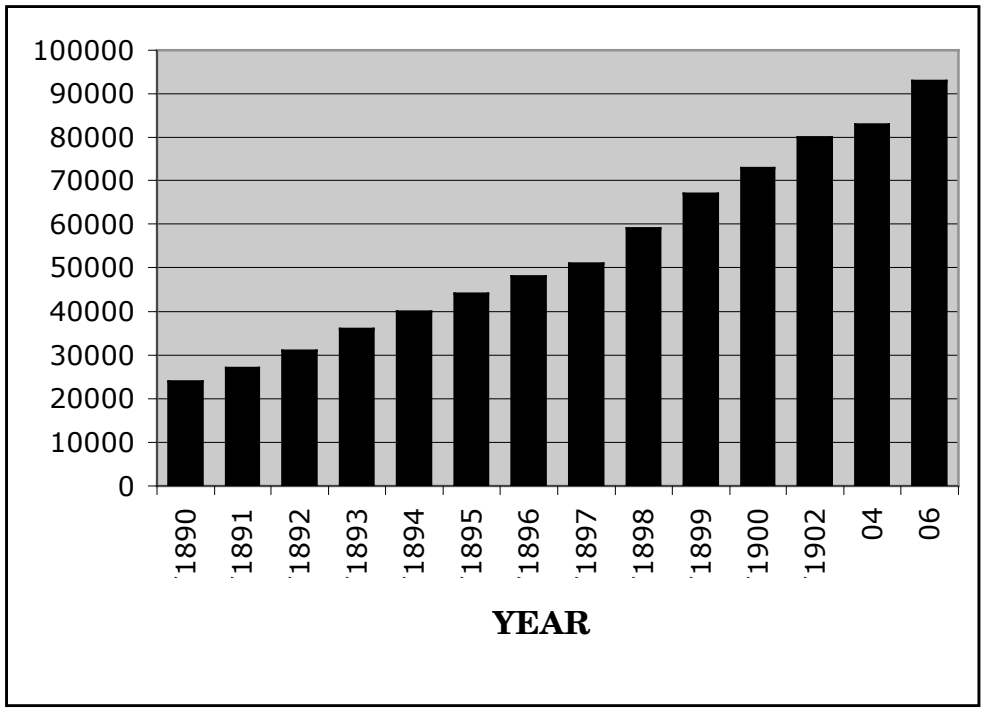


Figure 3.5 Number of Houses Sewered 1890-1906



Information from MWS&DB Annual Reports

The population of the surrounding neighbourhoods also grew and in 1898 the Water Board together with the Public Works Department began some experiments with filters and tanks with the idea of changing to biological treatment of the sewage because of the complaints from neighbouring localities

and threats of legal action.[41] By 1900 William Hamlet, the Government Analyst, was proclaiming the Botany sewage farm as a dismal failure. The land was waterlogged and fouled, he said.[42] Complaints about the sewage farm were stepped up in the next few years. In 1903 a local resident described how what seemed like raw sewage was conveyed via open channels onto the land. The sewage percolated through the sand and was washed into the Cooks River where, after the tide receded, the sediment was dried by the sun and blown "all over the place as far as Tempe". The resident said that local fishermen were complaining that their livelihoods were being threatened because fish and prawns were becoming scarce in the Cooks River and also because people were reluctant to buy fish caught in the Cooks River because of the sewage.[43]

The Medical Officer of the Water Board, Dr Mailler-Kendall, responded to these complaints in a way that was to become typical of Water Board dealings with the public. He said that the Board had done all it could to minimise the smell from the farm and satisfy people who were complaining. He suggested that many of the smells came from the Chinese gardens and wool-scouring and boiling down establishments at Alexandria and Botany. Sewage did not harm fish and anyway he had never noticed a fishing industry at Cooks River. Tanneries and wool-washing works all discharged their wastes into the Cooks River and the sewage farm could not be blamed for its pollution. There was no danger to health. The Water Board, he said, wanted to change the sewage farm to a septic system but did not have the money.[44]

The next day Dr Ashburton Thompson, President of the Board of Health, confirmed that the Board of Health considered the Sewage farm to be a very bad nuisance but that he believed that the Water Board engineers had done all they could to stop the nuisance. He said he had advised the local authorities that "the only proper and satisfactory course" was to use the Public Health Act and summons those responsible for the farm management to Court where an order might be made that the nuisance be abated. The Council had not done this however.[45]

The statements of the Water Board Medical Officer also provoked a flock of letters to the editor. It was alleged that sewage was discharged directly into the Cooks River when it rained heavily. One writer exclaimed

> Surely dumping faecal matter in its crude state on the farm is not treatment...the manner in which the whole system is conducted is a disgrace to a civilised community.[46]

Property owners in the area were concerned about the sale and rental value of their properties and the local progress associations were considering combining to take legal action against the board because of the depreciation of property.[47]

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41 Henry, The Water Supply and Sewerage of Sydney, pp173-4.

42 William Hamlet, `Anniversary Address', Royal Society of NSW 34, 1900, p22.

43 Daily Telegraph, 7th May 1903.

44 ibid.

45 Daily Telegraph, 8th May 1903.

46 ibid.

47 ibid.

Two years later citizens of Rockdale and Arncliffe, the suburbs neighbouring the farm, admitted that although the smells from the farm had been retarding settlement in the area for some time and reducing property values the council and the property owners had tried to keep "the knowledge of the prevalence of these odours to themselves, not wishing to make the matter public" and had only spoken about it freely when the Government was proposing to do something about it.[48] This pattern of self-suppression of public complaint by local communities was to be repeated many times in the following decades.

In a later government report it was admitted that the sewage farm did give off "exceedingly disagreeable and offensive" odours although there was no evidence that these odours were unhealthy. The reason that the sewage farm was such a nuisance, the report claimed, was because of the unsuitability of the area. The soil was raw sand and therefore did not contain enough organisms for breaking down the sewage and the location was subject to tides so that the land was periodically saturated with salt water and sewage "to an extent that makes successful operation impossible".[49] This finding is in marked contrast to the assurances given by the engineers earlier on.

Besides the physical unsuitability of the site, the farm was overloaded. The planned rest times for the filter beds were not always practicable and the land had become "sewage sick" so that little profit could be obtained from growing vegetables on it.[50]

The Sydney Sewage farm was compared with those in Melbourne and Adelaide and found to be distinctly lacking. Both these latter farms, the report claimed, were profitably operated without public complaint. The Melbourne farm, at Werribee (4.5 miles from any centre of population) covered 8,847 acres of land, all of which were suitable for farming and would have been classed as agricultural land before the application of sewage. 22-25 million gallons of sewage were disposed of on the farm daily. (cf 931 acres at Botany of which 200 were usable for 7 million gallons daily)[51]

By 1905 complaints had reached such a level that a Parliamentary Standing Committee on Public Works met to consider a scheme for treating the sewage from the Western suburbs which at the time was discharging onto a part of the sewage farm near Arncliffe. The Committee, admitting that complaints had been justified, recommended that four septic tanks and filters be installed to deal with this sewage.[52]

That same year, 1905, swine fever caused the destruction of the farm's pigs and although pig raising had been profitable it was not resumed after this. By 1908 so much of the farm was continually flooded because of the greatly increased flow of sewage (6.75 million gallons daily) that the raising of crops had become a very

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48 Parliamentary Standing Committee on Public Works, Scheme for Treatment of Sewage at the Western Suburbs Outfall on the Rockdale Sewage Farm, 1905, p9.

49 Parliamentary Standing Committee on Public Works, Disposal of Sewage from the Western, Southern, Illawarra, and Botany Districts, 1908, p7.

50 ibid., pp7-8.

51 ibid., p10.

52 Parliamentary Standing Committee on Public Works, Scheme for Treatment of Sewage at the Western Suburbs Outfall on the Rockdale Sewage Farm, 1905.

small proportion of the farm's activities and a few years later crops were abandoned altogether.[53]

In 1916 the Southern and Western Suburbs Ocean Outfall Sewer was completed (see next chapter) and the sewage farm ceased to operate. In 1918 there was an attempt to lease out the old filter bed areas and it was found that the soil had already reverted to raw sand.[54]

CHEMICAL PRECIPITATION - A SHORT LIVED EXPERIMENT

By 1891, George Stayton, the government engineer who had recommended that the sewerage of the Western suburbs be treated at the Botany sewage farm by intermittent downward filtration, was arguing against the use of this method for the sewage of Parramatta which lay too far west of the city to consider ocean disposal in the short term. He had just returned from a tour of British sewage treatment works and had presented a report to parliament on methods of sewage purification. Stayton claimed that intermittent downward filtration was not "making any particular advance in England".[55] He was particularly impressed, however, by three different systems of chemical precipitation.[56]

Chemicals were first used to deodorise and disinfect sewage. The idea was not so much to sterilise the sewage as to retard its putrefaction until it could be disposed of so that it would not create a nuisance or endanger the public health. Chemicals used for this purpose included carbolic acid, charcoal, chloride of lime, permanganate, sodium hypochlorite and chlorine.[57]

Chemical precipitation for the purposes of purifying sewage was used in Britain following the Public Health Act of 1875 which was aimed at protecting rivers which had become grossly polluted by the combination of water-carriage technology and discharge into the nearest watercourse. The Act insisted that sewage be treated before discharge. Sewage farming had been the preferred method but land was often scarce or unsuitable in British inland towns and cities. Chemical precipitation before land treatment reduced the amount of land required.[58]

The first chemical precipitant patented was lime. The Botany Sewage Farm had utilised lime precipitation as a preliminary treatment before the effluent was treated by the land, however, it was never referred to as an example of the use of chemical precipitation as it was considered that this part of the process was very minor. At one stage the addition of lime was discontinued at the sewage farm but it was found that the sewage was more beneficial to the crops when the lime was

53 Henry, The Water Supply and Sewerage of Sydney, pp173-4.

54 ibid.

55 George Stayton, Sewage Purification, NSW Legislative Assembly, 1891, p14.

56 ibid., p1.

57 H.H.Stanbridge, History of Sewage Treatment in Britain, Part 3, Institute of Water Pollution Control, Kent, 1976, p4.

58 John Sidwick, `A Brief History of Sewage Treatment-1', Effluent and Water Treatment Journal, February 1976, p68.

added. The sludge which was precipitated out was used to form banks or was applied directly to the land and the Board claimed that it caused no problem.[59]

Between 1856 and 1876 it is estimated that over 400 patents were granted for chemical precipitants.[60] Little was understood about the science behind precipitants and a writer at the time observed,

> Inventors seem mainly to have looked out for articles which were cheap, or entirely worthless, and heaped them together without any definite notion of the part which they were separately and collectively to play. This alone can count for the recommendation of such bodies as coal-ashes, soot, salt, gypsum, etc., which in almost every case would do more harm than good. Very often we see, especially in the older specifications, materials given as alternatives whose action, if any, must be evidently quite dissimilar the one to the other.[61]

Often the precipitants were unwanted by-products of industrial processes used with some other material.[62]

Many limited liability companies were formed to exploit the situation and make profits from patented precipitation processes. They promoted their processes using test results from experiments often undertaken by their own employees and literature giving a misleading interpretation of the results. By 1884 they had all gone into liquidation and their treatment works had become the property of the local authorities.[63]

At first it was hoped that the expense of treating the sewage could be recouped from turning the precipitated sludge into a valuable fertiliser.[64] This notion was based on a belief that the valuable constituents of the sewage were contained in the solids and that the chemicals used for precipitation would increase the fertilising properties of those solids. It was thought that the precipitated solids would be in a far more convenient form for conversion to manure and transportation to farms and would therefore be a more economical means of utilising the sewage than applying the sewage directly to the land. [65]

It was generally recognised by opponents and proponents alike that chemical precipitation did not purify the sewage but merely clarified it and that the chemical precipitation had to be used in conjunction with some sort of filtering process.[66] For Stayton's Parramatta scheme he proposed that a patented chemical precipitation system, known as the International system, be used. It had two stages. In the first stage the sewage was precipitated and deodorized in settling tanks with a magnetic precipitant and deodorant called "ferozone" (trade

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59 M.S.W.&D.B., Annual Report, 1901, p70.

60 Stanbridge, History of Sewage Treatment in Britain, Part 3, p8.

61 J.W.Slater, quoted by Stanbridge, Part 3, History of Sewage Treatment in Britain, p9.

62 Stanbridge, History of Sewage Treatment in Britain, part 3, p9.

63 ibid., p12.

64 Sewage and Health Board, Twelfth and Final Report, p9.

65 Stanbridge, History of Sewage Treatment in Britain, Part 3, p8.

66 J.M.Smail & W.L.de L.Roberts, 'Purification of Sewage', Australasian Association for the Advancement of Science II, 1890, p682.

name for a preparation of salts of iron and alumina). In the second stage artificial filters were proposed rather than sand or earth. The partly purified sewage-effluent would pass through "polarite" filter beds (another trade name for a "specially prepared rustless and magnetic oxide of iron) which were supposed to trap the remaining solids and oxidise putrescible matter held in solution. The sludge could be mixed with refuse or pressed and dried and sold to farmers.[67]

This scheme never went ahead however. On Stayton's advice the Parliamentary Standing Committee on Public Works had recommended against a proposed sewage farm for Parramatta and suggested that instead, the sewage be dealt with by a system of precipitation and filtration "or other effective modern process".[68] However, there was much debate over this controversial decision particularly from sewage farm proponents, and engineers were divided over the relative merits of sewage farming and chemical precipitation with filtration.

As in previous debates over sewage disposal, neither side could agree on the efficacy, nuisance potential, fertilising potential or economics of each proposal. A key point of dispute was the suitability of the site for sewage farming. Stayton argued that the proposed site for the sewage farm was unsuitable because it was low-lying and consisted mainly of clay. He warned that the area would become surcharged and water-logged with sewage and give off offensive smells. He argued that the "International" system of precipitation and filtration that he advocated could be carried out close to populated areas without any smells or nuisance and would be more economical.[69]

The Commissioner and Engineer-in-Chief for Roads, Bridges and Sewers, Mr R.R.P.Hickson, who had proposed the sewage farm at Parramatta, disagreed with Stayton completely. It had been proposed to treat the sewage at Parramatta by a combination of broad irrigation and downward intermittent filtration on 42 acres of sand filling and 22 acres of friable clay "which although not capable of taking so much sewage [as sand] is considered by authorities to be even a better filtering medium".[70] The site, argued Hickson, was the best in the area because of its distance from population, its ability to deal with the drainage of Granville and other nearby Municipalities and its capability of expansion.[71]

Stayton argued that a sewage farm would be costly whilst Hickson disputed that his scheme was more expensive than Stayton's. Hickson claimed that intermittent-downward filtration was the best method of sewage purification to use.

> With reference to the question of the relative advantages of chemical precipitation and land filtration, I can without hesitation say that at the present time no sanitary engineer of eminence in Europe or

67 Stayton, Sewage Purification, pp4-5.

68 Parliamentary Standing Committee on Public Works, Sewerage Works for Parramatta, 1892, p5.

69 ibid., p8.

70 R.R.P. Hickson, Parramatta Sewerage Scheme, 1892, p6.

71 ibid., p4.

> America will be found who will give unqualified preference to the former.[72]

Precipitation had been adopted, Hickson pointed out, in London and some towns in Britain because land for filtration was not available, was too expensive or was unsuitable. Chemical precipitants merely clarified the sewage and retarded the action of nitrifying organisms in any subsequent filtering process. The International System, Hickson pointed out, had only been around for five years and while over 400 patents had been taken out for various precipitating mediums, "the "survivals" could be counted on the fingers."[73] Almost all the available literature on the advantages of the system, he claimed, was published by the International company itself.[74] Stayton, on the other hand, argued that a recent Commission in Britain had determined that precipitation together with filtration gave "the best effluent known" and that this was a widely used method for towns in Britain.[75]

Another problem with chemical treatment, pointed out by engineers with the Water Board, was the difficulty of varying the dosage according to the varying strength and quantity of sewage during any twenty-four hour period. Some experiments had in fact been carried out at the Botany Sewage Farm with various quantities of lime and a lime/iron sulphate mixture. It was found that the amount required to be added to get a good result was so large that the costs, the increased bulk of sludge produced and the extra machinery required "would far outweigh any advantage obtained".[76]

At the end of his dissenting report, Hickson urged that no action be taken until "a competent and unprejudiced engineering opinion" had been obtained.[77] The then Minister for Public Works agreed with this proposal and an expert board of three engineers was appointed. The board of Messrs Wardell, Chamier and Napier Bell reported in favour of the sewage farm scheme with the only modification being that a separate rather than partially separate system of sewerage be adopted which would exclude all rainwater. They claimed the proposed area would be "amply large enough" and quite suitable for sewage farming.[78]

The Parliamentary Standing Committee again met to discuss the question in the light of the expert board's findings. The Standing Committee excused their previous recommendations that a sewage farm should not be established on the grounds that they had not been given all the information in a way that would have enabled them to come to a proper conclusion.

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72 Hickson, Parramatta Sewerage Scheme, p1.

73 ibid., pp 1-4.

74 ibid., p3.

75 Parliamentary Standing Committee on Public Works, Drainage Works, North Shore, 1888, Minutes of Evidence, p5.

76 Smail & Roberts, 'Purification of Sewage', pp682-3.

77 R.R.P. Hickson, Parramatta Sewerage Scheme, p7.

78 Parliamentary Standing Committee on Public Works, Sewerage Works for Parramatta, Second Report, 1894, p6.

> Evidence, too, respecting the presence of microbes and their action in relation to sewage has been given in the present inquiry with a fullness of detail not supplied in the first inquiry, and from authorities whose testimony necessarily carries considerable weight.[79]

Nonetheless the Standing Committee still recommended against the proposal for a sewage farm on grounds "other than either the nature of the farm or the method of dealing with the sewage." The cost was "a serious amount to expend in connection with the municipality of Parramatta" and Parramatta was unable to pay the rates necessary to cover the interest payments on the capital expenditure. Nor did it want the proposed works.[80]

The government felt that each municipality should manage their own affairs and therefore expected Parramatta to pay for whatever sewerage scheme was finally accepted. The Committee was therefore concerned about the ability of the people of Parramatta to pay for a sewage farm of the size required.

> The extent to which many of the municipalities of the Colony are indebted to the Government, and their failure to make the necessary repayments, are matters of grave importance in the consideration of any proposed further expenditure in this direction; but in coming to a conclusion in regard to the proposed sewerage works the Committee are more directly influenced by the evidence respecting the inadequacy of the proposed sewage farm [81]

The previous Mayor of Parramatta and his Council had been in favour of the scheme during the first inquiry two years before and approval had been given by council for a sewage farm to be constructed. The new Mayor felt that rate-payers would not want to pay the required amount and yet he was sure the Council would not rescind its approval. He argued that the pollution of Parramatta River was caused by Government Institutions anyway and the government should pay for any necessary sewerage system.[82]

It seems that the Standing Committee had used Stayton's report to recommend against the sewage farm when the real reasons for their opposition were quite different and of a much more political nature. Their attempts to hang their opposition on technical grounds were undermined because of the disagreement occurring within the engineering profession.

Complaints about the state of the Parramatta River continued and in 1898, the government ordered a referendum of rate-payers to be taken. 349 people voted in favour of the sewage farm scheme and 111 voted against it but the situation was not resolved until 1905 when special legislation was passed to allow the Public Works Department to construct a sewerage scheme for Parramatta and then hand it over to the Council on completion.[83] By 1905 however, sewage farms were definitely out of favour and so too were chemical precipitation schemes.

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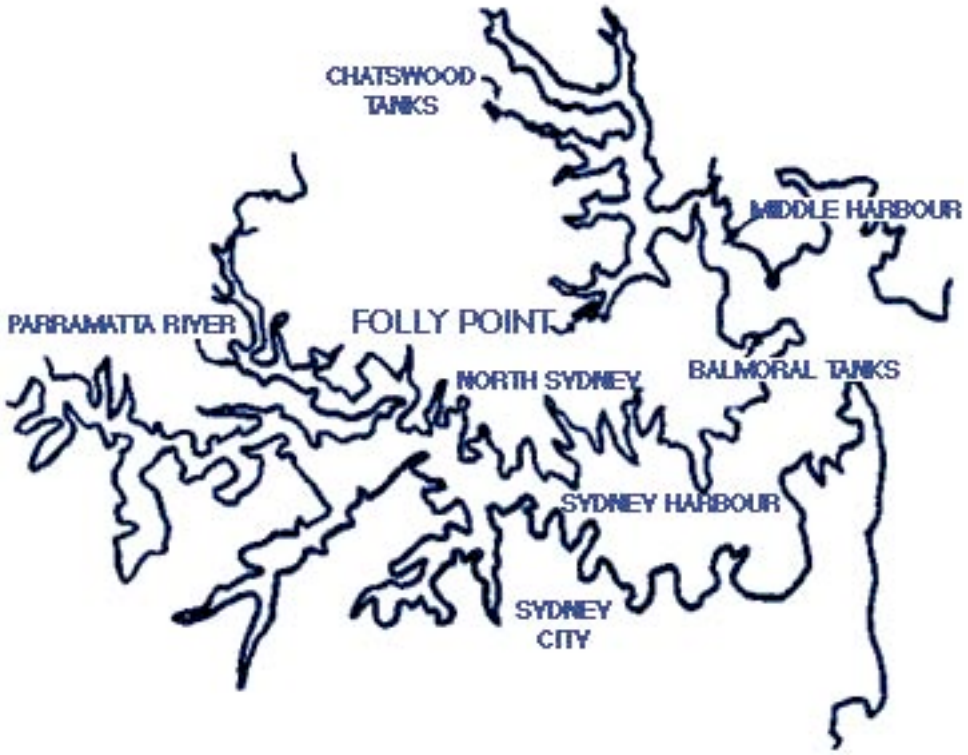
79 ibid., p7.
80 ibid., p8.
81 ibid., p11.
82 ibid., p9.
83 W.V. Aird, The Water Supply, Sewerage and Drainage of Sydney, p161.

Although chemical precipitation was never tried at Parramatta, it was experimented with for a very short time at North Sydney. For North Shore sewage, ocean disposal was not feasible in the short term and the disposal of raw sewage into the Harbour was no longer acceptable. Chemical precipitation was first proposed in 1882 by the Public Works Department and again in a report by Stayton four years later. It was proposed that the sewage be chemically treated and discharged near Willoughby Falls at the head of Long Bay which was in Middle Harbour. The place was later named Folly Point.[84] (see figure 3.6)

Figure 3.6 Folly Point



It was intended that the sewage would be screened before having lime and sulphate of iron mixed with it. It would spend some time in settling tanks where a sludge would be precipitated out and then the clear effluent would be intermittently filtered through 6 feet of sand, on land reclaimed from tidal waters, before being discharged into the bay.[85] The sludge would be made into sludge cake using filter presses and then burnt in furnaces since "it was deemed inadvisable to rely solely for any demand for the product as a means of disposal" and because burning was the most "efficacious" method of disposal.[86]

There was some public opposition from locals concerned that a nuisance would be created and the bay polluted. A local alderman was worried that the final effluent might still pollute the harbour, that the sand might not be a very good

84 Parliamentary Standing Committee on Public Works, Drainage Works, North Shore, 1888.

85 ibid.

86 J. Davis, `The North Sydney and Double Bay Sewerage Schemes', Journal of Royal Society of NSW 33, 1899, pxx.

filter, that the underlying drains might become blocked with sand and that the area chosen was too small.[87] Another witness to the hearing held by the Public Works Committee admitted that he had no professional knowledge but noted that the waters in Long Bay were very still and that any discharge into them was liable to remain there, build up and spoil the area which had been a pleasure resort for many visitors and would otherwise be one of the most beautiful areas in New South Wales.[88]

Several engineers assured the Public Works Committee that no nuisance would arise from the proposed method of treatment and that it was the best of all possible options, having given no trouble in Britain.[89] Stayton claimed that the area set aside for treatment would be sufficient for all time and that the entire sewerage system would be still thoroughly efficient in eighty or one hundred years time.[90]

Work began on the North Sydney sewerage works in 1891 and they were duly handed over to the Water Board on their completion in 1899. But in their annual report the following year the Board claimed that there were not enough tanks "to meet the requirements of the rapid expansion of the sewerage system" and that additional works had been authorised.[91] The year after that the precipitation process was abandoned.

The Board's engineer claimed that after a few months it had been found that the cost of lime for precipitation, sludge pressing and fuel for burning the sludge was too great. Various experiments for improvement had been tried such as combining the sludge with combustible materials such a sawdust and coal-dust. These had been unsuccessful and it was necessary to mix the sludge with lime to form the sludge cake.[92] There had also been trouble with the sand filtering area which "had every appearance of becoming sour and sewage sick" and this required regular harrowing to keep it aerated.[93] In a later report, the Board also admitted that there had been a number of complaints of nuisances.[94]

A British Local Government survey in 1894 of 234 towns that had or were still using chemical treatment found that none had made a profit from manufacture of fertiliser, 30 had made some income but 204 had made no income. 174 were still using chemicals.[95] When it was realised that fertiliser manufacture was not profitable the disposal of the precipitated sludge became the biggest problem facing those using chemical treatment.[96]

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87 Parliamentary Standing Committee on Public Works, Drainage Works, North Shore, 1888, Minutes of Evidence, pp13-14.

88 ibid., Minutes of Evidence, p16.

89 ibid.

90 ibid., Minutes of Evidence, pp5-6.

91 M.W.S.&D.B., Annual Report, 1900, pp4, 86.

92 ibid.

93 M.W.S.&D.B., Annual Report, 1900, p86.

94 M.W.S.&D.B., Annual Report, 1903, p21.

95 Stanbridge, History of Sewage Treatment in Britain, part 3, p19.

96 John Sidwick, 'A Brief History of Sewage Treatment-1', p70.

SERIOUS EXPERIMENTS WITH SEPTIC TANKS

As the precipitated sludge came to be considered to be an expensive nuisance rather than an asset, engineers searched for a means of treating the sewage which would not produce sludge.

> It has been felt for some time that any means of treating sewage without the production of sludge, would be hailed by sanitary engineers as a great advance on present methods.[97]

Purely biological methods were attractive because they held the promise of eliminating the sludge which was proving to be a nuisance with chemical precipitation. The septic tank was one such process. It was essentially a horizontal-flow primary sedimentation tank providing a very long retention period. Sewage entered and left the tank below the surface so that anaerobic microbes could operate. The sludge, which at first was not believed to accumulate, was not removed very often and never entirely removed so that there were always microbes present.[98]

Anaerobic tanks had been used as far back as 1860 but it was not until 1881 that it was found in France that organic solids liquified under such conditions and this was attributed to the anaerobic action taking place.[99] By the end of the century septic tanks were being hailed as the answer to the sludge problem and an automatic process with no accompanying nuisance and no need for expensive chemicals.[100] Although septic tanks were said to eliminate the sludge problem, at least one engineering writer has wondered in retrospect about the extent to which scientific judgement was influenced by wishful thinking.[101]

Septic tanks replaced precipitation tanks in many places but it was soon realised that they were not the panacea that had been hoped for. The reduction in sludge volume was mainly caused by consolidation in the septic tank and loss of solids with the effluent. Not only that but septic tanks were found to be smelly and the effluent, which was more unpleasant than from other tank processes, would often clog filters because of the high solids content.[102]

Septic tanks, whilst at first as popular in the U.S. as in Britain lost favour because of patent disputes arising from the original British patent of the process. Also many tanks were built as septic tanks by people who did not understand the scientific principles involved, and their subsequent failure gave septic tanks a bad name.[103]

One form of septic tank was introduced by W.D.Scott-Moncrieff in 1891. The 'cultivation tank' was a combined septic tank and upward-flow straining filter.

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97 Henry Deane, `President's Address', Journal of Royal Society of NSW 32, 1898, p17.

98 H.H.Stanbridge, History of Sewage Treatment in Britain, Part 4, Kent, 1976, p42.

99 ibid.

100 Deane, `President's Address', pp17-8; William Hamlet, `Anniversary Address', *J*ournal of Royal Society of NSW 34, 1900, p27.

101 John Sidwick, 'A Brief History of Sewage Treatment-1', p295.

102 ibid., p296.

103 Leonard Metcalf & Harrison Eddy, American Sewerage Practice, vol III, 1st ed, McGraw-Hill, New York, 1915, p17.

The idea was that the soluble constituents of sewage would be more readily broken down by nitrifying organisms if they were first subjected to anaerobic conditions.[104] When chemical precipitation was found to be unsuitable at North Sydney it was decided to convert one of the precipitation tanks "into a bacteria bed, on the Scott-Moncrieff principle"[105] to find a less offensive, cheaper method of treatment as well as to get rid of "that gigantic nuisance-sludge."[106]

That same year, J Davis, the Engineer-in-Chief for Sewerage Construction, Public Works Department proposed a scheme of sewerage for what were then called the Illawarra Suburbs. These suburbs included Kogarah and Rockdale and were adjacent to the sewage farm but Davis recommended that the sewage of this area be treated by septic tanks and filters.[107]

The Board engineers were also keen, despite Ministerial reluctance, to make similar experiments with a view to treating the sewage from the main southern outfall "on biological principles" on the sewage farm, again with a view to saving money and because "the biological treatment of sewage is the most modern approved scientific principle". Experimental tanks had been installed at the Botany Sewage Farm in 1898 and preparations for experiments were already under way for the sewage from the Rookwood asylum.[108]

A Water Board engineer claimed that the results of experiments carried out on the sewage farm showed that the septic tank system lived up to all expectations and claims that had been made for it.[109] Added advantages were that the tanks tended to equalise an irregular flow of sewage and, where a coarse grain filter was used with the Scott-Moncrieff method, screening became unnecessary.

The precipitation tanks at North Sydney were all converted to open septic tanks in 1902 with the effluent from them still going onto the sand filter beds. The Board engineer claimed an excellent resulting effluent, no smells and a considerable cost saving. Also septic tanks were constructed at Chatswood and later Balmoral to treat the sewage from that area.[110] (see figure 3.6) The Government analyst urged in that year's Water Board report that the success of the experiments with septic tanks and with Scott-Moncrieff cultivation beds justified the whole of Sydney's sewage being treated in this way.[111] Septic tanks were also given a vote of confidence by the President of the Royal Society of N.S.W., an engineer himself, in 1903 when he claimed that septic tanks had been recognised in England as being "an essential part of modern bacterial purification processes".[112]

Along with the praise, however, there were a number of complaints about the smells arising from the North Sydney tanks. The newspapers had been reporting

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104 Stanbridge, History of Sewage Treatment in Britain, part 4, p54.

105 M.W.S.&D.B., Annual Report, 1900, p4.

106 M.W.S.&D.B., Annual Report, 1903, p21.

107 J.Davis, Report on Proposed Scheme of Sewerage for the Illawarra Suburbs, 1900.

108 ibid., p5.

109 M.W.S.&D.B., Annual Report, 1901, p71.

110 M.W.S.&D.B., Annual Report, 1902, pp21,65.

111 ibid., p73.

112 W.H.Warren, `Presidential Address', Journal of Royal Society of NSW 37, 1903, p47.

complaints about the works from nearby residents and from boating people. The local council had made representations to the Water Board in 1903 without success and the Mayor had declared conditions at Folly Point to be unsatisfactory.[113]

It was decided to cover the septic tanks up and, although the Board was sure that this would remove all nuisance from the works, it was decided to install equipment for ascertaining the rate of dilution during storm-water flows "in order to meet complaints"[114] (presumably by being able to say that the sewage was extremely diluted at times of heavy rainfall when the system was likely to become overloaded and sewage might have to flow through the tanks more quickly than was desirable.) Nevertheless the complaints continued and the Board's engineers became defensive,

> Within a year several additional dwellings have been erected in proximity to the works and find ready occupation. If the works were so bad from a sanitary standpoint as stated on several occasions, the land would be unoccupied, but the reverse is the case.[115]

The Board in fact denied any problem until the Fisheries Commission closed the area to fishing.[116] Yet even then the Water Board Chief Engineer claimed that there was no nuisance caused by the effluent being discharged into the water. He claimed that fish were to be seen playing around the outfall and that fish could be found there when they could not be found elsewhere.[117]

During a public hearing in 1905 residents of Drummoyne were invited to inspect Folly Point to see the operation of septic tanks, which were being proposed for their area. Witnesses described what they saw at Folly Point as "an abominable nuisance" and reported that many of the ladies on the wharf at the time were made sick by it.[118]

At the 1905 hearing the engineer representing the Water Board claimed that the Folly Point works did not pollute the bay in any way and he was loath to admit any fault with the works. He readily blamed the geography of the place,

> it is a peculiar place,. It is shaped like the neck of a bottle, and, when the north-easter blows, the effluvium from the tank goes up the cliff, and people on the top get a whiff of it.[119]

However, he did admit that Folly Point was not a good example of an effective treatment works and, when pressed, agreed that prejudices formed against septic tanks after visiting the works were well grounded. He made the excuse that it

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113 Daily Telegraph, 6th August 1903.

114 M.W.S.&D.B., Annual Report, 1903, p7; M.W.S.&D.B., Annual Report, 1904, p66.

115 M.W.S.&D.B., Annual Report, 1906, p91.

116 Daily Telegraph, 18th January 1904.

117 Parliamentary Standing Committee on Public Works, Scheme of Sewerage for the Municipality of Drummoyne, Report, 1906, p6.

118 ibid., pp10,12.

119 ibid., p48.

was after all set up for chemical treatment and had been adapted to septic tanks.[120]

By 1912, the sand filters at Folly Point were overloaded and "sewage sick" and had to be relieved with the addition of artificial filters and detritus tanks.[121] The nuisance continued at Folly Point until it was decided that an ocean outfall should be built at North Head and that the sewage feeding into Folly Point be rerouted. Yet before this could be accomplished the Water Board was taken to the Equity Court in 1919 by a neighbouring estate for negligence and nuisance over its conduct of the works. After several weeks the Board was found not to be negligent but was restrained from operating in a way that would cause nuisance. All extensions to the northern suburbs sewerage system had to be postponed until the Board could do something about the works, despite the outcry from residents of unsewered areas.[122]

MARKING OUT THE ENGINEER'S TERRITORY

Despite the disagreements over various treatment methods, engineers almost universally preferred ocean disposal wherever it was economically available. Clark, the English engineer who had recommended the sewage farm in Sydney, stated that he believed that sewage farming could be used as a method of treating sewage but because a loss would accompany such an operation direct discharge into deep water was preferable where it was convenient. Since it was not convenient for the south draining sewage he agreed in principle, and one supposes reluctantly, with the sewage farm.[123]

Similarly the engineering Committee of the Sydney Sewage and Health Board pointed out that the sewage farm would not be recommended if the sewage could be discharged into the sea economically. On the Board there was some argument over whether the government would be willing to cover the cost of taking the sewage all the way to the sea, given the "overflowing Treasury" at that time of national prosperity. But it was pointed out that the yearly interest payments for works which were not immediately necessary "would not be calculated to increase the prosperity of the country." [124]

Also when the sewerage of North Sydney was being considered, the top engineers from both the Public Works Department and the Water Board, Joseph Davis and Thomas Keele, supported septic tank treatment as being second only to ocean disposal, which in this case was too expensive. [125]

The engineering text books of the nineteenth century are mostly unanimous in the opinion that ocean disposal was the most preferable method of dealing with sewage. For example Baldwin Latham, a well-known author of the engineering text "Sanitary Engineering", argued that experience showed that the fertilising

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120 ibid., p50.

121 W.V. Aird, The Water Supply, Sewerage and Drainage of Sydney, pp154-5.

122 Henry, The Water Supply and Sewerage of Sydney, p195.

123 Clark, Drainage of the City of Sydney and Suburbs, p13.

124 Sewage and Health Board, Twelfth and Final Report, pp146.

125 Parliamentary Standing Committee on Public Works, Drainage Works, North Shore, 1888, Minutes of Evidence, p5.

components of the sewage could not be extracted profitably and therefore it should not be considered a great waste to put the sewage into the sea.[126]

The preference by engineers for ocean disposal was not based purely on cost-effectiveness or even the desire for minimal operating costs as can be seen by the constant reiteration of this preference even when a more cost effective alternative was available. In their drive for control, sewage treatment was unattractive because it was to a large extent unpredictable and relatively labour intensive whilst ocean disposal seemed to eliminate the need for treatment altogether. Ocean outfalls were much more controllable.

Problems such as overloading, mechanical breakdown and offensive odours were all distinct possibilities when sewage was being treated. A sewage farm, chemical precipitation or septic tanks required careful management and constant attention. An outfall on the other hand was like an environmental flush toilet with all the advantages of automatic and immediate removal and no dependence on human responsibility. Or so it seemed.

The push to utilise sewage motivated many advocates of sewage farming, both broad irrigation and downward intermittent irrigation, and later chemical precipitation. However, engineers who wrote at the end of the nineteenth century took a different perspective to the public and many other professional groups. Engineers were not necessarily against the use of sewage farms but they considered them primarily in terms of their cost effectiveness and efficiency at purifying the sewage; the waste or utilisation of manure was quite secondary. "Intermittent downward filtration" in particular was viewed simply as a cheap means of dealing with the sewage and the land was simply a medium for purification.[127]

For example, Henry Robinson, an English Professor of Civil Engineering, claimed that sewage farms were too often considered merely from an agricultural point of view rather than from a sanitary point of view.[128]

> The reason why sewage farming has been so unduly pressed and advocated is, that in the early days of sewage utilisation, those who directed public opinion on the question came to the conclusion that the full chemical value of sewage could be realised by its application to land.[129]

He pointed out that the purification of sewage and the raising of crops sometimes came into conflict. This occurred when it rained and large quantities of sewage would arrive at a farm which was already watered by the rain. On such occasions, Robinson argued, "the agricultural part of the matter must be disregarded" and the sanitary necessity alone kept in view.[130] It should be noted that this difficulty resulted from the use of water carriage technology which

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126 Baldwin Latham, Sanitary Engineering: A Guide to the Construction of Works of Sewerage and Drainage with Tables, 2nd ed, E.&F.N.Spon, London, 1878, p444.

127 ibid., pp133-4.

128 Henry Robinson, Sewerage and Sewage Disposal, E.&F.N.Spon, London, 1896, p48.

129 ibid., pp48-9.

130 ibid.

ensured that the sewage would be accompanied by a large quantity of water whether the farm required it or not.

Australian engineers also viewed sewage farming merely as one method of purifying sewage effluent rather than as a means of utilising the fertilising powers of the sewage. Benefits that came from enriching the land were merely part of the economics of the operation. W.H.Warren, Professor of Civil and Mechanical Engineering at Sydney University, like many of his contemporaries, considered that sewage farming was an appropriate option for sewage disposal when it was cheaper than disposal to sea.[131]

Chemical precipitation was another step in a process which aimed at minimising the land required for treatment rather than maximising the land which would benefit from the fertiliser. Chemical precipitation still required that the sewage be subject to downward intermittent filtration, but a smaller area was required once the sewage had much of its suspended solids filtered out. Research into artificial filters in the 1880's offered hopes that the land area required would be reduced even further by the use of materials that had a high surface area to weight ratio.[132]

Artificial filters put an end to any pretences that the sewage was being utilised as it was filtered and septic tanks heralded the end of efforts to utilise the sludge as manure. The development of septic tanks offered even more progress in this quest for processes that required less and less space. A 1917 editorial in an Australian engineering magazine recognised that septic tank treatment was "the outcome of efforts to reduce the space required for the treatment of sewage." [133]

The development of sewage treatment methods marked a steady trend away from sewage utilisation and was characterised by a search for less land intensive solutions. (see figure 3.7) Although the land pressures in Sydney in the nineteenth century were less marked than in Britain or the United States, Sydney engineers were caught up in the flow. The ocean disposal of raw sewage was a solution which required no land and offered no sewage utilisation; it was the ideal solution.

Engineers also preferred ocean disposal because sewage farming was an area less closely aligned to their traditional skills and there were pressures from other professional groups to take control of the area, especially once the biological mechanisms of the sewage farm became better understood.

In 1894 the President of the Royal Society, T.P.Anderson Stuart, M.D. who was Professor of Physiology at Sydney University explained to a meeting of fellow scientists how theories of decomposition had changed. It had previously been thought that decomposition was principally a chemical process mainly due to direct oxidation. It had been discovered, however, that organisms in the soil converted the nitrogenous components of dead organic matter into nitrites and nitrates which were harmless and dissolved in water or were taken up by the

131 W.H.Warren, `President's Address', Australasian Association for Advancement of Science 4, 1892, p165.

132 Stanbridge, History of Sewage Treatment in Britain, Part 6, pp25-37.

133 'Septic Tank for Sewage Treatment', The Commonwealth Engineer, July 2, 1917, p307.

roots of plants. These "nitrifying organisms" were essential to the supply of food to plants.[134]

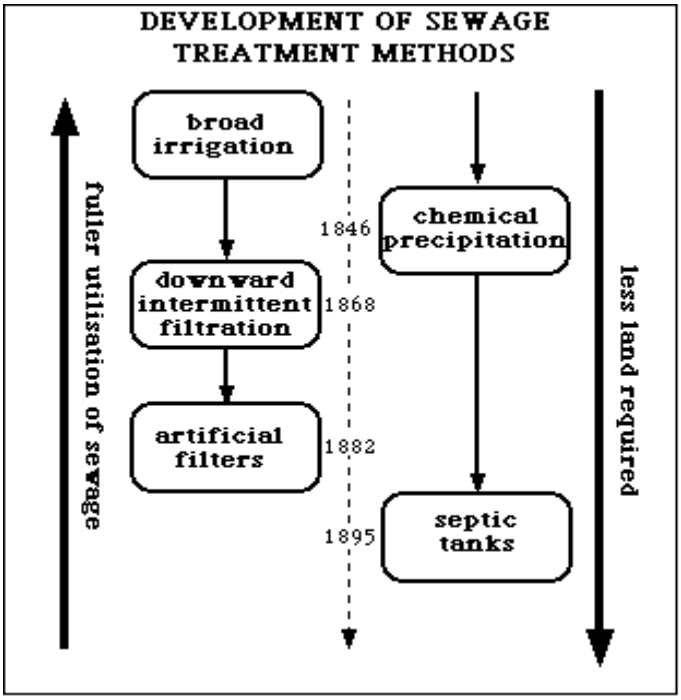

Figure 3.7

It was because of this discovery that Anderson Stuart believed that sewage farming was the most natural and efficient mode of disposing of sewage where sufficient areas of proper soil were available. [135] He felt this discovery of nitrifying organisms and their action in decomposing organic matter removed the work of disposing of sewage away from the sewerage engineer to the biologist.

> now one may say that it is the business of the engineer to collect and distribute the sewage, but that it is mainly that of the biologist or of the chemist to say how it should be disposed or destroyed.[136]

Similar arguments were made with respect to chemical precipitation and septic tank treatment. Hamlet, the government analyst, believed that

> Methods of removal are mechanical, and belong to the domain of the engineer; methods of disposal are of another order, and belong to the domain of biology and chemistry...[137]

The "naturalness" of a sewage farm, which appealed to some sections of the public, was not a desirable attribute to engineers who sought to harness and control nature with their technologies and thereby make their bid for expertise. This was why septic tank treatment appealed to engineers much more than sewage farming as a modern and scientific operation which was really "the

134 T.P.Anderson Stuart, `Anniversary Address', Royal Society of NSW 28, 1894, pp16-17.
135 ibid., pp18-19.
136 ibid., p18.
137 Hamlet, `Anniversary Address', p22.

natural method of sewage purification subject to control".[138] Sewage farms seemed to be too unpredictable. So did chemical precipitation. Septic tanks were not labour intensive and were virtually automatic. There was much more engineering consensus over septic tanks and for this reason septic tanks proliferated around Australia in places where ocean disposal was expensive and the myths associated with their operation, such as the elimination of sludge, continued long after the evidence seemed to destroy them.

Septic tanks also offered an opportunity for engineers to experiment with decentralised sewage treatment systems. The existence of the sewage farm at Webb's grant acted as a magnet for several later sewerage schemes. Stayton says he considered a proposal to convey the Western Suburbs sewage westward to the model farm at Rookwood where it could be used for irrigation. He rejected the proposal on economical grounds. The costs would included the cost of pumping the sewage to the requisite altitude and preparing about 2000 acres of land to receive it. He admitted that the proposed establishment of a sewage farm at Botany was "naturally a strong inducement to consider whether a sufficient area would be available for the purification of the sewage from the Western system".[139]

This tendency towards centralisation was a conscious one. Stayton rejected the idea of having several local systems of sewerage discharging at separate locations rather than one centralised scheme. He argued that there were few suitable sites for sewage to be treated locally and that separate management would involve extra expense.[140] However, centralisation puts huge stresses on treatment plants and Sydney's sewage farm suffered accordingly.

Septic tanks allowed sewage treatment to be far more regionalised because tanks could be small and required a minimum of supervision. In Sydney, in places which were sparsely populated, low-lying but close to waterways, septic tank treatment offered a short term, cheap solution which avoided the cost of pumping the sewage to a higher level so that it could be fed into existing sewerage systems and also the consequences of further burdening the Botany sewage farm.

The interest of engineers in septic tank treatment was a purely pragmatic one. The preference for ocean disposal remained but in situations where it was too costly they were willing to consider other options, even those that were subject to claims by other professional groups. Those claims were never accepted by engineers and so they continued to use biological treatment methods as part of their own arsenal of technologies when it suited them.

When a septic tank system was being considered for Drummoyne (see figure 3.6 for location) the engineers said that it was not fair to the people living near the sewage farm "to handicap the people there by dragging all the sewage to that place" and that if the biological system had been known before the sewage farm was laid out they may have had a far less centralised system, but rather treated the sewage at Homebush Bay and other places.[141]

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138 ibid., p33.

139 Stayton, Sewerage and Drainage of the Western Suburbs, p8.

140 ibid., p7.

141 ibid., p48.

> We have a magnificent harbour, with plenty of arms; and having the biological system why should we go to the expense of taking the sewage miles away when the locality could treat it at its own door, and discharge it into a tidal river. [142]

However, septic tanks were not popular with local communities because of the likely nuisance they would cause and in the long term. The ocean outfalls offered a centralised disposal option that could not, it seemed, be overloaded.

CONCLUSION: THE ADVANTAGES OF FAILED EXPERIMENTS

To a large extent the debates between advocates of sewage farms and ocean outfalls mirrored those between dry conservancy and water-carriage enthusiasts. The desire to see sewage utilised persisted in the public mind whilst the desire of the engineers and the sewage authorities for cheap, "minimum fuss" solutions that could be controlled, as far as possible, meant that ocean disposal without treatment was seen as the ideal solution for coastal towns and cities. In Sydney, where in some places it was actually cheaper to treat the sewage on land before discharge into a waterway than to transport the sewage all the way to the sea, the ocean disposal option was reluctantly shelved but not discarded.

The ultimate preference for ocean disposal in the long term shaped the location of treatment sites and allowed the engineers to take a very experimental approach to treatment methods. They were able to try the latest methods being pioneered in Britain and contribute their findings to international engineering forums and take part in the sanitary engineering debates over treatment methods. They always had the fall back position of extending the sewers to the ocean later when populations would be larger and more rates available to repay loans. In the meantime they could play.

These experiments, particularly the Botany sewage farm, also had the additional benefit of allowing the authorities to placate the sewage utilisation lobby which had a large measure of popular support. However, because the sewage farm was always a doubtful experiment forced upon the engineers by a stubborn public and a distant sea, it was not given a fair chance of success. It was located in a low-lying sandy and swampy area with little room for expansion. This was because the engineers chose a place that the sewage could flow to by gravity, without pumping and which was on the way to the sea. (Fears of public reaction also dictated that the spot be remote from existing population centres.) The chosen method of sewage farming, downward intermittent filtration was already a compromise on full utilisation of the sewage. Full scale irrigation with the sewage would have fertilised and required far more land.

Later, Sydney Water Board engineers were able to claim that various methods of land treatment had been tried and failed and that this justified their policy of always using ocean disposal where practicable. The failure of these methods, however, was due in large part to their perceived experimental and temporary nature, which led to poor siting, overloading and poor management. The continued existence of sewage farms in Melbourne and in other countries bears testimony to this.

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142 ibid., p49.

The overloading was an inevitable result of planning for short time spans but also the draw that existing facilities had for new sewerage schemes looking for an outlet. An existing treatment facility seemed a more economical discharge point to engineers than a new site and a new treatment facility, despite the possibility that the facility might become overloaded. Short term economics does not consider long term consequences. Moreover a centralised facility more easily facilitated any eventual extension to the ocean.

The attempts of engineers to carve out their own territory for sanitary engineering in the face of bids by biologists and chemists was also an important influence in the growing unpopularity of land based treatment and the push towards the ocean.