Fifth National Conference on
Engineering Heritage 1990
Perth,3-5 December 1990

A Heritage of Waste

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SUMMARY This paper presents a case study in interpreting engineering heritage by examining the role of public works in shaping an inner-city area of Sydney, centred on Blackwattle and Rozelle Bays. This area has a rich and varied engineering history, with an opening bridge built in 1861 and replaced in 1903; roadworks built on two causeways which cut off bays in 1857 and 1903; reclamation of the bays; sewerage mains including aqueducts, as well as harbour works.

However, the study identifies waste disposal works as the most significant heritage sites in the precinct. The history of the sewerage mains, drainage works, and refuse disposal sites, reveals an intriguing link between past sanitation problems and the suburban development of Sydney, its traffic routes and port facilities.

These findings on the importance of waste and waste disposal in shaping a city have implications for building a research model for interpreting engineering heritage sites in inner city areas.

More immediately, the paper suggests that recording and interpreting engineering heritage is essential to an adequate understanding of Australian history, and should be undertaken independent of arguments for preservation.

1 INTRODUCTION

In Sydney Harbour, Blackwattle and Rozelle Bays form a fish-tail off Johnston's Bay, curved behind Sydney's central business district, and separated from it by Darling Harbour and the Pyrmont peninsula.

Two hundred hundred years ago this was a landscape of blackwattle and rosellas (Figure 1); one hundred years later it was a busy port. Now, most of the timber yards, wharves, cranes, and shipping berths have been replaced by the Sydney fish market, extensive parks, home units and a High School (Figure 2). A marina and a major bridge to carry the western distributor of Sydney's traffic are proposed.

Over the past 200 years Blackwattle and Rozelle Bays have developed their own history - a history which reflects the impacts of a burgeoning city; a city in need of more residential land, expanding its industries and developing its port; but at the same time, a city generating waste and as it grows, destroying the pristine environment and polluting its creeks and waterways. Indeed, the history reflects the demand for engineering solutions to a city suffocating in its own filth.

Most of the significant items of engineering heritage in this place are those related to waste disposal - the site of the 1857 Blackwattle Bay sewage outfall, the 1890s Wattle Street pumping station, the 1895 White's Creek and Johnston's Creek sewer aqueducts, the reclaimed swamps which now form Wentworth Park and Rozelle Bicentennial Park, and the ruins of the 1934 Pyrmont Incinerator.

Studying the remnant structures because of their significance in relation to problem solving, innovation, or their association with a particular engineer is interesting; but unless the results are viewed in a wider context, their importance as part of our engineering heritage and their place in Australian history can be easily overlooked. Engineering heritage must be interpreted and valued not only for what it tells us about engineering and engineers, but also about the culture which engineering both serves and shapes.

2 Blackwattle Bay and the new Victorian Age

The Colony was founded at Sydney Cove in 1788 because a freshwater stream there supplied ample water. However, by 1795 the Tank Stream was becoming polluted and by 1810, Governor Macquarie ordered slaughter houses, tanneries, breweries and distilleries that drained into the stream to be pulled down. Despite attempts to protect the catchment, rubbish, slops and sewage continued to find their way into the stream and in 1826 it was abandoned as a source of water.

New sources of water were tapped on the margins of the town, at Lachlan Swamps in the east and Blackwattle Swamp to the west, but by the 1840s when Sydney was proclaimed a city, industries and houses had in turn occupied these areas and the new sources had also become spoiled by pollution.

At Blackwattle Bay during the 1830s and 1840s gangs of convicts worked the sandstone quarries along the massive Pyrmont cliffs, and the stone was punted to building sites in the rapidly growing town.

With the blackwattle trees long since cut down, Blackwattle Creek, from the bay to the Parramatta road, had become an industrial site conveniently placed for access to the town. John Tooth's Kent Brewery, and Robert Cooper's gin distillery were located near the head of the creek with the distillery dam upstream of the Blackwattle Creek bridge on the Parramatta road. (The brewery still occupies the same site).

Slaughter houses built on piles over Blackwattle Creek supplied half of Sydney's beef and mutton, and associated enterprises - piggeries, tanneries, a woolen textile factory and a boiling-down works, were all established along the Creek. Blood, offal and effluent were simply washed away by the tide, and rats infested the boundary wall of the creek, built of sheepskulls, bullock horns, and bones. By 1848 the resulting pollution had become so bad that a parliamentary inquiry recommended the removal of the slaughter houses, piggeries, tanneries and the boiling-down works.(1)

3 The Abattoir, its Roads and Bridges

In a climate of urgency the Government determined to establish a public abattoir and chose a site on Glebe Island, the craggy land between White Bay and Johnston's Bay. The "island" was virtually surrounded by water and had a rather forbidding aspect with its dark cliffs and thick bushland. It was an appropriate location, as it fulfilled the need to separate the abattoirs from residential areas and the city's public places, whilst minimising the distance meat would be carted to supply the city.

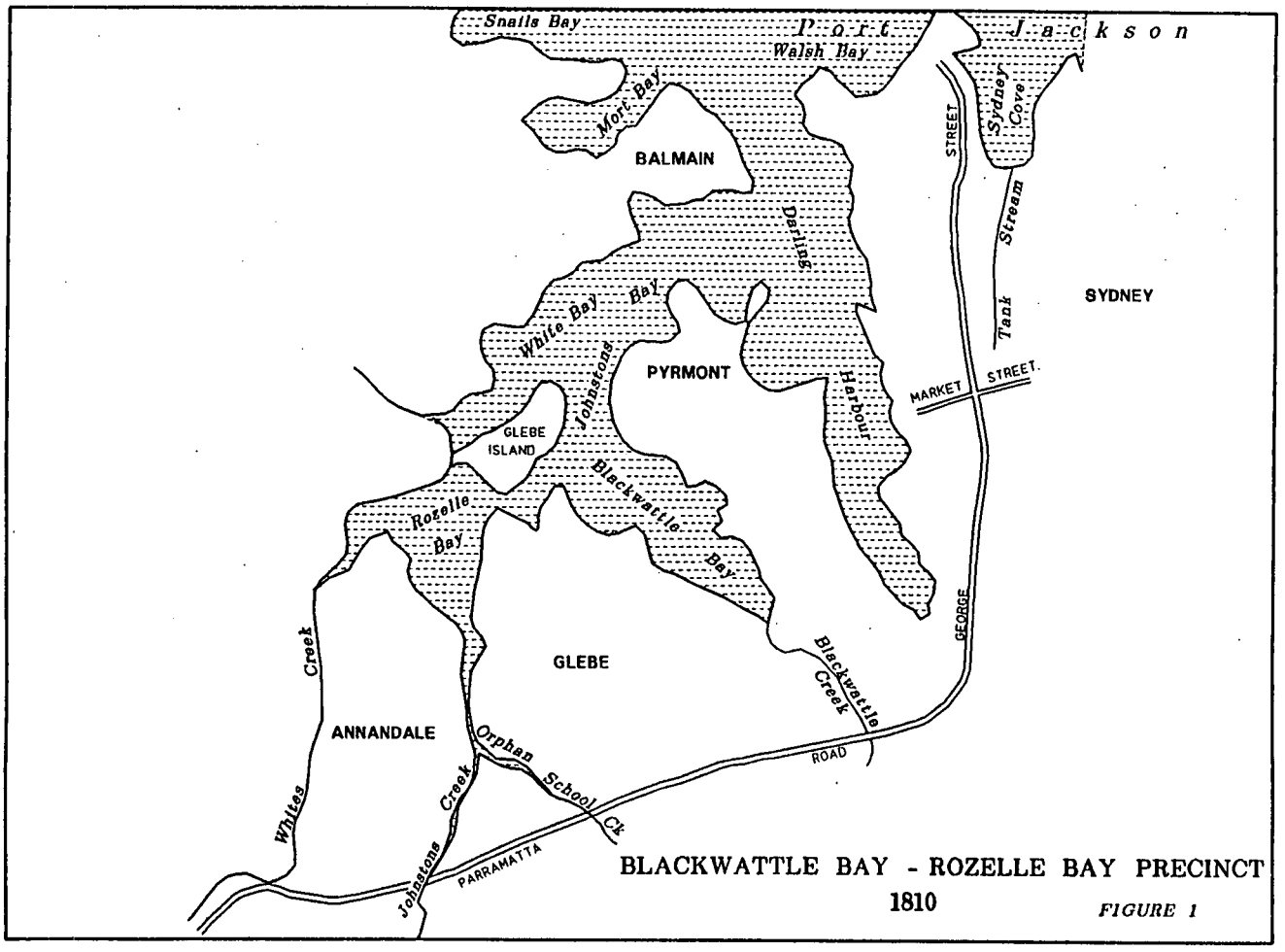
Edmund Blacket, the Colonial Architect, took the Montmartre abattoirs as a guide for the buildings he designed.(2) A problem to be overcome was that of getting live stock to the abattoirs, and transporting meat quickly to the city, for time was crucial in this pre-refrigeration era. A private company was commissioned in 1850 to provide the necessary roads and bridges for vehicles bringing produce from the western farms and fresh meat from the proposed abbatoirs to the city markets. The most direct route from the abattoirs' site required a crossing from Glebe Island to Glebe Point, through Glebe, Pyrmont and over Darling Harbour.

The only road to the city was Parramatta Road, and the new Pyrmont Bridge Company proposed a connection from the abattoirs to Parramatta Road and thence through Glebe and over toll bridges across Blackwattle Bay and Darling Harbour. This was a more profitable route which avoided the expenses of a Glebe bridge leading only to the abattoirs, but it ignored the requirement to connect the abattoirs and Market Street.(3)

The Company completed Pyrmont Bridge Road, with a causeway over Blackwattle Swamp and a swing span toll bridge over Darling Harbour in 1857, but failed to honour its agreement to provide access to Glebe Island, an obligation it dismissed as "that apparently endless question of the Abattoir road". When the abattoirs opened in 1860, the butchers leasing premises and the dealers buying from them, were provided with government-run steam punts, while the Government also undertook to build the belated bridge.(4)

E. O. Moriarty, the first Engineer-in-Chief for Harbours and Rivers in the newly established Department of Public Works, was directed to design a bridge from Glebe Island, not to Glebe Point, but across Johnston's Bay to Pyrmont. Construction began on 10 October 1860.(5)

The twenty-eight feet wide bridge, the abattoirs road and the approach to the bridge, cut into the rock of Glebe Island, were completed at the end of



BLACKWATTLE BAY - ROZELLE BAY PRECINCT
1810

FIGURE 1

1861. The bridge had a swing span at the Pyrmont shore, operated by a hand winch, which gave a thirty-four foot opening. Suburbs beyond Glebe Island now had direct access to the city, and Balmain, with few residents in 1850, had by 1864 become a busy industrial and residential area with a population of 3,500.(6)

4 Blackwattle Bay Swamp, Self-government, and Sewerage

As well as the closure of the Blackwattle Bay slaughter houses, improvements in dealing with sewage were a major issue in Sydney in the 1840s. A City Council was established in 1842, but was unable to install a sewerage system. Consequently, the Legislative Council appointed commissioners under whose administration the work was commenced.

When the Colony became self-governing in 1856, a Department of Public Works was established, and although water supply, drainage and sewerage works were regarded as "domestic" matters and thus the province of local government, the critical public health problem and the constant public attention it received, forced the colonial government to take a role in this work from the first.

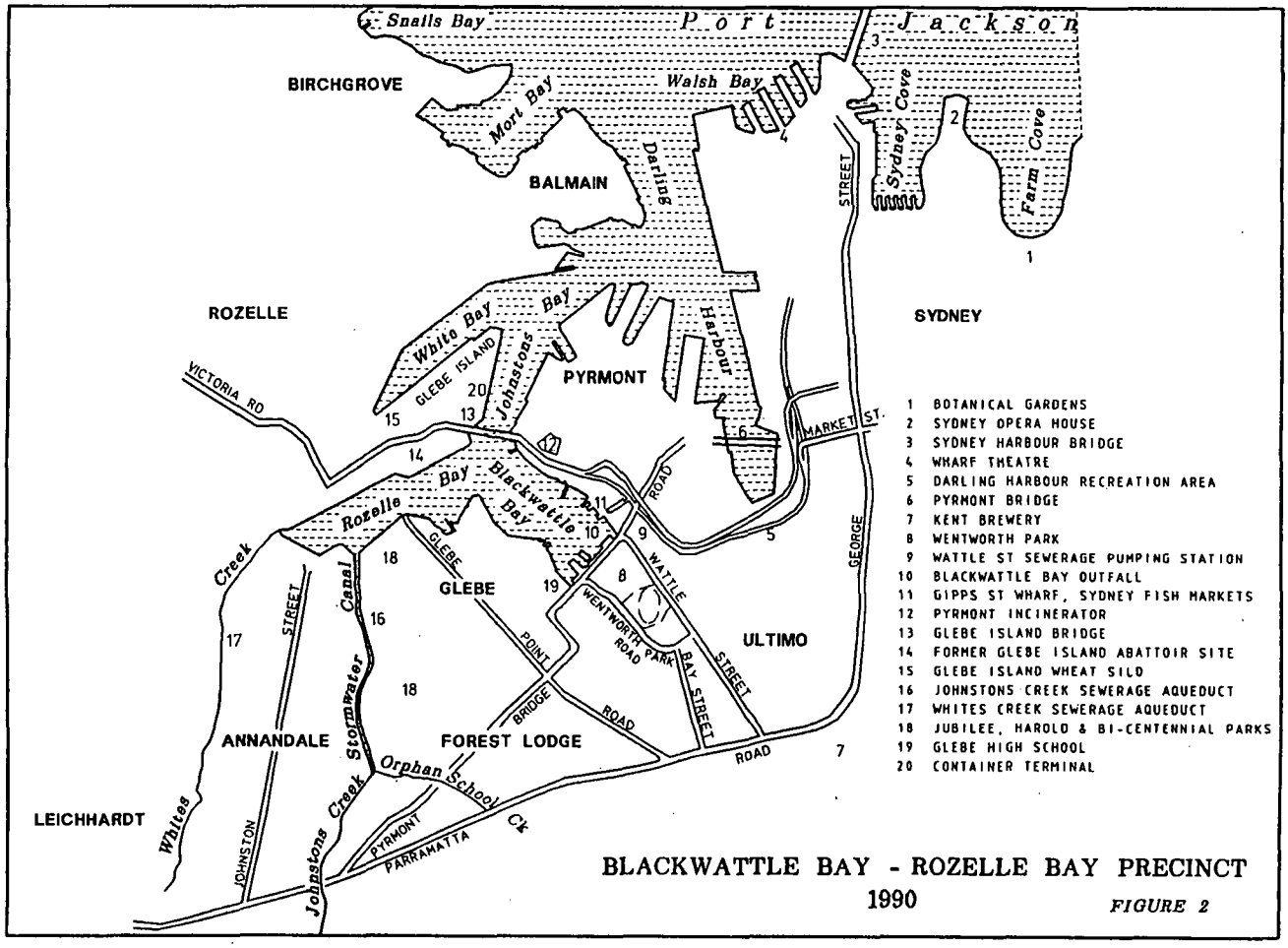
A work completed in 1857 was a six feet by four feet sewerage main along Wattle Street at the eastern edge of Blackwattle Swamp, from which sewage, storm-water, and other drainage was collected. The main ran three kilometres from the new railway terminus at Redfern and discharged into the south-eastern corner of Blackwattle Swamp behind the new causeway. Despite this and other improvements, much of the neighbourhood was not connected to the sewer, and industrial effluent remained a serious problem in the creek, which William Jevons described in 1858:

> "The foul mud deposited in the channel, giving off a fearful stench renders this place as unhealthy and disgusting to one and all the senses as can well be conceived."(7)

The causeway over Blackwattle Swamp accentuated the serious drainage and sanitation problems of the area. The outfall site silted up so that the sewer discharged onto a mudflat until it was extended under the causeway in 1869. The distillery, brewery, tannery, and boot factory remained and these, together with the Colonial Sugar Refinery's Chippendale factory, used Blackwattle Creek - referred to as "the sugar company's creek" - for effluent disposal.

With the slaughter houses and accompanying stock paddocks gone, more cramped houses accumulated on the slopes which drained into the swamp, and increased the silting up of that section of the bay cut off by the causeway. As the cesspits around the swamp increased, overflow was frequent. The smells permeated even the sewered houses in the more pleasant Glebe streets, while the mud of the swamp and the channel of the creek retained the nauseating detritus of all the industries along its course.

There was little popular understanding of the way in which gastro-intestinal disease spread, or of the different means of infection from smallpox, cholera, typhoid, dysentery, measles, scarlet fever and diphtheria - all of which appeared in serious outbreaks in the poorer inner city streets



BLACKWATTLE BAY - ROZELLE BAY PRECINCT
1990 *FIGURE 2*

from the 1860s. In France Louis Pasteur was then working on the theory of germ infection, but the conventional wisdom was that these "miasmatic fevers" were spread by "noxious effluvia" and that dampness and swamps were major sources of the evil-smelling miasmas or vapours. The evil smells were, nonetheless, a reliable sign of a critical sanitation problem. Glebe Council in 1865 declared the situation intolerable and urged the colonial government to reclaim Blackwattle Swamp for which 10,000 pounds was voted in 1869.

5 Reclamation of Blackwattle Swamp

The method of reclaiming the swamp preferred by Moriarty was to use silt dredged from the Harbour. Although an economical means of getting rid of dredged material and of obtaining suitable fill for large-scale reclamation, this was at the time a laborious process. It involved the ladder-bucket dredges discharging onto barges, which were towed to the reclamation areas, the material shovelled into barrows and wheeled to dumping sites!

Tenders were called twice during 1869, but none was accepted as the lowest was twice the estimate. Moriarty's attempts to get permission from the Pyrmont Bridge Company to alter the causeway to admit the punts were unsuccessful and under the 1855 Pyrmont Bridge Company Act, the Government had no power to require the Company to agree. The only option was for the Government to purchase the causeway and while negotiations continued, tenders were again called in 1870. One of the unsuccessful tenders was from a group of unemployed mechanics, labourers and others of the City of Sydney for undertaking the work "on the co-operative principle", with the Government supplying the necessary plant.

Although a contract was let at the end of 1870, it was not until 1873 that the Blackwattle Bay Land Reclamation Act passed through Parliament and the Public Works Department brought the Pyrmont Bridge road including the Blackwattle causeway. The original plans for the reclamation had included subdivision into residential lots, but the 1873 Act forbade building on the reclaimed area because of the inadequate drainage. The work was completed in 1877. In response to lobbying by local sporting enthusiasts, six and a quarter acres were set apart for a cricket ground in 1882, and areas were designated for other popular recreations such as quoits. The new parkland was gazetted Wentworth Park on 10 November 1885 after the native-born explorer and statesman William Charles Wentworth who had died in 1872.

The reclamation of Blackwattle Swamp, and dedication of the new park, changed the character of the area and land values increased, prompting a flurry of adjacent subdivision. Lots on the borders of the reclamation were sold and the firm of Hardie and Gorman laid out a subdivision on reclaimed land at the head of the former swamp in 1878, despite the ban on building on the site. Although the City Council refused to make roads there and the City Surveyor warned that the drainage problems would persist, houses were built and tenants of the area, known as Blackfriars Estate, endured the predicted dampness and flooding.(8)

Despite the reclamation and the completion in 1887 of a sandstone seas wall, the contents of the bay remained unsavoury, as the public wharf built in 1888 trapped sewage and the piles caged an accumulation of dead animals. Like the other harbour outfalls, thirty years after its construction, the Blackwattle Bay outfall caused siltation and regular dredging was required. The bay was no longer flushed with floodwaters coming down the creek, or by tides washing in and out of the swamp. Observing the silting up of the bay, merchants and shippers declared the reclamation a mistake.(9)

6 Legislation, Lobbying, and Public Health

The Sewage and Health Board, established in 1875, issued a series of reports on housing, sewerage, water supply, and problems caused by industrial effluent, particularly in the Blackwattle Bay area. Citing the evidence of critical sanitation problems in such places, the members of this Board, the City Council, and the press campaigned for a permanent Board of Public Health, but this was not established until 1896.

The harbour was still the city's sewer, and in 1878 the Department of Public Works completed the Glebe to Blackwattle sewer line, carrying sewage from the new water closets in the better houses of Glebe to the outfall into Blackwattle Bay.

The resiting of the abattoirs merely transferred the waste disposal problem from Blackwattle Swamp to Rozelle Bay and in 1880, the Cattanach Chemical Works Company was engaged to dredge and disinfect Rozelle Bay in an attempt to reduce the accumulation of abattoir waste. The work extended right across the bay to the public baths at Glebe Point, which had become unfit for use through pollution.

Only a generation after the opening of the new public abattoirs, the city had grown right around the site, and an Abattoirs Removal League was formed to pressure the Government once more to distance this essential nuisance from the sight, sound and smell of the citizens of the expanding city.(10)

7 Housing, Drainage and a New Sewerage System

While Blackwattle Bay was given its finished form by 1888, tidal swamps fringed with mangroves still extended from Rozelle Bay up along Johnston's Creek and Orphan School Creek. Houses like Sir Henry Parkes' Johnston Street residence overlooked the bay from the steep cliffs on the Annandale side. The hilltop sites were pleasant and healthy, while the people living down near the creeks suffered a high rate of sickness. Orphan School Creek which ran from the swampy area in the
northern part of the University of Sydney grounds had by 1887 become "a sewer", to which was attributed the disease, discomfort, and death of the poor who rented houses in the area.

The reclamation of the swamps behind Rozelle Bay began in 1893 when a ballast dyke was built from the mouth of White's Creek to Glebe Point. At White's Creek in Rozelle Bay, the new Von Schmidt dredge the "Groper" was put to work which cut the clay up with rotating knives below a vertical suction pipe and pumped it half a mile, to be discharged behind the stone dyke. By 1897 levelling and grassing was proceeding as the filling was completed, and the White's Creek stormwater canal had been finished. In 1899 a roadway was built from Glebe Point to Annandale Wharf at the foot of Johnston Street, and the reclamation was complete in 1902. Jubilee Park

and Harold Park were established on the reclaimed area and in 1988, land along the waterfront previously used for timber storage, was returned to the community and became Rozelle Bay Bicentennial Park.

In 1895 tenders were called for sewering of the Forest Lodge - Balmain streets. The northern main sewer was extended to the area by two arched aqueducts, then the biggest structures ever built using the Monier concrete system. W. J. Baltzer, who pioneered in Australia the reinforcing of concrete structures with steel or iron rods, was an engineering draftsman with the Department of Public Works, before joining the firm of Carter Gummow, contractors for the new aqueducts. These great arches, completed in 1897, carry the sewerage main across Johnston's and White's creeks and over the reclaimed area behind Rozelle Bay.(12)

As houses were built on the Blackfriars Estate and the number of people living in the cramped streets between Wentworth Park and Parramatta Road, and around the Park, increased, the central stormwater channel and the Wattle Street sewer became inadequate. In 1898 Joseph Davis, PWD Engineer for Sewerage Construction designed the Bay Street overflow, a new drainage line running into Blackwattle Bay with the section of the pipe through Wentworth Park covered with girders and jack arches.

The mains leading to harbour sewage outfalls were gradually brought into the new Bondi ocean outfall system in the 1890s. As part of this work, a pumping station was built at the corner of Wattle Street and Pyrmont Bridge Road to raise sewage from the low level areas previously served by the Blackwattle Bay outfall.(13)

8 Replacing the Glebe Island Bridge

Traffic to Balmain and beyond increased, as did the size of loads, such that by 1882, Glebe Island Bridge was taking five times more than the loading for which it had been designed. By this time both Pyrmont and Glebe Island bridges were reaching the end of the average expected life for timber bridges, which was then twenty-five years.(14)

Despite constant repairs both bridges suffered substantial damage from infestation. As E. M. de Burgh, the new Chief Engineer for Bridges put it, they were eaten by white ant from the top and cobra (teredo) from the botton. De Burgh described Glebe Island Bridge as like a table on very long legs. To save costs when the bridge was built, the walings which acted as diagonal struts, had not been coppered below the waterline, and had rotted, so that as traffic crossed the bridge, the "legs" swung, loosening all the joints. In 1894, Glebe Island bridge was assessed as in danger of collapse if even a small vessel were to collide with one of the defective piers.(15)

Given the task of replacing the bridges, in 1898 PWD engineer Percy Allan designed a stone causeway with a steel swing-span in the centre to cross the 2,300-foot strait between Glebe Island and Pyrmont. This bridge was completed in 1903.

The new Pyrmont Bridge had been opened in 1902 and it and the Glebe Island Bridge were the first electrically-operated opening bridges in the world, and their construction and performance were monitored closely.(16)

9 Removing the Abattoir

The Abattoir was now surrounded by industrial and domestic activity. By 1892, Balmain had become Sydney's most heavily populated suburb. Blackwattle and Rozelle Bays had become the main depot for the thriving coastal timber trade with fifteen timber yards around the water front, boatbuilding well established and wharves and timber mills in constant use. Timber merchants at Pyrmont and Blackwattle Bay, and the complaints of seamen who objected to berthing because of the overwhelming stench held the threat of further industrial action in this period following the 1890 maritime strike.(17)

Things were better around in Johnston's Bay, where coastal ships unloaded sugarcane at the Colonial Sugar Refinery's jetties, and ocean going ships loaded the refined sugar for export. Waterfront facilities completed by the PWD in 1894 included a bridge at the end of Rozelle Bay over Orphan School Creek, a second public wharf in Blackwattle Bay, and another at White Bay.(18)

Though the sewage and drainage systems had improved, in 1903 complaints over the condition and odour of the bays were also regularly made in meetings of the Glebe and Balmain councils and in the press. The accumulation of silt uncovered each low tide gave off a strong and offensive odour, but because of retrenchments, the dredge "Charon", which the Sydney Harbour Trust had put to work, was only able to work one shift a day.

Despite attempts to reduce the nuisance caused by the Glebe Island abattoirs - now circled by the suburbs of Glebe, Annandale, "Lilliebridge", and Balmain - the same arguments of fifty years before, which had resulted in the establishment of the abattoirs, prompted an inquiry in 1903. This recommended relocation and reorganisation of the abattoirs, the evidence given at the Inquiry disclosing "a disgusting state of affairs".

In 1906 the State Government acquired land at Homebush, ten miles west of Sydney and here the Department of Public Works built a vast new State Abattoirs complex, which opened in 1917.(19)

10 Other Garbage

Disposal of garbage was also a problem and in 1899 the Sydney City Council reclaimed an area on the Pyrmont side of Blackwattle Bay and built a wharf at the foot of Gipps Street (the site of the present Sydney Fish Markets). This was one of the Council's garbage disposal wharves, where for decades the city's refuse was loaded onto punts which when full, were towed to sea and the contents dumped. This method of disposal continued during the 1920s, with the punts left for long periods at the wharves causing considerable nuisance and complaints such as those of workers in the timber yards.(20)

Finally, in 1930 the Sydney City Council contracted the Reverberatory Incinerator and Engineering Company (RIEC) to install the company's garbage destructors, which were designed by the architectural firm of Walter Burley Griffin and Marion Mahoney Griffin. Whilst a number of these plants were built, such as at Willoughby in Sydney (now a fashionable restaurant), the Pyrmont incinerator was the most significant.

It was designed as a monument to the total destruction of matter - Marion Mahoney Griffin later recalled that the design and decoration of the Pyrmont Incinerator, built in 1934 (the year of the splitting of the atom) recorded the pre-eminence of science and technology. The use of technology to detroy waste, so constant and unavoidable a nuisance, seemed a benign application of science, whether in the process used by the RIEC or in the potential of atomic fission. The hieroglyphic-like decoration around the building celebrated this potential in depicting the states from atomic fission - "warmth, light, sound and magnetism".(12)

11 Impact on the Developing City

The dramatic change in the shape of Glebe Island began with construction of the abattoirs in the 1850s, when roads were cut out of the rock. It continued with construction of wharves, wheat silos and a container terminal. Long since demolished, the abattoirs had a permanent affect, not only on the shape of Glebe Island, but on the shape of Sydney. In a sense the absent abattoirs, perched on now imaginary cliffs, dominate the history of this area. Because of the abattoirs the first Glebe Island Bridge was built, and because of the communication with the city provided by that bridge, adjacent suburbs grew. In turn the Iron Cove and Gladesville bridges and Victoria Road were built and opened up to development, the norther banks of the Parramatta River. The second Glebe Island Bridge had to cater for the increased traffic brought in from the suburbs along Victoria Road. And all this stemmed from the decision 150 years ago to clean up Blackwattle Bay by building a public abattoir on isolated Glebe Island.

The creeks and bays which were dumps for the refuse of factories, slaughter yards and homes, in stages determined by the sanitary culture of the period, became engineered sewers, drains, and reclamation sites. The topography of Wentworth Park, Rozelle Bay Bicentennial Park and Jubilee and Harold Parks will always indicate their origins as reclaimed swamps and each also marks its moment in engineering history by the method of reclamation. Both are crossed by goods railway viaducts, which could also be said to owe their place to the reclaimed ground.

The public works history of Blackwattle and Rozelle Bays reveals an intriguing but under-rated factor in the growth of cities - the influence of waste - and suggests that the interpretation of engineering heritage should provide for a focus on the concealed but fascinating underside of a city, where public works serve the most private purposes. Both domestic waste and the waste products of industries, accumulate to create a "sewageshed", a critical point where waste is acknowledged as a public problem. The subsequent engineering response can have a complex and permanent effect on the shape of a city. In this precinct, solutions were never the result of prior planning - it would seem the levels of waste always came as a surprise.

The "sewageshed" model recognises critical periods for examining population growth and quantities and composition of domestic and industrial effluent. The model also focuses on contemporary local and overseas disposal technologies; the age and adequacy of existing sewerage, drainage, and garbage works; economic factors, policy responses, and on public and personal hygiene - those practices, and standards, at work and at home which contribute to the sanitary culture of a society and thus to development of cities.

12 Conclusion

Current rapid change threatens may of the relics identified in this paper and raises urgent questions about conservation priorities and the recognition of the heritage value of industrial sites.

The 1896 Annandale sewerage aqueducts, the 1903 Glebe Island Bridge, and the 1934 Pyrmont Incinerator are all recognised as significant items of engineering heritage, having been noted by the Australian Heritage Commission or listed by the National Trust. Nevertheless, the second Glebe Island Bridge is to be demolished to make way for the third, and the Pyrmont Incinerator is in ruins.

However, some recycling is in progress. Whilst the Pyrmont Bridge is no longer used by road traffic, it now carries pedestrians and the monorail to Darling Harbour. This area itself has undergone change in use and adaptation. It has been an industrial area, a port, a railway goods yard (after reclamation) and is now an entertainment and recreation area.

The purpose of this paper is not a call to arms to defend these sites from re-development, but to argue that recording sites should be a precondition if their destruction is necessary. Without the physical reminder of heritage sites, a secondary record is essential, not only to an adequate assessment of engineering practice and performance, but also to understanding our past.

(1) General Order 15 September 1810, **Historical Records of New South Wales**, vol. 7, pp.410 - 411; P.R. Stephensen (1985) **The history and description of Sydney Harbour**, Sydney, Rigby p.228; Freda MacDonnell (1975) **The Glebe: portraits and places**, Sydney, Ure Smith pp.11, 76; P.C. Williams, Reminiscences of old Sydney **Descent**, vol.16, no.4., p.171.

(2) Report from the Select Committee on slaughter houses **New South Wales Legislative Council Votes & Proceedings 1848**; Colonial Architect to Colonial Secretary, 18 September 1850, AONSW 2/893.

(3) Colonial Architect's memorandum 10 October 1850, Sketch Glebe Island 1850, Walter Beames to Secretary for Lands and Public Works 19 March 1858, AONSW 2/893; **Government Gazette** March 1854, 7 September 1855; MacDonnell op.cit., p.66.

(4) Walter Beames to Secretary for Lands and Public Works 19 March 1858, AONSW 2/893.

(5) Plan ... showing the bridges and roads to be constructed by the Pyrmont Bridge Company, AONSW 2/1896; **Sydney Mail** 13 October 1860.

(6) Statistical Register 1861, 1871-1874; Tyler evidence Public Works Committee Report 1894 **New South Wales Legislative Assembly Votes & Proceedings Vol 5 1894-1895; Sydney Mail** 13 October 1860; p.8; A. Sierp (1974); **A colonial life in New South Wales** Adelaide,

Rigby, p.52; A.J. Mayne (1982) **Fever, squalor, and vice; Sanitation and social policy in Victorian Sydney**, University of Queensland Press.

(7) F.J.J. Henry (1939) **The water supply and sewerage of Sydney**, Sydney: Halstead Press, p.157; Jevons quoted in MacDonnell op.cit., p.12.

(8) Proposed reclamation Blackwattle Swamp 1873-1874, AONSW plan 2026; Shirley Fitzgerald 1987 **Rising Damp: Sydney 1870-1890**, Melbourne, Oxford University Press, pp.67-8; MacDonnell op.cit., p.114; **The Empire** 21 June 1869, p.3.

(9) PWDAR 1894 p.2; Hickson evidence, Francis Guy evidence, Edward Knox evidence Public Works Committee Report 1894.

(10) Map of Glebe Island 1899, AONSW map 646; MacDonnell op.cit., p.116.

(11) A.B. Portus (1896) Centrifugal pump dredging in New South Wales **Journal and Proceedings of the Royal Society of New South Wales** Vol 30 pp. cx-cxxx; PWDAR 1893-1894, pp.40, 44; 1895-1896 p.28; 1896-1897 pp.38-39, 1899-1900 p.41; 1905-1906 p.59.

(12) D.J. Fraser (1985) Early reinforced concrete in New South Wales (1895-1915) **Journal of the Institution of Engineers Australia** vol GE9 No.2 pp.82-91.

(13) PWDAR 1897-1898 p.122; Henry op.cit, pp.163, 168.

(14) Hickson evidence, Public Works Committee Report 1894.

(15) PWDAR 1889, 1890, 1891, 1893-1894, 1894-1895 p.45; Tyler evidence, de Burgh evidence, Public Works Committee Report 1894.

(16) PWDAR 1889-1900 pp.79, 115, 1903-1904.

(17) Francis Guy evidence, Public Works Committee Report 1894; Mayne op.cit., p.220.

(18) **Glebe Gazette 1903**; PWDAR 1893-1894 p.37; 1896-1897 p.54; AONSW map 630.

(19) Stephensen op.cit., p.222.

(20) MacDonnell op.cit., pp.117-118.

(21) Michael Matthews (1982) **Pyrmont and Ultimo: a history**, Ultimo, Pyrmont, Ultimo History Project, p.60; Michael Markham (1988) The Griffin Incinerators **Transition** Autumn pp.31-43.