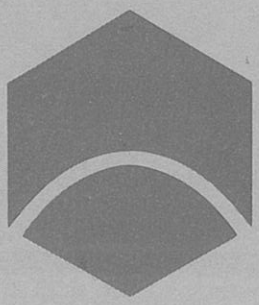
NEWCASTLE HARBOUR
A NATIONAL ENGINEERING LANDMARK

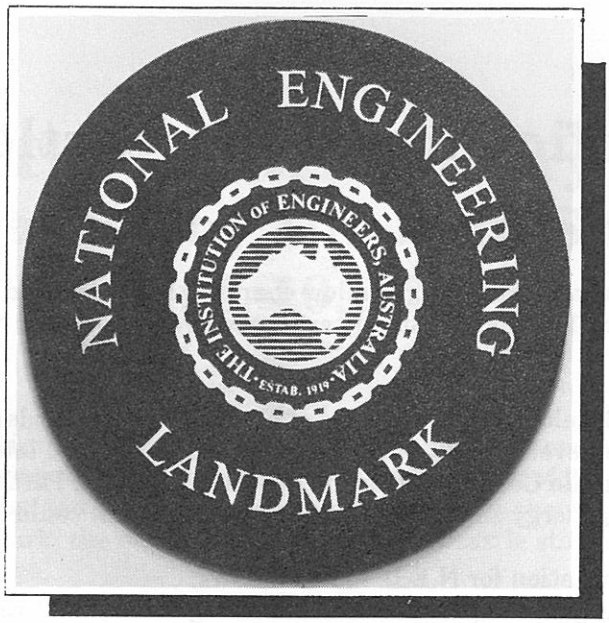


The Institution of Engineers, Australia

THE UNVEILING OF THE
NATIONAL ENGINEERING LANDMARK PLAQUE

by
His Excellency
Mr. Bill Hayden
Governor General of Australia

on
Tuesday, July 18, 1989



The Institution of Engineers, Australia, inaugurated in 1983 the "Australian Engineering Plaquing Program to bring deserved public recognition to historic engineering works and sites. This program was developed by the National Heritage Panel of the Institution on the basis of similar activities which have been operated successfully for many years by major engineering organisations, particularly in the USA.

There are two types of plaque. Many buildings, sites, exhibits and other engineering works are of historical significance and may be identified by an **Historic Engineering Marker**. Eleven of these ranging from the Stump Jump Plough to the Story Bridge (in Brisbane) had been recognised by the end of 1988.

For works of particularly outstanding engineering importance, the Institution reserves its ultimate accolade: **The National Engineering Landmark (N.E.L.)**.

N.E.L.'s are few in number and are only awarded after the most careful scrutiny. Nominations must be accompanied by thoroughly researched supporting documentation.

Newcastle Harbour joins the four only so far awarded:

Lennox's Landsdown Bridge (Sydney)
Coolgardie Goldfields Water Supply (WA)
Sydney Harbour Bridge (Sydney)
Busbys Bore – Sydney's first water supply (Sydney)

The Significance of Newcastle Harbour

From a natural estuary of winding shifting shallow channels between sand banks and mud flats and a hazardous entrance, about 170 years of steady engineering development have produced one of Australia's greatest ports.

It was only the continued development of the Port of Newcastle to a standard acceptable to shipping of the time which made the development of the Newcastle coal field and later Newcastle steel works possible. Shipping of Newcastle Coal to Melbourne, Adelaide, Hobart, Perth, etc. gave these cities up until well into this century, energy supplies at much lower cost than could be obtained elsewhere.

The main points of the nomination for N.E.L. are as follows:
* This is an example of steady development over such a long term that it rarely receives recognition.

* The Macquarie breakwater, commenced in 1818 was the first ocean breakwater built in Australia. It is one of the few major convict built works and is still in use.

* The further seaward breakwaters proposed by E.O. Moriarty in the 1850's for urgent construction involved constructional problems but were continually developed until well into this century. They achieved their purpose.

* The careful design of river training walls and reclamation of land behind, as laid out by Moriarty in the 1850's and continued upstream until the 1960's, shaped the harbour as it is today and facilitated tidal scour of channels.

* In particular, the construction of the "Dyke", (1860–1885) a training wall almost bisecting the estuary, represented a control concept well ahead of its time and an amazingly long sighted vision of the growth of the Port.

* Heavy siltation from the sporadic large floods of the Hunter River caused enormous emergency dredging problems and promoted effective research into silt deposition.

* Breaking of the rock bar at harbour mouth, with ocean exposure, from 8.4m to 11.6m and then 15.2m was a world class engineering task.

The key plan which made continued development possible was produced by Edward Orpen Moriarty C.E. born 1824; Engineer for Newcastle Harbour Works 1855–1858; Engineering-in-Chief, Harbours and Rivers Branch of P.W.D. 1858–1888.

Work was entirely under control of Public Works Department until 1958. It was then phased to complete control by Maritime Services Board in 1971.

The engineering history is briefly outlined in the following pages. For a fuller account see "Shaping the Hunter" published by Newcastle Division of the Institution and "Bar Dangerous" by Terry Callen (Newcastle Maritime Museum).

The Hunter Estuary as Discovered by Dr. John Shortland (Sept. 10, 1797)

The estuary, considerably wider than the harbour is now, was a broad expanse of sand banks and mud flats intersected by moving winding channels with a water depth of 2.5 to 4 metres. Signal Hill (now Fort Scratchley) extended towards the river, with steep cliffs to the river side. Most of the area now forming the Foreshore Park, the old railway yards and Newcastle station was a large shallow lagoon.

An entrance between Signal Hill and Nobbys was beset by shallow reefs but was commonly used for the first few years of settlement. Another channel to the North of Nobbys lay between reefs extending North Eastward and a large submerged sandbank: "The Oyster Bank" which caused the wreck of many ships.

"During heavy gales, waves rolled through the South Channel completely into the harbour, rendering it unsafe for vessels to lie in the more open and exposed parts."

John Henderson, of the Australian Agricultural Company, after inspecting the area in the 1820's, concluded "that the estuary of the Hunter River would not be a suitable harbour for vessels engaged in the export trade".

For the Northern channel, since the 1830's the only harbour entrance, Moriarty recorded in 1861, "The other obstructions to the entrance of the port which render it in rough weather almost inaccessible to sailing vessels, and at all times both dangerous and difficult to leave or enter except with a fair wind and favouring tide are firstly the Bar and, secondly the Oyster Bank, an extensive and shallow sand bank, having only five feet of water on it, which stretches into the very mouth of the harbour. There is a considerable depth of water on the Bar, fully twenty three feet, so that its ill effects are only felt by the rollers or high-rolling waves it creates, and which render vessels at time almost unmanageable when crossing it in rough weather, the peril being increased by its close proximity to the Oyster Bank".

The lure of coal as a potential export (seams were visible at the waterline at Nobbys and Signal Hill and along the coastal cliffs) and the desire to move convicts away from Sydney led to the formation of a convict settlement, despite the inadequacies of the harbour.

The vast rainforest, with much cedar up the river and the shell deposits of Stockton, proved initially even more attractive than coal. By the late 1820's settlers from Maitland to the Upper Hunter needed ship access for their supplies and produce to their wharf at Morpeth.

The trade was there. The problems had to be faced and a port developed.

The Development of the Port

"MACQUARIE'S PIER"

Governor Lachlan Macquarie in 1818 laid the foundation stone of the first harbour works – an ocean breakwater across the south channel to link Beacon Hill to Nobbys Island. This was a sound decision which made future development possible. The orders that that this was to be built by convict labour with rock quarried from the faces of Beacon Hill. No heavy equipment was provided. Work was slow and frequently washed away. When the main convict settlement was moved to Port Macquarie in 1822 only a third of the gap had been filled. After strenuous protests from the region, work was resumed in 1832. Colonel J. Barney, R.E., the Colonial Engineer, advised more attention to the quality and size of rock. A junction was made in 1846 and the objectives were achieved – a reasonably stable channel north of Nobbys and safer conditions in the harbour.

This was Australia's first ocean breakwater and one of the largest convict built works. Much was still to be learned. Washways were frequent. It was not until large strong sandstone blocks of ten tonnes or more were brought by rail from a quarry at Waratah, that this breakwater was finally stabilised in 1872 and sand built up to form Nobbys beach.

GROWING TO A CRISIS IN THE 1850'S

The trade from the Hunter Region grew rapidly from the opening up of the settlement in 1823. A regular steam ship service operated from Morpeth to Sydney. From 1830 coal production increased from the A.A. Company which built "staithes" ("shoots") – elevated rail tracks from which coal wagons were emptied directly into ships – at the edge of the coal channel from the line of Brown St. westwards. The Newcastle Coal and Copper Company built in the same area in the 1850's, and others were opening up. The Great Northern Railway was completed from Newcastle to Maitland.

By the mid 1850's port problems had reached crisis level. Wrecks continued on the oyster bank, ships to Morpeth were frequently stranded on sandbanks between Newcastle and Tomago, the coal channel occasionally shoaled up so that coal ships had to be loaded by lighter. Wharfage in Newcastle was inadequate – Queens Wharf had just been commenced, extending eastward towards Beacon Hill from the Watt St. pier. Political pressure was so strong that the government appointed a dynamic young engineer – Edward Orpen Moriarty – as "Superintendent of Improvements to the Navigation of the Hunter River" in November 1855.

EDWARD ORPEN MORIARTY AND THE MORIARTY PLAN

Born in Ireland in 1824, Moriarty graduated BA and MA from Trinity College, Dublin and obtained his engineering training by pupillage on a range of works from breakwater construction, railway survey and construction and shipbuilding.

In Newcastle he rapidly tackled the upriver problems by building a series of short retaining walls up to low tide level to direct the tidal flow of the river to a single straight channel. These walls, built at low cost from ships ballast, were completely successful.

He made detailed studies of river and wave flow patterns, of the nature of the material in the river shoals and of the circumstances of wrecks and other mishaps at the harbour mouth. From these studies he produced, in stages, the three aspects of the development plan for the port of Newcastle.

1. To build a Northern Breakwater, North East from inside Pirate Point (a sandy spit extending beyond the tip of present Stockton) and to extend the Southern Breakwater beyond Nobbys.

2. To direct tidal flow along the developing city wharf line by building stone walls to form a "smooth and even curve".

3. To almost bisect the estuary with a long stone wall, with a tidal basin behind it, from Port Waratah almost to the coal staithes – "The Dyke".

This plan determined the present shape of the harbour and enabled development far beyond the expectations of the author.

The progress will be outlined in the following paragraphs.

Moriarty was promoted in October, 1858 to Chief Engineer of the Harbours and Rivers Branch of the new Department of Public Works. Before he left Newcastle he had ordered and commissioned a large bucket-ladder dredge for the Hunter, and placed orders for steam cranes for Queens Wharf. (The remains of the foundations of these may be seen at low water level between No. 2 Tug Wharf and the Pilot Station.)

THE BREAKWATERS

The Northern Breakwater presented continuing problems as the foundation was a deep sand bed with a continuous drift of sand from Stockton Beach to the harbour entrance. An initial ballast wall was rapidly completed as far as the ocean beach, but government funds dried up and it was not until 1884 that Moriarty's original plan to use large sandstone blocks from Waratah was implemented, finishing the original plan in 1886.

By 1895, sand from Stockton beach had built up to the end of the breakwater and sand was moving round into the harbour. Engineer C.W. Darley secured approval for a new breakwater 3000ft long starting north of the original and extending far beyond. Work was interrupted for several years through lack of funding. Another dynamic engineer, Percy Allen, with unremitting attention to selection and placing of quarry rock had this completed and fully stabilised by the time he left Newcastle in 1912. The Oyster Bank is no longer a menace to mariners.

This breakwater was built across several old wrecks. The shoreward end of the original remains as the river side of a wave trap – to absorb the energy of incoming waves before they enter the harbour.

The Southern Breakwater suffered similar funding delays, with resultant washaway at the unfinished end. It was not completed until well into this century and still requires maintenance by the dumping of sixty ton concrete blocks.

Horseshoe Beach is the result of a final river training wall built in about 1876 from the end of Queens Wharf to Lighthouse Reef. It also serves as a wave trap. The sand built up behind it has become Camp Shortland and Horseshoe Beach.

THE RIVER TRAINING WALLS

These were built of rock ballast from incoming sailing ships over some fifty years from the 1850's. Moriarty was meticulous in the execution of this plan, dredging out earlier walls where they interfered with the designed smooth line of wall. This even shoreline was established along the city shore and around the tip of Stockton by 1870 and beneficial results were noted.

From the end of the sailing ship era early this century, rockwalling with quarried stone was continued up stream beyond the original plan. The original ballast walls have been maintained by dumping quarried stone.

THE DYKE

This daring project is a training wall over a kilometre long at the river edge of a mudbank extending out from Bullock Island (or Chapman Island, later Onybegamba and now Carrington). The objectives were to improve the training of river flow and to provide wharf space for further development. The training proposal was well ahead of its time, it was not until some fifteen years later that investigations in Europe showed that dredging alone was inadequate for control of tidally moved shoals in an estuary of this type, that such massive training walls were essential.

As Dr. Damaris Bairstow, an industrial archaeologist, wrote recently, "The whole concept was grandiose, possibly the biggest harbour construction proposal in the Southern Hemisphere". Certainly at a time when the whole port trade was handled by the 500m of Queens Wharf and a few coal staithes, it was a visionary proposal to look at well over 2000 metres of extra wharf space along the city side and the Dyke. By the 1920's more than this was in use.

Dumping the ballast "along a line of poles" to form the Dyke began in 1862. Developing as ballast was available, the work was complete by 1874. The Department of Railways procured the most modern hydraulic cranes available; built a hydraulic power house, a rail link from Hamilton and tracks to service the cranes. By 1878 almost all coal loading had been transferred to the Dyke, making the city a much cleaner and quieter place.

The Basin as envisaged behind the Eastern end of the Dyke was dredged out and provided with wharves and coal loading cranes between 1910 and 1920.

"By the turn of the century the world's windjammer fleet was crowding into Newcastle for coal. Newcastle ranked as the world's seventh port. Often there were more than 100 vessels".

DEVELOPMENT FROM 1915

The establishment of The Broken Hill Proprietary steelworks in 1915 completely changed the industrial pattern of Newcastle. The existence of a working harbour was a significant factor in the selection of this site (as instanced by BHP's requirement that a navigable depth of 25 feet should be maintained). This required continuous dredging at nearly 2 million tons of silt per annum. A dredging fleet was built up with three ladder dredges, suction dredges, a grab bucket dredge and attendant barges, tugs and launches. Despite this, contractors had to be called in to handle the three and a half million tons per annum for removal after the 1949 and 1955 floods.

Wheat silos were built at the S.W. corner of the basin. A further basin was dredged at the mouth of Throsby Creek to provide heavy duty wharfage and accommodate a floating dock. Land was reclaimed at Carrington and Stockton and upstream of the steelworks by pumping silt ashore. The great project was the reclamation of the series of swampy upstream islands to produce about 2500 hectares of industrial land between 1951 and 1964. This is now the industrial area, "Kooragang Island".

Before reclamation was completed, the ecological importance of mangrove swamps gained recognition. Reclamation was halted on the main river side north of Stockton bridge. These wetlands are maintained as such.

Intensive research into siltation demonstrated the importance of separating shallow areas and tidal flats from the main stream. The building of rockwalls for this purpose continued.

From 1960, the use of cranes to dump 10 ton hoppers of coal into ship holds was abandoned. Travelling belt conveyor loaders were built in 1967 in the basin at 1000 tons/hr., in 1977 in the main channel for 4000 tons/hr., and in 1983 on Kooragang Island for 10000 tons/hr.

DEEPENING THE HARBOUR

By 1950, the twenty five foot depth specified by BHP had been increased to over 27ft. (8.4m) but the rapid increase in ship sizes was making this inadequate, particularly for the coal trade. The problem was the rock bar; a wide bar of hard rock across the entrance in line with and beyond Nobbys and a similar smaller bar near the tip of the Dyke. Chipping away with a rock-breaker (a massive steel bar with a pointed tip dropped from a barge mounted tower) had only achieved about half a metre overall in forty years of random effort. In 1950, intensive work was proposed to reach 10.5 metres; by 1961 the target was 11.6m and Dillinghams, an internationally experienced contractor, was engaged to break the bar by drilling and blasting. After many difficulties with hard rock and the ocean exposure, the depth was achieved by 1964. Within ten years it was clear that much greater depth was required and in 1977 a contract was let to Westham Dredging Ltd. for deepening to 15.2m. This rock removal programme was by far the largest of its type in Australia and one for which there was little precedent anywhere in the world. Special drill rigs were designed and built in Newcastle to support the drilling platform on spuds jacked down to the channel floor. A buoy to measure wave height was designed by M.S.B. to give warning of rising seas. The task was completed to schedule in 1983. Since then the port regularly loads bulk carriers with over 100,000 tons of coal.

Engineering planning and vision and continuous work developed this impossible estuary to respond to the increasing needs of shipping to now become one of Australia's great ports. Without this, Newcastle would never have grown; there would be no steel industry here, nor would the coal industry of the region have developed to the extent that it has.

Notable Engineers in Development of the Port of Newcastle

Large engineering projects are a team enterprise. It is difficult to assess to whom more or less credit is due. The following list of men who have major inputs to Port Development has been made up from records of the P.W.D. and the M.S.B. It should indicate the continuity of professional engineering for the harbour. Apologies are offered for any inadvertent omissions.

Public Works Department

Col. George Barney	1836
Capt. Merion Moriarty	1834
Wolstan Ellis	1854
Edward Orpen Moriarty	1855–1858
William Anderson	1858–1872
Cecil W. Darley	1867–1901
Thomas W. Keele	1874–1875
R.R.P. Hickson	1881–1888
Percy Allen	1908–1912
E.O.K. Green	1946–1957
A.R. Ford	1950–1954
W. Dumphy	1951–1973
A. Brazier	1969–1975
W.J. Kerle	1970–1975
V.C. Lindsay	1960–1983

Maritime Services Board

J. Wallace	1961–1983
G.H. Hore	1961–1965
G. Turner	1976–1979
B. Williams	1976–1979
J. Layzell	1979–1984
C. Jenkins	1972–1982

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Mr. E. Coulin
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Mr. T. Callen

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Newcastle Harbour

The port of Newcastle has been developed from a shallow estuary into one of Australia's largest deep water ports by more than 170 years of continual engineering works.

Based on E.O. Moriarty's plan of the 1850's, these have involved ocean breakwaters, training walls, dredging and undersea blasting. The port has been the keystone to the development of Newcastle and the Hunter region.

Dedicated by:

The Institution of Engineers, Australia

The Public Works Department, NSW

MSB Hunter Ports Authority

1989

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